The relationship between parents addicted to mobile phone and adolescent addicted to the Internet

Ying ZHOUa, Xiao ZHANGa, Jyh-Chong LIANGb, Chin-Chung TSAIc

a School Educational Technology, Beijing Normal University, China
b Graduate Institute of Applied Science and Technology, National Taiwan University of Science and Technology, Taiwan
c Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
yzh@bnu.edu.cn

Abstract: Previous studies had revealed that the mobile phone addiction existed among adolescents. However, in China, along with the popular of smart phone, the situation of addicted to mobile phone changed and emerged some new features. Meanwhile, the influence between parents addicted to mobile phone and children addicted to the Internet has been realized gradually. The study evaluated the relation of both of them based on the factor analysis. The participants comprised one of parents of 311 middle school students in Beijing. The results revealed that they had significant positive correlation (r=0.32, p<0.001), and also Internet addiction of children was related to the parents’ activities that parents participated by mobile phone, like Game & Video and Job & study.

Keywords: mobile phone addiction, Internet addiction, exploratory factor analysis, parents

1. Introduction

The popularity of mobile phone remains higher and higher, especially after emergence of smart phone. However, research has showed adolescents and adults are possibly addicted to the mobile phone (Lin 2010). In recent years, many scholars began to focus on mobile phone addiction.

A scale has developed to evaluate the mobile phone addiction for Korean adolescents. 20 items were divided into three factors: Factor 1 (withdrawal/tolerance), Factor 2 (life dysfunction) and Factor 3 (compulsion/persistence) explaining 55.45% of total variance. An item, for example, ‘When I can’t use a mobile phone, I am exasperated’, belongs to Factor 1 (Koo 2009). A study on mobile phone addiction has done aiming at 269 Taiwanese female university students. The study presented two scales: one is the Mobile Phone Usage Behavior Scale (MPUB) surveyed the frequency of mobile phone use (‘How many messages do you send per day?’); the other is Mobile Phone Addiction Scale (MPA) by revising Young (1998) Internet Addiction Scale (‘I neglect school assignment to spend more time using mobile phone’). And then there are 11 items classified three factors, named as (1) Time Management and its Problems (an example is While using mobile phone, you would think ‘just give me some more minutes’). (2) Academic Problems in School and its Influence (an example is ‘Because I spend too much time on mobile phone, my school work or my marks are influenced). (3) Reality Substitute (an example is ‘Before having to do something I always check the mobile phone to see whether there are missed calls or text messages) explaining 65.95% of total variance. Results are that MPA can positively predict MPUB, and female university students with MPA will make more phone calls and send more text messages (Hong, Chiu et al. 2012). Also, With mobile phone addiction becoming serious, the sleep quality will be worse (Sahin, Ozdemir et al. 2013). Mobile phone addiction and academic-success has significant negative correlation, and addiction to mobile phone and the level of depression has a positive correlation (Cagan, Unsal et al. 2014).

As the use of smart phone more and more widely, application software developed for smart phone is more and more rich. It is fashionable for Users to surf the Internet by mobile phone and to use software downloaded from the Internet. Thereupon, the activities that users participate by phone are
changing. People began to complain some new activities lend their friends and family to be more addicted to phone than phone calls and text messages. Moreover, accompanied by the activities, some new features of mobile phone addiction appeared. Particularly, it is probably harmful for students if parents addicted to mobile phone. Nevertheless the research is still a blank.

In this background, by absorbing and summarized the previous research results, the study aims at developing a scale to survey the addiction to mobile phone for adult. It is just for parents in this study. And further to explore the relationship between parents addicted to the mobile phone and students addicted to the Internet.

2. Method

2.1 Participants

The participants in this study comprised one of parents of 311 middle school students in Beijing. There were 104 fathers and 199 mothers. Based on what the parents filled in the questionnaire, there are 185 first grade students of junior middle school and 126 second grade students of senior high school. The child of 157 parents was schoolboy, and of 149 was schoolgirl. These parents were from a middle-level school. Among them, education background of 26.8% was high school or below, 30.7% was junior college, 30.1% was undergraduate, 7.8% was master and 4.6% was doctor.

2.2 Instrument

The instrument used in this study mainly included two scales, one was for mobile phone activities and addiction of parents, and other was for Internet addiction of their children.

Referring to previous research, the study developed a scale to measure parents’ mobile phone activities and addiction (MPAA). The study considered some popular activities among smart phone adult users of china in the last two years. In addition, besides the items about withdrawal reaction which were contained by majority of Internet addiction scales, the study designed some items about smart phone addiction aiming at the addictive features of the new activities.

To measure Internet addiction of children, the Internet Addiction Test (IAT) (Tsimtsiou, Haidich et al. 2014) by Young was chosen in the study. IAT consisted of 20 items and a 6-ponits Likert scale, scoring as 0-5, measured each item. The total score ranged from 0 to 100, and represented the degree of an Internet user addicted to Internet. However, this study invited parents to evaluate the situation and degree of Internet addiction for their children, so I in the each item was revised as my child.

2.3 Data analysis and procedures

In analyzing the scale about the usage of mobile phone, exploratory factor analysis was used to reduce the items. The total score of IAT was calculated based on the sum of 20 Internet addiction items, and represented the Internet addiction degree of student. The Pearson correlation analysis of MPAA and IAT were used for explore the relation between parents addicted to mobile phone and students addicted to the Internet.

3. Results

3.1 Exploratory factor analysis for MPAA

To clarify the structure of the parents’ MPAA, an exploratory factor analysis with a varimax rotation was performed. Table 1 presented the results, revealing seven factors: Social & information, Job & study, Game & video, Instant usage, Psychic gratification, Boring usage, Withdrawal reaction. The eigenvalues of the seven factors from the principle component analysis were all larger than 0.85. Items
with a factor loading of less than 0.50 and with many cross-loadings were omitted. A total of 21 items were retained in the final version of the MPAA, and the total variance explained was 71.96%. The Cronbach’s alpha coefficients for the seven factors were 0.76, 0.81, 0.66, 0.72, 0.94, 0.82, and 0.61, and the overall alpha was 0.91, which revealed high reliability of these factors. Table 1 also presented the factor means and the standard deviations of MPAA. As shown in Table 1, the “Social & information” factor (mean=2.58) were scored highly by parents among the first three factors about activities that parents participated in by mobile phone, and “Instant usage” factor (mean=2.65) were scored highly by parents among the last four factors about parents addicted to mobile phone. Parent’s score on “Withdrawal reaction” factor (mean=0.81) were lowly.

Table 1: Rotated factor loading, Cronbach’s alpha values, factor means, and standard deviations for the three factors of activities that parents participated in by mobile phone and the four factors of parents addicted to mobile phone in MPAA

<table>
<thead>
<tr>
<th>Factor 1: Social &amp; information, alpha=0.76, mean=2.58, S.D.=1.26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 2: Job &amp; study, alpha=0.81, mean=1.73, S.D.=1.23</td>
</tr>
<tr>
<td>Factor 3: Game &amp; video, alpha=0.66, mean=1.21, S.D.=1.08</td>
</tr>
<tr>
<td>Factor 4: Instant usage, alpha=0.72, mean=2.65, S.D.=1.34</td>
</tr>
<tr>
<td>Factor 5: Psychic gratification, alpha=0.94, mean=1.50, S.D.=1.43</td>
</tr>
<tr>
<td>Factor 6: Boring usage, alpha=0.82, mean=1.84, S.D.=1.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social &amp; information1</td>
<td>I access Social Networking Services by mobile phone.</td>
<td>0.73</td>
</tr>
<tr>
<td>Social &amp; information2</td>
<td>I search information on the Internet by mobile phone.</td>
<td>0.72</td>
</tr>
<tr>
<td>Social &amp; information3</td>
<td>I watch the Internet news by mobile phone.</td>
<td>0.70</td>
</tr>
<tr>
<td>Job &amp; study1</td>
<td>I assist my work by mobile phone.</td>
<td>0.81</td>
</tr>
<tr>
<td>Job &amp; study2</td>
<td>I study by mobile phone.</td>
<td>0.63</td>
</tr>
<tr>
<td>Job &amp; study3</td>
<td>I download application software by mobile phone.</td>
<td>0.63</td>
</tr>
<tr>
<td>Job &amp; study4</td>
<td>I use all sorts of small software on mobile phone.</td>
<td>0.59</td>
</tr>
<tr>
<td>Game &amp; video1</td>
<td>I play game by mobile phone.</td>
<td>0.83</td>
</tr>
<tr>
<td>Game &amp; video2</td>
<td>I watch video by mobile phone.</td>
<td>0.61</td>
</tr>
<tr>
<td>Game &amp; video3</td>
<td>I read novel by mobile phone.</td>
<td>0.57</td>
</tr>
<tr>
<td>Instant usage1</td>
<td>When the phone rang, I will take it up immediately.</td>
<td>0.84</td>
</tr>
<tr>
<td>Instant usage2</td>
<td>I take a look at the phone first after getting up.</td>
<td>0.70</td>
</tr>
<tr>
<td>Instant usage3</td>
<td>I take a look at the phone before bed.</td>
<td>0.60</td>
</tr>
<tr>
<td>Psychic gratification1</td>
<td>When using those applications on phone that I like, I feel relaxed.</td>
<td>0.91</td>
</tr>
<tr>
<td>Psychic gratification2</td>
<td>When using those applications on the phone that I like, I am happy.</td>
<td>0.90</td>
</tr>
<tr>
<td>Boring usage1</td>
<td>Encountering something I do not know how to do, I will pick up the phone to do something.</td>
<td>0.74</td>
</tr>
<tr>
<td>Boring usage2</td>
<td>At bored time, I will find something to look at or get something to do from the phone.</td>
<td>0.73</td>
</tr>
<tr>
<td>Boring usage3</td>
<td>When I have nothing to do, I will pick up the phone to do something.</td>
<td>0.56</td>
</tr>
</tbody>
</table>
Factor7: Withdrawal reaction, alpha=0.61, mean=0.81, S.D.=0.98

Withdrawal reaction 1: In some cases not suitable for using a phone, I will look for opportunities to use the phone as much as possible. 0.72
Withdrawal reaction 2: In front of my family, I will hide my thirst for the use of phone. 0.70
Withdrawal reaction 3: When I cannot use the phone for a period of time, I feel restless. 0.53

Loadings less than 0.50 were omitted. Overall α=0.91, total variance explained=71.96%.

3.2 Relation between MPAA and IAT

To find out the relation between MPAA and IAT, a person correlation analysis was performed in this study, as shown in Table 2.

At first, the results showed that the activities that parents participated in by mobile phone were all significantly correlated with the features addicted to mobile phone ($p<0.001$). The correlation between boring usage and the three factors about the activities were all the highest than three other factors about the features.

And then, the results indicated that IAT of students had the highest correlation with Boring usage of parents ($r=0.36, p<0.001$), implying that higher degree of Internet addiction for students tended to higher boring usage for their parents. Next, parents’ instant usage ($r=0.21, p<0.001$) and withdrawal reaction ($r=0.22, p<0.001$) also had higher correlation with IAT of students. Moreover the last four factors were all significantly correlated with IAT of students. Using the sum total of 11 items belongs to the last four factors represented the degree of parents addicted to mobile phone. The sum total was positively related to IAT of students ($r=0.32, p<0.001$), namely, the relation was established between parents addicted to mobile phone and students addicted to the Internet.

On the other hand, students’ IAT and parents’ Job & study ($r=0.13, p<0.05$) existed significant positive correlation, as well as to students’ IAT and parents’ Game & video ($r=0.16, p<0.01$). It means that what parents participated by mobile phone had the relation with students addicted to the Internet. In three factors about the activities, the factor Game & video, in other words, the activities like playing game, watching video or reading novel on mobile phone for parents existed an influence with Internet addiction of students. And the same influence existed between the factor Job & study of parents and Internet addiction of students.

Table 2: The correlations between MPAA and IAT

<table>
<thead>
<tr>
<th>Social &amp; information</th>
<th>Job &amp; study</th>
<th>Game &amp; video</th>
<th>Instant usage</th>
<th>Psychic gratification</th>
<th>Boring usage</th>
<th>Withdrawal reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social &amp; information</td>
<td>0.43***</td>
<td>0.40***</td>
<td>0.54***</td>
<td>0.35***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job &amp; study</td>
<td>0.42***</td>
<td>0.47***</td>
<td>0.52***</td>
<td>0.35***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Game &amp; video</td>
<td>0.28***</td>
<td>0.39***</td>
<td>0.50***</td>
<td>0.35***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAT</td>
<td>0.09</td>
<td>0.13*</td>
<td>0.16**</td>
<td>0.21***</td>
<td>0.16***</td>
<td>0.36***</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ***p<0.001

4. Discussions and conclusions

The study developed the survey measuring the situation of parents using mobile phone, containing activities that the parents participated in by mobile phone, above all smart phone, and some new features of parents addicted to mobile phone, such as instant usage and boring usage of phone. It is different with previous scale for mobile phone addiction because pervious scales were generally developed based on referring to Internet addiction scales being composed of expending time, affecting social function and withdrawal reaction. However, there were some problems. Expending time during
using mobile phone was often fragmentary. It led to be unconscious the passing of time for people. Secondly, the items about affecting social function in previous scales were mainly about adolescents, for instance, “I can’t do my homework or study because of cell phone use” (Koo 2009). Nevertheless, since adult’s identities were complex, their social functions were diverse. It is difficult to describe clearly by using several items. So the study redeveloped some items to measure the features about parents, namely adults. Relying on the exploratory factor analysis, it is proved that these items had good reliability and structural validity. In the present seven factors, the first three factors can describe what parents do on mobile phone; furthermore the last four factors can evaluate the mobile phone addiction of parents.

The correlation relation was shown between the seven factors and Internet addiction of students in this study. The results were consistent with our assumptions. It could be because, on the one hand, addicted to mobile phone of parents set children a bad example; on the other hand, due to addicting to mobile phone, parents ignored their children and got little time with them. These caused that some psychological needs of children cannot be satisfied, such as sense of safety, belonging, intimacy, etc. The missing of the psychological needs had the relation with the Internet addiction of adolescent (Yen, Yen et al. 2007, Yao, He et al. 2014).

The study suggested parents themselves to make some rules for using mobile phone. For example, to avoid the feature of instant usage of addiction to mobile phone, parents should strongly demand themselves not to touch the phone during 1-2 hours after getting up and before sleeping. At bored time, according to thinking deeply in advance, designedly to do some positive suitable activities so as not to take the phone to kill time. In addition, it is important to note, even though you are working or studying by phone, what your children notice is just that you immerse yourself in the phone. Further, the phone should be a tool. If you feel happy when using it and feel bothered when no using it, you have to be careful, because the phone may be grabbing your attention against your children. In a word, parents themselves need to notice the mobile phone usage, since it had the relation with addicting to the Internet of children.

Acknowledgements

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References

Developing an instrument to assess teachers’ belief, confidence and motivation about digital game-based learning

Yu-Hsuan CHANG* & Meng-Jung TSAI
Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
M10111017@mail.ntust.edu.tw

Abstract: The purpose of this study was to develop an instrument regarding teachers’ belief, confidence and motivation of digital game-based learning pedagogies. A pool of 30 items was developed by revising items from Grove, Bourgonjon and Van Looy (2012)’s scale. A survey was used to examine and validate the instrument’s structure and reliability. The participants include 134 in-service and pre-service teachers in Taiwan. An exploratory factor analysis with principal component method with varimax rotation was adopted to explore the factor structure of the instrument. Finally, a questionnaire was developed with a total of 13 items under three dimensions: confidence, belief and motivation. The internal reliabilities, alpha coefficients, were adequate for the overall scale (0.87) and for all the three subscales (0.83, 0.77 and 0.81, respectively). Applications of this instrument have been discussed at the end of this paper.

Keywords: Digital game-based learning, teacher education, confidence, motivation, belief

1. Introduction

Over the past few years, digital games have played an important role in education. Games not only bring entertainment to us, but also spark innovative thinking. Digital games offer teachers and students potentially power learning environments (Oblinger, 2004). Nowadays, digital game-based learning is widely used in education all over the world. There are several features about digital game-based learning: rules, goals, feedback, challenge and interaction, for instance (Prensky, 2001).

Because of these characteristics, digital games are used to try to raise students’ motivation and promote students’ performance. A study conducted by Papastergiou pointed out the gaming approach can enhance both students’ knowledge of computer memory concepts and motivation. Educational computer games are used to improve learning environment, regardless of students’ gender (Papastergiou, 2009). Besides, Divjak and Tomic’ (2011) revealed that adopting computer games can promote mathematics learning. To integrate computer games into learning may bring some good effects on learning, such as arising students’ learning motivation and attitude; and further, it can make students have better learning outcomes than before.

From 2000 to 2010, there are more and more researches about digital game-based learning have been raised (Hwang & Wu, 2012). In recent years, the researches have indicated that digital game-based learning can bring others positive impacts for education. For instance, the experimental result showed that a game-based problem solving environment not only highly inspired users’ concept learning, but greatly created entertainment (Cai, Bharathi, Klein, & Klein-Seetharaman, 2003).

As we can see, many studies have indicated that it is worthwhile adopting game-based learning to engage students. But in reality, there were not totally have positive responses. The prior research made a survey to survey 1048 in-service and 656 pre-service teachers about using video games in classroom. The result showed that there was less than half of the in-service teachers use gaming in their teaching (Ruggiero, 2013).

There are many innovative digital games, however, there are used in real classroom not very often. Hence, the purpose of this study is to develop a scale to assess teachers’ belief, confidence and motivation about game-based learning pedagogies.
2. Method

2.1 The development of previous scales

A scale was developed by Frederik, Jeroen and Jan, to explore the teachers’ adoption intention of digital games (Grove, Bourgonjon, and Van Looy, 2012). The scale focused on usefulness, ease of use and behavioral intention. The factors tended to investigate the technology acceptance of digital game-based learning.

Another scale is developed by Hsu, Su and Liang, they used a framework to measure the preschool teachers’ Technological Pedagogical Content Knowledge-Games (TPACK-G) as well as their acceptance of digital game-based learning (Hsu, Su and Liang, 2012). The previous scales all explore that teachers’ can use digital games to represent the content or not.

2.2 The development of this scales

To develop this scale, a pool of 18 items was collected by mainly adapting items from developing by Frederik, Jeroen and Jan in 2012 and writing new items (Grove, Bourgonjon, and Van Looy, 2012). They proposed the following six following subscales for exploring teachers’ adoption intention of digital games: usefulness, ease of use, experience, learning opportunities, curriculum relatedness, behavioral intention, including a total of 19 items. The rating range of the scale is from “strongly disagree” to “strongly agree” and is presented in a five-point Likert scale. The original reliability (Cronbach’s alpha) coefficients are 0.86, 0.74, 0.89, 0.93, 0.69 and 0.92, respectively for usefulness, ease of use, experience, learning opportunities, curriculum relatedness, behavioral intention.

The items was developed in this study mainly basing upon these items, and this study change the term in the scale terms into “Confidence”, “Belief”, “Motivation”. Besides, the author developed 8 additional items for the initial pool of items. The scale in this study hoped to develop a scale with low to high levels. As a result, the initial pool items in the scale included a total of 30 items. Each statement was measured on five-point Likert scale.

2.2.1 Participants

The participants in this study included 134 in-service and pre-service teachers in Taiwan. Among the participants, 71% are female, and 29% are male. Their age was from 21 to 51, and the mean age of all participants was 31.4 years (SD = 8.25).

3. Illustrations

3.1 Factor analysis

An exploratory factor analysis with principal component method with varimax rotation was adopted to explore the factor structure of the instrument. As seen in Table 1, the eigen values of the three factors were larger than one: 5.281, 1.735 and 1.146. Our three factors was retained in the final version of the scale, and they accounted for 62.8% of variance. Items were retained only when their loading was greater than 0.50 for the relevant factor and less than 0.50 for the non-relevant factor. The initial 30 items were reduced to 13 items. The internal reliability index, alpha coefficients, were adequate for the overall scale (0.87) and for the three subscales, 0.83, 0.77 and 0.81.
Table 1: Rotated factor loadings and Cronbach’s alpha values for the three factors of the scale.

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1: Confidence</th>
<th>Factor 2: Belief</th>
<th>Factor 3: Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>0.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>0.741</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>0.814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>0.742</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factor 1: Confidence $\alpha=0.83$

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1: Confidence</th>
<th>Factor 2: Belief</th>
<th>Factor 3: Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.672</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>0.609</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0.549</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>0.766</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>0.758</td>
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</table>

Factor 2: Belief $\alpha=0.77$

<table>
<thead>
<tr>
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<th>Factor 1: Confidence</th>
<th>Factor 2: Belief</th>
<th>Factor 3: Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.680</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>0.682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>0.660</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factor 3: Motivation $\alpha=0.81$

<table>
<thead>
<tr>
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<th>Factor 1: Confidence</th>
<th>Factor 2: Belief</th>
<th>Factor 3: Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.281</td>
<td>0.635</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.35</td>
<td>0.813</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.146</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Eigen value

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1: Confidence</th>
<th>Factor 2: Belief</th>
<th>Factor 3: Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>40.62</td>
<td>13.35</td>
<td></td>
<td>8.82</td>
</tr>
</tbody>
</table>

3.2 Retained items on the scale

The retained items and responding subscales was shown in Table2. A detailed description of the three subscales was presented below:


Table 2: Retained items on the scale.

<table>
<thead>
<tr>
<th>Item No.a</th>
<th>Subscale</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Confidence</td>
<td>It is difficult for me to integrate digital games into the instructions.</td>
</tr>
<tr>
<td>23</td>
<td>Confidence</td>
<td>I have no idea how to integrate digital games into the curriculum.</td>
</tr>
<tr>
<td>24</td>
<td>Confidence</td>
<td>I consider to use digital games in my courses.</td>
</tr>
<tr>
<td>27</td>
<td>Confidence</td>
<td>I always feel upset when I use digital games in my classrooms.</td>
</tr>
<tr>
<td>6</td>
<td>Belief</td>
<td>Digital games offer opportunities to experiment with knowledge.</td>
</tr>
<tr>
<td>19</td>
<td>Belief</td>
<td>Digital games increase my productivity in my job.</td>
</tr>
<tr>
<td>20</td>
<td>Belief</td>
<td>Digital games offer opportunities to motivate students.</td>
</tr>
<tr>
<td>26</td>
<td>Belief</td>
<td>Using digital games makes teaching easy.</td>
</tr>
<tr>
<td>28</td>
<td>Belief</td>
<td>Digital games provide students opportunities to solve problems.</td>
</tr>
<tr>
<td>4</td>
<td>Motivation</td>
<td>It is easy for me to design a digital game-based curriculum.</td>
</tr>
<tr>
<td>9</td>
<td>Motivation</td>
<td>Digital games enhance my effectiveness in my job.</td>
</tr>
<tr>
<td>14</td>
<td>Motivation</td>
<td>I’m planning to use digital games in my classrooms.</td>
</tr>
<tr>
<td>22</td>
<td>Motivation</td>
<td>When I prepare my teaching plans, I’ll link the curriculum with digital games.</td>
</tr>
</tbody>
</table>

* The item number indicates the item order in the initial version of the scale (a total of 30 items).
3.3 Inter-correlation matrix of three factors
Table 3 further presented the inter-correlation matrix among three subscales. Because of the correlations reach significant level of 0.001, the three factors measure in a coherent way.

Table 3: Inter-correlation matrix matrix of three factors.

<table>
<thead>
<tr>
<th>Three factors</th>
<th>Confidence</th>
<th>Belief</th>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>–</td>
<td>0.390***</td>
<td>0.497***</td>
</tr>
<tr>
<td>Belief</td>
<td></td>
<td>0.599***</td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>0.497***</td>
<td></td>
<td>0.599***</td>
</tr>
</tbody>
</table>

*P < 0.05, **P < 0.01, ***P < 0.001.

4. Discussion

This study developed a scale regarding teachers’ belief, confidence and motivation of digital game-based learning pedagogies. Over past few years, digital games have played an important role in education. There were some of scales have developed to assessing teacher’ adoption intention and acceptance of digital games. Compare with these instruments in the following.

A previous framework was proposed by Frederik, Jeroen and Jan, to assess which factors influence the individual adoption intention of a teacher toward game-based learning (Grove et al., 2012). The instrument with the following six subscales: ease of use, usefulness, experience, behavioral intention and learning opportunities, constructing on the basis of previous research using the TAM (Bourgonjon et al., 2012). The study focused on measuring teacher’ adoption intention toward adopt digital games.

CTPCK was developed Hsu, Su and Liang to examine the effects of the technology- and pedagogy-oriented course design on improving the in-service preschool teachers’ Technological Pedagogical Content Knowledge- Games (TPACK-G). They assessed teachers’ acceptance of digital game-based learning. Based on integrate ICT into classroom teaching and learning: which type of knowledge (e.g., TK, CK, or PK) should be instructed first during the course or not (Hsu et al., 2012).

This study was developed the scale about exploring the teachers’ beliefs of teaching toward digital game-based learning. Because of beliefs might influenced teachers’ teaching method. Hence, the study was developed the scale with the following three subscales: confidence, belief and motivation. Firstly, assess teachers’ experience with design a digital game-based curriculum. Then, measuring whether they feel that adopting digital games into classrooms were usefulness or not. Finally, measuring teachers’ confidence and they will adopt digital games in the future or not. Through this instrument to realize teachers’ opinion toward integrate digital games in teaching.

Hope can use this instrument through from inside mental to outside behavior’s way to realize teachers’ opinion toward integrate digital games in teaching; and further, to improve and promote the implement of digital game-based learning.

References


Eye-tracking analyses of text-and-graphic design effects on E-book reading process and performance: “Spanish color vocabulary” as an example

Tse-Wen PAN* & Meng-Jung TSAI*

*Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan, ROC
*M10111008@mail.ntust.edu.tw

Abstract: This study aimed to explore how graphical design effects on learner's E-book control and visual behaviors by an eye-tracking experiment. The participants were twelve university students with novice experience of Spanish who were asked to read and learn basic Spanish vocabularies in E-book display on iPad. Participants were randomly assigned into two groups of reading materials with high-related graphics and low-related graphics. An ASL MobileEye eye tracker was used to track and record the gaze data of learners. Each participant's action of controls and visual attention during the experiment were observed and coded. Wilcoxon test, Mann–Whitney U tests and Pearson’s correlation analyses were used to analyze the data. The results of this study suggest that low-related graphical design may reduce the effectiveness of learning. Future study is suggested to explore the effects of E-book cue design on students’ visual attention and learning performance.

Keywords: E-book; eye tracking; visual attention; multimedia, reading

1. Introduction

1.1 E-books

Recently, since tablet computers are equipped with sundry features, such as touch screen, wireless networking capabilities and the storage of memory (Lim, Lee, and Ahn, 2013), it becomes popular in education field; therefore there has been much research about how it affect student’s learning performance. E-book is a popular format to represent multimedia as the learning material; it includes text, text-speech, music, sound and animation (Korat, and Shamir, 2004). E-book also includes some features, such as hidden button, quick view, keyword searching and bookmark (Vassiliou, and Rowley, 2008). In terms of the content, E-book on mobile device is more flexible and interesting than the content on the printed material (Woody, Daniel, and Baker, 2010). Previous study compared the effect of read text in print and read on screen, the result showed that students who read E-books compared to printed texts had higher affective learning and psychomotor learning (Rockinson-Szapkiw, Couduff, Carter, and Bennett, 2013). However, another result of study found that students didn’t enjoy in E-book reading and had very low scores on comprehension tests (Lam, Lam, Lam, and McNaught, 2009). Those inconsistent findings suggests researcher to explore deeply in this field.

1.2 Visual attention and reading behavior

Eye-fixation is the instinctive reaction of stimuli, therefore, visual attention analysis result may be the stronger evidence of mental processes of reading and other visual activity of learner (Rayner, 1998). Visual attention is based on eye movement, and can be trace back to “eye-mind” assumption (Just, and Carpenter, 1976) which suggests that tracking one’s eye movements could help people to realize his visual attention. Recently, eye tracking technology was started applying on cognitive process of
learning research to disclose how human process information while learning. Previous researchers divided different eye movement measures into three categories (Lai, et al., 2013):
• Temporal: to answer the “when” and “how long” questions related to cognitive processing.
• Spatial: to answer the “where” and “how” questions related to cognitive processing.
• Count: to show the importance of the visual content.

1.3 Cognitive theory of multimedia

According to dual-coding theory of Paivio, compare with single media, previous researcher found that multimedia may help learner effectively and enhance learning performance. Besides, in the past findings, researcher found that non-related material may distracts learner’s attention and waste learner’s time on non-related graphic, reducing information process in working memory and increase cognitive overload (Mayer, 2009).

2. Purpose

The aim of this study is to exam the effects of multimedia design on students’ visual attention; researcher used an eye tracking examination in this study. Specifically, this study disclosed how two different design of graphic in the E-book (i.e., high-related graphic of the Spanish vocabulary and low-related graphic of the vocabulary) effect learning performance (i.e., posttests for Spanish vocabulary) and visual attention (i.e., number of times zone observed, duration before first fixation arrival, percent time fixated related to total fixation, pupil size, total time in zone, fixation count, total fixation duration). This study further explored the relation between learners’ background and reading behavior (i.e. total click number of pronunciation button). The research questions included in following:
RQ1: What is the rule of eye movement of different groups’ learner’s between text and graphic while E-book reading?
RQ2: Is there any significantly difference in students’ E-book reading behaviors between high-related and low-related graphic groups?
RQ3: Is there any significant relationship between learners’ visual attention and posttests?

3. Methods

3.1 Participants

Twelve university students from north Taiwan were novice Spanish learner were randomly assigned into high-related graphic group or low-related graphic group.

3.2 Learning material

Two versions E-book of Spanish vocabulary presented in iPad was used in this study, both version include ten pages with ten color vocabulary in each page. The high-related material as shown in Figure1, since apple is red, the graphic is high-related to the vocabulary “rojo (red)”. On the other hand, in the
low-related graphic material (Figure2), the graphic of “rojo (red)” is a man doing gymnastics which is low-related to the vocabulary.

3.3 Eye-Tracking system

In this study, ASL Mobile Eye-XG with a sampling rate of 30 Hz was used to track participants’ eye-movements through the experiment and Participants was free to move their head. During the experiment, participants’ E-book control and eye movement was recorded separately as the same time.

3.4 Background Questionnaire

To realize participants’ language learning experience, preferences, attitude and personal background, the background questionnaire was assessed before the reading task.

3.5 Posttest

To observe the effect of reading task, an immediately posttest (i.e., posttest1), a three day delayed posttest (i.e., posttest2) and a one week delayed posttest (i.e., posttest3) was assessed after the reading task. The better scores the participants had indicated the more learning content they remembered.

3.6 Reading behavior Analyses

According to prior literature (Lai, et al., 2013), E-book control behavior and several eye movement measures were observed, which are defined as follows:

- Total clicking number: the number of time that participant clicked the hidden bottom to listen the pronunciation of the vocabulary.
- Number of times zone observed: sum of visited fixations count and saccade count.
- Duration before first fixation arrival (seconds): time spent on the first fixation.
- Percent time fixated related to total fixation: total time spent on fixations in a look zone related to all look zone.
- Average pupil size (pixel2): the average size of pupil while looking in specific look zone.
- Total time in zone (seconds): sum of fixations saccade time in a look zone.
- Fixation count: total number of fixation counted in a look zone.
- Total fixation duration (seconds): total time spent on fixations

3.7 Statistical

Mann–Whitney U test was used to analysis the difference in students' E-book reading behaviors between high-related and low-related graphic groups. Besides, correlation analyses was used to analyses the relationship between learners’ backgrounds and reading behaviors, as well as the relationship between learners’ visual attention and posttests.

3.8 Statistical

In this study, Mann–Whitney U test was used to analysis the differences of three posttests and reading behavior between two groups. Besides, Wilcoxon test was used to analysis the retention of each posttest. Third, Pearson’s correlation was use to analysis participants’ background and reading behavior.

4. Results

4.1 Results of Wilcoxon test on text and graphic
Though the Wilcoxon test, the findings showed that all eye movement measures of text and graphic were significant different with each other in low-related graphic group. However, in high-related graphic group, there was no significant different between text DBFFA (duration before first fixation arrival) and graphic DBFFA (p = 0.24). Meanwhile, in the high-related graphic group, the pupil size of text had no significant different to the pupil size of graphic (p = 0.46).

4.2 Results of Mann–Whitney U test result on visual attention

Though the Mann-Whitney U test, we found that low-related graphic group (mean = 13.16) had significant higher number of times zone observed (p = 0.02) compared to the high-related graphic group (mean = 7.10). It meant learner in low-related graphic group spent significant more time of observing the graphic zone than the high-related group.

4.3 Correlation between posttests and eye movement measures

The results of correlation between posttests and reading behavior showed that in high-related graphic group, the average pupil size was significantly negative related to the posttest1 (r = -0.832, p = 0.040) and the posttest2 (r = -0.882, p = 0.020).

In the low-related graphic group, the total fixation duration was significantly negative related to posttest1 (r = -0.820, p = 0.045), posttest2 (r = -0.895, p = 0.016) and posttest3 (r = -0.817, p = 0.047). The percent time fixated related to total fixation was significantly negative to posttest1 (r = -0.882, p = 0.02) and posttest2 (r = -0.852, p = 0.31). Total time in zone was significant negative to posttest2 (r = -0.860, p = 0.028). Fixation count was significantly negative to posttest2 (r = -0.867, p = 0.025).

These result may indicated that low-related graphic was unhelpful to the performance of learner.

5. Discussion and conclusion

This study was aimed to investigate the effect of graphic design on E-book reading behavior and learning performance. First, we found that learners who were in low-related graphic group had significant longer DBFFA on text zone than graphic zone, which may indicate learner who read low-related graphic thought the graphic is not helpful for them to memorize the content. Secondly, low-related graphic group spent more time observing the graphic zone, which is inconsistent with previous findings (Tsai, Hou, Lai, Liu, and Yang, 2012) (Balslev, et al., 2012) that learners fixated relevant information longer within text-based environment. Third, in the high-related graphic group, the smaller the students’ pupil size is, the higher scores the students had. According to previous study (Seeber, and Kerzel, 2011), this result may indicated that when learners read high-related graphic, the cognitive load may be lower and could result in better learning efficiency. On the contrary, in the low-related graphic group, the more effort they spent on the graphic zone, the lower learning outcome they had. It may be indicate that low-related graphics created cognitive load to learners.

In sum, according to these findings and previous study (Mayer, 2009), relevant graphic and text is suggested to arrange in pairs while design vocabulary learning material. In other words, vocabulary learning material designers should be careful to selecting appropriate graphics.

Future study was suggested to explore the relation between mental effort and pupil size of learner through interview method. In addition, more complex cognitive test was suggested to assess learner’s learning performance. Moreover, future study is suggested to explore the effects of E-book cue design on students' visual attention and learning performance.

References


Abstract: Previous studies indicated that there were some difficulties of astronomy teaching in Thailand because of teachers’ lacking of content and pedagogical knowledge. Building up some spaces for Thai astronomy teacher learning community may allow them to gain their knowledge and pedagogy about astronomy. A weblog (blog) as a web-based technology may allow Thai astronomy teachers’ community to improve pedagogical knowledge and astronomy concepts through expressing and exchanging ideas interaction and collaboration, social networking and group work. This paper share ideas of provide weblog for learning community of Thai astronomy teachers. The knowledge of sharing in weblog may have implications for professional development of Thai astronomy teachers.

Keywords: Weblog, learning community, astronomy, pedagogy

1. Introduction

Astronomy is one of the key areas for citizens in the 21st century. It can play a unique role in facilitating education and capacity building of citizens in society; and in furthering sustainable development throughout the world (Percy, 1996; Plummer, 2006). Knowledge of astronomy can increase public awareness, understanding and appreciation of science and technology which are important in all countries, both developed and developing (Percy, 2005). Astronomy is a science that transcends cultures, has been prominent in the news in recent years, and can generate excitement in young minds as no other science can. Astronomy is useful for understanding other science and mathematics concepts, and for developing problem solving skills, which are important in our technological world (Lebofsky, Canizo, & Lebofsky, 1996).

Teaching and learning astronomy in schools is highly justifiable. It not only prepare individuals for becoming astronomers in the future but also prepares citizens as a new generation who have deeper understanding of science, the ability to think critically and be able to explain astronomical phenomena that occur in everyday life and are relevant to their culture and society. However, it seems that there are some difficulties of astronomy teaching in Thailand. Astronomy is just obviously appearing in both the 2001 and later the 2008 Thailand school science curriculum (IPST, 2008). Not many Thai school science teachers graduated in astronomy area. Some previous studies found that the cause of Thai students’ misconception about astronomy was teachers’ low capability in teaching astronomy. Teachers could not provide constructivist learning models or instructional media for astronomy (Khongpugdee, Sukonthachat, & Phonphok; 2009; Khongpugdee, 2010; Dahsah et al., 2012).

Building up some spaces for Thai astronomy teacher learning community may allow them to gain their knowledge and pedagogy about astronomy. Teachers are embracing technology as a way to increase instructional effectiveness and reach the 21st century learner. The Internet is currently applied in a wide range of e-learning settings, and various innovative web-based learning systems have been developed over the last few years. Numerous information technologies have emerged to support this type of educational environment, by facilitating communication and collaboration among online learners. Blogs, wikis, Facebook, and microblogs are all technologies in educational contexts in many studies (Cole, 2009; Huang, 2011; Robertson, 2011).
A weblog (blog) is a web-based technology that allows people to quickly share their thoughts and comments with the entire web population. Persons who are not necessarily familiar with web design codes (HTML, CSS) are able to successfully post an article with multimedia materials. This advantage has increased recent attention to pedagogical roles of blogs in the e-learning literature. Compared with other popular social software applications (wikis, online forums, facebook, and microblogs), blogs can be more applied more broadly, allowing simplified web pages, links, and resource collections (Huang, 2011). There were many studies using the blog for diverse learning groups, ranging from primary (Davis 2006, Tse et al. 2010) and secondary education (Angelaina & Jimoyiannis 2009) to higher education (Blau et al. 2009, Kerawalla et al. 2009, Tan et al. 2010) and teachers’ professional development as well (Makri & Kinigos 2007).

Since 2010, The Technology for Teaching and Learning Center, under the Thai Ministry of Education every years training Thai teachers to create blog content through “wordpress” free blog service (URL: http://www.wordpress.com). Many teachers who attend in the workshop created blogs and used as effective strategies for teaching and learning in their class. Some studies show that students more satisfied and they was higher achievement after learning by using a weblog that applying with social media (Facebook, Google Docs, Slideshare, and Youtube) (Sudprakone, 2012; Anantasook, 2014). In addition, other teachers can use content from various educational blogs which some teachers designed, in their classroom. Because of their organizational and pedagogical features, blog for Thai astronomy teachers’ community can offer enhanced opportunities to teachers, not only to improve pedagogical skills, but to construct new knowledge through expressing and exchanging ideas, critical and reflective thinking, interaction and collaboration, social networking and group work.

2. Weblog as Learning Community for Thai astronomy teachers

The weblog which concern in this study is astronomy education's blog [www.astroeducation.com], was started blogging in January 2013. The objective’s blog setting was provided for teaching and learning on astronomy, astronomy education, in the Thai's basic educational levels (Grade 1-12). This blog consist of seven main menus; (1) author's astronomical activities, (2) news and announce, (3) astronomy lesson (4) astronomy knowledge, (5) learning medias, (6) astronomy curriculum, and (7) CERN physics teacher projects. These all menus and some articles are show in figure 1.

![figure 1. The first page of astronomy education's blog [www.astroeducation.com].](image-url)
The first author's astronomical activities menu includes the author's news or activities when he attended in the astronomy workshop and conference. For example, the author attend in the Eratosthenes workshop; measure circumference of the Earth on 25-27 March 2013, and the Institute for the Promotion of Teaching Science and Technology (IPST)'s workshop for astronomy teacher on 11-15 March 2013. The author present his research study in the title "The Poster for Archaeoastronomy and Geology of Prasats in Surin Province: the Learning Material" in the International Conference of Educational Research (ICER) 2011 on 9 November 2011.

The second news and announce menu that include the news of astronomy workshop or projects which many organizations such as the Institute for the Promotion of Teaching Science and Technology (IPST), the Thai Astronomy Society, The National Astronomical Research Institute of Thailand (NARIT) and The Learning centre for Earth Science and Astronomy (LESA), create activities for teachers who teaching astronomy.

The third astronomy lesson menu consists of two archaeoastronomy lessons. The first lesson was designed for enhancing learners’ understanding on how the direction of 30 Surin province prasats’ (Hindu temple) structure was provided in order to face to the East at the position of sunrise on Equinox day. The lesson provided the picture and detail of all prasats in term of age, purpose, material and direction of construction which were checked and survey by the author before created the lesson. The learning requires students to take action according to the guidelines for two hours in weblog class and one hour outside of the class. They were enthusiastic and interested in the group activity and knew more about Hindu temple that relevant to the movement of the Sun. The second lesson is the operation of measure circumference of the Earth on Vernal Equinox day. The author used the Eratosthenes method, and a difference technique for measure circumference of the Earth. Because of the Sun move on the Equator in the Vernal Equinox day. The author applied the Google Earth free online program for measured the distance from the participants’ location to the Equator. In this part, the author created many articles while he stayed in New Zealand. Thai and Lao teachers and students (N=67) in difference locations, who submitted in this operation, learn the content from this part and successfully to measure circumference of the Earth on 23-24 March 2014.

The fourth astronomy knowledge menu that include several articles which wrote and post on the blog by the author. It can categories in two sub-menus; (1) the concept of time and calendar, (2) the concept of astronomy in daily life. This part benefits for person who interests on astronomy in Thai societal and cultural context.

The fifth learning media menu that involve astronomy media such as video clip, astronomy textbook, and free astronomical program that were shared on the internet. The author selected and categorized them which benefit for students and teachers in the basic educational level. This main menu includes three sub-menus; (1) video clips content for students, (2) video clips training for astronomy teachers, (3) astronomy textbooks and astronomical program.

The sixth astronomy curriculum menu that involve three sub-menu which link to the astronomy level in Thai science curriculum that include primary level, lower secondary level and upper secondary level. However, only astronomy lessons and learning material on the upper secondary level were stipulated in the first year. This menu can support both teacher and students for teaching and learning astronomy in their classroom.

The final main menu is CERN physics teacher projects menu. This part include particle physics knowledge from the European Organization for Nuclear Research (CERN)-Physics High School Teacher Programme which the author interest individually. This menu benefits for physics teachers who interests in particle physics laboratory and planning to attend in the CERN-Physics High School Teacher Programme.
3. Community Building of Thai Astronomy Teacher Weblog: First Year

The first year of the community building of Thai astronomy teacher weblog indicated a good start. The number of teacher access to the blog and the number of teachers who have become members in astronomy education's fanpage (https://www.facebook.com/astroeducation) are increasing daily. The blogger normally posts many articles in each menu but focuses on the sixth menu. The author provides astronomy learning material such as learning activities, learning packets, and lesson plans for teachers teaching astronomy content at the upper secondary level [http://www.astroeducation.com/category/curriculum/highlevel/]. All documents contain necessary information for teacher looking to start using it in their astronomy classroom. The blog currently has not many articles, but it was visited around 200-250 visitors per day.

The community seems to consider pedagogical knowledge. They usually come to the sixth menu, astronomy curriculum menu, through Google search for using learning material for teaching. Then, they download all files by themselves or e-mail to the astronomy education blogger for sending files to them. Their communication was related to a need for pedagogical knowledge as follows:

“I don’t have any learning material, could you please send it to me.” Ketsaraporn [02/07/2013]

“Now, I don’t have lesson plan, the plan for teaching astronomy, could you please send it to me. Thank you very much.” Pensrit Kaewnongsong [22/11/2013]

“I am biology teacher, but I was assigned to teach astronomy in this semester, I, therefore, need assistance in teaching astronomy. Could you please send lesson plan and files of astronomy content to me?” Phacharanapat Boonseela [07/01/2014]

“This is the first time for me to teach astronomy, could you please send lesson plan and files of astronomy content to me.” Sririyakorn Jullee [19/04/2014], Rewadee Chansamut [06/05/2014]

“I am a new teacher, I am learning the teaching technique. Could I receive your files?” Panida [30/04/2014]

It indicated that astronomy teaching had difficulty for them. They asked for learning materials or even lesson plan because most of them were first time to teach astronomy. Even some of them are not new science teachers, they are new astronomy teachers. This similar to previous studies found the problem of astronomy teaching in Thailand (Khongpugdee, Sukonthachat, & Phonphok; 2009; Khongpugdee, 2010; Dahsah et al., 2012). It could be mentioned that the contents in this astronomy education blog can support teachers for teaching and learning astronomy in Thailand.

4. Conclusion

The astronomy education blog could build Thai astronomy teachers’ community up. First year of sharing in the blog indicated that teachers required not only pedagogical knowledge but also astronomy concepts. It is probably because most of astronomy teachers have no background of astronomy areas. The weblog may increase of providing media to enhance constructing astronomy concept. More interaction between experts and naive astronomy teachers should be provided in order to set up the atmosphere of professional development through the blog.

References


The Perceived and Expected User experiences of AR Book Reading: the Perspective of Parents

Kun-Hung CHENG* & Chin-Chung TSAI*
*Department of Communication and Technology, National Chiao Tung University, Taiwan
bGraduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
*kuhu@mail.nctu.edu.tw

Abstract: Studies regarding augmented reality (AR) books generally indicated its advantages on reading performance. Positive attitude toward the usage of AR books and acceptance of usability with AR books was also responded by users including samples of students and parents. AR books create a new experience of reading; and the further exploration of user experience beyond usability when using AR applications can be considered. The present study hence invited 29 pairs of parents and their children coming from different regions in Taiwan to join a shared AR book reading activity. Each parent was interviewed for understanding their perceived user experiences and expected user experiences of the selected AR book in this study; and the qualitative data was analyzed through phenomenographic method. The results showed that the parents perceived using the AR book in both emotional senses (e.g., joy and surprise) and cognitive senses (e.g., increasing attention). However, some of them perceived negative experiences such as interrupting traditional book reading by AR. Also, AR books are expected to provide parents with rich interaction and vivid animation for experiencing the augmented information. The diverse user experiences of the AR book reading perceived by the parents could be elaborated to further explore their relationships with intention to use and usage behaviors. The characteristics of perceived and expected user experiences responded by the parents found in this study can also be the basis for the practical design of AR books in the future.

Keywords: augmented reality, book reading, user experience, parents, phenomenographic method

1. Introduction

An augmented reality (AR) book, combining conventional paper book and real-time synthetic information for its simultaneous presentation through a screen device, has been considered its advantages on learning recently (Cheng & Tsai, 2014; Ibáñez et al., 2014). In addition to the experiences of paper book reading, AR books offer more virtual information such as 3D objects, video, or audio relevant to the book pages for users to read and thus originate a new reading experience. For the effects of AR books on reading performance, past studies have indicated their benefits (Abas & Zaman, 2011; Vate-U-Lan, 2012). AR book systems could enhance students’ motivation to learn (Di Serio et al., 2013). Acceptance of usability (e.g., effectiveness, efficiency, satisfactory) with AR books was also responded by students (Chang et al., 2011). In terms of parents’ attitude toward their children’s use of AR technology in preschool education, they were inclined to agree with that AR could motivate their children to learn (Cascales et al., 2013). However, these findings only initially investigated the usability issues regarding users’ attitude toward AR. Since AR books involve a new experience of reading, the further exploration of user experience beyond usability when using AR applications can be considered (Cheng & Tsai, 2013).

According to ISO, the definition of user experience is “a person’s perceptions and responses that result from the use or anticipated use of a product, system or service.” The definition may elicit the ideas that while a user’s perceptions of “use” of a system stands for the concept of perceived user experience, a user’s perceptions of “anticipated use” of a system indicates the concept of expected user experience. Moreover, researchers mostly agree with the notion that user experience moves beyond
usability toward more emotional concern about the interaction between users and products or systems (Desmet et al., 2007). Nevertheless, user experience involves a consequence of a user’s internal state (e.g., motivation or mood), the characteristics of the designed system (e.g., usability or functionality), and the context within which the interaction occurs (Hassenzahl & Tractinsky, 2006). The findings imply that user experience is a broader scope including usability issues that designers are suggested to concern.

With regard to the research on the user experience of AR applications, recently, a study interviewed 28 participants in a shopping mall for exploring the expected user experience of mobile AR services for business purposes (Olsson et al., 2013). They found several characteristics of user experience (e.g., feelings of being connected with other people using the services) and requirements (e.g., requirements of privacy protection in interacting with the services) that affect and facilitate the mobile AR experiences. However, related research on user experience studies with AR applications is still limited, particularly on reading AR books along with parents’ perspectives. Based on the two facets of perceived user experience and expected user experience discussed previously, this study therefore explored parents’ experiences when reading an AR book with their children and qualitatively categorized the characteristics of user experience. Specifically, the research questions are as follows:

1. What is the parents’ perceived user experiences of the AR book reading?
2. What is the parents’ expected user experiences of the AR book reading?

2. Method

The participants in this study included 29 pairs of parents and their children coming from different regions in Taiwan (i.e., 10 pairs from northern region, 9 pairs from central region, and 10 pairs from southern region). While the ages of the children are between 4 and 9 (mean=6.48, SD=1.21), the parents are between 24 and 60 years old (mean=37.72, SD=7.79). Most of the parents were familiar with using smartphones or tablet PCs; however, they generally did not experience the demonstration of AR.

An AR picture book with artistic introduction, namely “The adventures of Yuyu: Yuyu Yang artistic journey (published by National Chiao Tung University Press in Taiwan),” was utilized as the learning material in this study. In a pair setting, the parents and their children were required to freely share reading with an iPad. A trained research assistant introduced the reading process and the usage of the book before the activity began. When the participants finished the AR book reading, all the parents were interviewed for understanding their perceived user experiences and expected user experiences of AR book. The guiding interview questions include:

1. Please describe the feelings when you read the AR book.
2. What do you experience in the process of the AR book reading?
3. What do you expect to experience when reading an AR book?
4. What content of an AR book and the format it present do you expect to see?

The interviews were undertaken in Chinese and audio-recorded, as well as fully transcribed. To reveal the user experiences of the parents in the learning activity, this study conducted a phenomenographic method, which was used to analyze and further categorize students’ conceptions of learning in previous studies (e.g., Tsai et al., 2011; Lee et al., 2013), to examine the verbatim transcripts of the parent interviews. Specifically, for each parent’s interview transcripts, the researcher firstly marked the most important sentences that could represent their main idea of experiencing the AR book reading. The content-specific consistencies and differences across the interviewed parents’ responses were then explored and summarized by comparing the selected sentences. Following previous steps, the qualitatively different categories of the user experiences of AR book reading perceived and expected by the parents can be constructed.

3. Results and discussion

3.1. Perceived user experiences
With an initial attempt to probe parents’ user experiences of an AR book reading, the present study conducted phenomenographic analysis and preliminarily found that the parents perceived both positive and negative user experiences. In terms of the positive user experiences, some parents can feel the reality of objects or environments via the AR technology; and they emotionally expressed their joy, amusement and playfulness that arise from a brand-new experience of reading. Feelings about the traditional book reading being surpassed by the experiences of AR book reading, particularly for the 3D elements or virtual information overlapping from the paper book, also surprised them. In addition to these emotional senses, they perceived the advantages of AR technology on reading in a cognitive sense, for example enhancing awareness, memory, and knowledge about the content of the book.

However, some of them perceived negative experiences that reading book with AR technology likely interrupted traditional book reading, as well as operating the AR book alone with problems of usability. Some parents felt an antipathy toward technology use and tended to forbid their children to use electronic devices. In the consideration of this study, the diverse user experiences of the AR book reading perceived by the parents could be elaborated to further explore their relationships with intention to use and usage behaviors.

3.2. Expected user experiences

Regarding the parents’ expectations of reading AR books, the present study found that they expected AR books to include more interactive design for users to interact with the virtual elements or information (e.g., tap the screen to control the augmented 3D objects). Also, they expected AR books to include more vivid animation regarding the book story to fulfill the content of the virtual information within the AR book. In other words, AR books are anticipated to provide parents with rich interaction and vivid animation for experiencing the augmented information with their children.

With regard to the help of learning, some parents expected more suitable content of AR books to draw on their children’s interests or needs (e.g., interesting topics, life-relevant materials, or abstract knowledge). Also, AR books with value-added materials integrated into the paper books (e.g., a craft of cutting paper for increasing the children’s impression of the artistic work) for their children were anticipated by the parents to be developed. Similar to the perceived user experiences found in this study, the parents also expected AR books to foster learning in a cognitive sense. Finally, some of them anticipated to read AR books with more ease of control, and even imagined to experience actual feelings of touching objects. An AR glass (e.g., Google glass) in the developing process may be up to the expectations of portability.

4. Conclusion

In sum, the characteristics of perceived and expected user experiences responded by the parents found in this study can be the basis for the practical design of AR books in the future. With more considerations in parents’ user experience, the acceptance of adopting AR books for their children to learn may be increased.

References


Design of MOOC for In-service Teacher Professional Development: A Case of Teachers’ Refresher Training Course in Hong Kong

Silu LIa*, Eric T. H. LUKb & Morris S. Y. JONGc

a, bCentre for the Advancement of Information Technology in Education, The Chinese University of Hong Kong, Hong Kong.

cDepartment of Curriculum and Instruction, The Chinese University of Hong Kong, Hong Kong

*siluli@cuhk.edu.hk

Abstract: This paper describes the design of a video-based massive open online course (MOOC) with a scalable activity structure for in-service teachers’ continuing professional development (CPD). The course has been developed and delivered in the open learning platform. We design this MOOC to aid teachers to learn anytime and anywhere, and exploit teacher professional training with the infusion of collaborative learning and self-directed learning.

Keywords: Massive open online courses (MOOCs), in-service teacher professional development, self-directed learning, computer supported collaborative learning

1. Introduction

The Internet has influenced the way we learn, work, live and socialize. The widespread use of computers and the Internet have made distance learning easier and faster. Massive Open Online Courses (MOOCs) are a recent development in distance education which began to emerge in 2012 (Pappano, 2012; Lewin, 2013). It has been anticipated that MOOCs will gain wide spread as an educational form. The rapid growth of information and communication technologies (ICT) and rising computer knowledge of people make possible appearance of this new educational form. Wikipedia (2014a) noted that there are two key features to a MOOC that contrast it with established university course delivery: (1) Open access- anyone can participate in an online course for free; (2) Scalability- courses are designed to support an indefinite number of participants.

In recent years, in-service teachers’ continuing professional development (CPD) in ICT is a major priority in K-12 education in Hong Kong. In-service teachers are demanded to learn continuously so as to enhance their professional capacity. Through engaging in continuing professional learning and reflection, teachers can acquire the professional knowledge and skills in ICT for assuming the role and responsibilities of a teacher (Advisory Committee on Teacher Education and Qualifications, 2009). Education Bureau, the Government of the Hong Kong SAR has organized a lot of refresher training courses (RTCs) in information technology in education professional development programmes for teachers.

However, we found that the attendance rates of these courses were unsatisfactory. RTCs generally must take place after school, in the weekends or in the summer holiday, thus imposing on teachers’ personal time, which cuts into time needed for other tasks. At the same time, we found that professional development experienced by substantial proportions of teachers lacks key pedagogical qualities that make it effective, including time to think about, collaborative learning, follow-up activities, and sharing with teachers from other schools (Smylie et al., 2001). So the sources and means of which RTCs are delivered to teachers should be carefully assessed.

To improve teacher professional development and foster their collaborative learning and self-directed learning, we design a MOOC, which has been developed to aid primary and secondary school teachers to implement effective teacher professional development training.
In the paper, we elaborate the reasons, principles and framework of the design of the above mentioned MOOC and conduct effective teacher professional development training to facilitate teachers’ self-directed learning and computer-support collaborative learning.

2. Background

2.1 Massive open online courses (MOOCs)

MOOCs are online courses aimed at unlimited participation and open access via web (Wikipedia, 2014a) and are receiving increasing attention and interest from several communities involved in online distance education. The first MOOC emerged from the open educational resources (OER) movement, named “Connectivism and Connective Knowledge (CCK08)”, was a unique event in 2008, which was led by George Siemens of Athabasca University and Stephen Downes of the National Research Council. In 2012, starting with the widely-publicized online courses at Stanford University, several universities are engaged in offering online versions of regular courses, through companies such as Coursera, Udacity and edX. Most in-service teachers cannot afford time to participate in conventional face-to-face professional development training courses. Thus MOOC provides a promising solution to the problem.

2.2 In-service Teachers Continuing Professional Development (CPD) in Hong Kong

Advisory Committee on Teacher Education and Qualifications (ACTEQ) in Hong Kong released “CPD Document 2003” in November 2003 and proposed a teachers’ CPD framework. A “soft” target of 150 CPD hours in a three-year cycle is set, within which teachers can deliberate on the direction and content. Teachers’ CPD refers to all kinds of learning opportunities that help them strengthen their professional practices. Today, ICT can facilitate not only delivery of instruction, but also learning process itself (Jung, 2005). Thus the government wishes to provide a variety of refresher training courses (RTCs) to teachers in Hong Kong to improve teachers’ ability to promote student learning and development and to update teachers’ knowledge and skills in teaching and learning. Generally, the course duration of each training event is 6 hours (in two 3-hour sessions on two different days to give ample time for participants to complete assignments between the two sessions). Event must take place in the evening of workdays, in the weekend or summer. The maximum number of participants for each event is 25.

2.3 WebQuest

A WebQuest is an inquiry-oriented format in which all the information that learners work with comes from the web (Dodge, 1995). It can foster collaborative learning through collaborative activities with a group-based project, encourage independent thinking and motivate students. The use of WebQuest can serve as a powerful and an efficient tool for teacher professional development (Johnson, 2004). It is also a learner-centric project-based learning approach for facilitating K-12 students to pursue collaborative inquiry learning on the Internet, and is becoming an integral part of education. For effective integration of WebQuest into school education, trainings should be provided to teachers to equip them with the pedagogical knowledge and skills required, which will facilitate teachers’ self-directed learning and collaborative learning. So we choose WebQuest as a production case to design this MOOC.

3. Design

3.1 Principles of the MOOC design
3.1.1 Self-directed learning (SDL)

Self-directed learning (SDL) is learning in which the conceptualization, design, conduct and evaluation of a learning project are directed by the learner (Brookfield, 2009). In the context of a self-directed learning environment, all decisions about how and what to learn, and how or whether to consult external resources, are decided by the learners. Some educational institutions are finding ways to support self-directed study through open-learning programs, non-traditional course offerings and other innovative programs (Knowles, 1975). Rita Kop mentioned that SDL on open online networks is now a possibility as communication and resources can be combined to create learning environments. Downes proposed that teaching strategies in his MOOC, named Connectivism & Connective Knowledge 08, allowed the educator to have the role of facilitator. Nowadays most of scholars and educators believed that MOOCs can facilitate participants’ self-directed learning.

In a traditional classroom of RTCs, knowledge transfer from educators to learners. However, in this study, teachers learn WebQuest through MOOC can manage their time, find resources and choose the subject they want to learn about or the activities they want to engage in.

3.1.2 Computer Supported Collaborative learning (CSCL)

Computer Supported Collaborative learning (CSCL) regards learning as a social process, where each individual participant, or learner, is responsible for creating his or her own knowledge through social interaction with other human beings by interacting with physical objects (Miyake, 2007). CSCL refers to an instruction method in which learners at various performance levels work together in small groups toward a common goal (Gokhale, 1995; Johnson & Johnson, 1986). The shared learning gives learners an opportunity to engage in discussion, take responsibility for their own learning, and thus become critical thinkers (Sills, 1991).

According to Vygotsky, knowledge is social in nature and is constructed through a process of collaboration, interaction and communication among learners in social settings. The collaborative learning through MOOC provides learners with opportunities to analyze, synthesize, and evaluate ideas cooperatively. Because in traditional classroom, teachers barely discuss and just listen what the educators taught. They barely have chance to share and receive constructive feedback. The massive open online platform can facilitate discussion and interaction among teachers.

In this MOOC, we set up a discussion forum for teachers to ask questions and discuss with peers. During the learning process, this WebQuest MOOC can facilitate teachers’ collaborative learning and then they can use WebQuest to teach their students to improve students’ high-level thinking and inquiry-based learning skills.

3.2 MOOC Design

3.2.1 Platform

Moodle is an open-source Course Management System (CMS) that universities, communities, colleges, K-12 schools, and even individual instructors use to add web technology to their courses (Cole & Foster, 2007). It presents one of the most widely used open-source e-learning platforms, enabling the creation of a course website and ensuring their access only to enrolled participants (Dougiamas & Taylor, 2003). Moodle allows the exchange of information among users geographically dispersed, through mechanisms of synchronous (chats) and asynchronous communication (discussion forums). It also has easily configurable features, allowing the creation of participants assessment processes (quizzes, online tests and surveys), as well as managing their tasks with their timetable (Mahmoud, 2008; Costa, 2012). According to the advantages of Moodle platform to enrich the process of teaching and learning, in this study we design and establish all the course materials using learning modules of Moodle platform. Figure 1 shows the modules of MOOC platform. Teachers who would like to participate in this course can login the platform anytime and anywhere. It solves the limitation of teachers’ time and geographical locations to a great extent.
3.2.2 Basic requirements

This MOOC is mainly composed of 12 video-based lecture modules, formative assessment quizzes (each articulated to the end of a module), discussion forums for teacher community building (facilitated by an online tutor), and summative assessment tests. Teachers can select their own learning track by taking different lecture modules in accordance with their own grade of teaching (primary or secondary) and their own subject of teaching (four Key Learning Areas (KLAs): English Language, Chinese Language, Mathematics, and Humanities). After passing all formative assessment quizzes and completing all community-building and summative assessment tests, participants will be awarded an e-Certificate, and six hours of CPD by EDB.

3.2.3 Quality

The design and content of this course captures some trends that have emerged in recent years in the field of MOOCs learning. To ensure teaching and learning effectiveness, course designers, instructors and online tutors involved in this course have provided teacher coaching support or teacher professional development in designing and implementing WebQuest in schools over five years.

3.2.4 Module design

The delivery structure for MOOC is based around a self-enrollment, self-paced completion of the learning activities that are presented over 2 months. In the system, teachers from different disciplines will decide when they would like to login the system to learn, where they want to set as a connection to assess to the course. What’s more, they could select their own learning track by taking different lecture modules in accordance with their own disciplines. The instructional content is delivered via a series of short video clips, which range from 10 to 20 minutes in length. Total duration of these video clips is 6 hours. The video clips were high-quality and developed with a professional television crew in a recording studio setting.
We design this MOOC with 12 modules. Each module contains a video clip. Except Module 4, to tailor-made the needs of teacher participants teaching in different KLAs in primary and secondary schools, we prepare 8 versions of video clips correspond to 8 types of KLAs. Figure 2 shows the modules design of this WebQuest MOOC.

3.2.5 Assessment

Since teachers may take different modules in different time, to give them larger flexibility to join this course, we arranged formative assessment quizzes with 3 multiple-choice questions (MCQs) at the end of each module. The MCQs were presented to teachers with the goal of allowing teachers to gauge their understanding of the material presented in each video clips. Teachers have to get a pass with at least 2 correct answers in a quiz before proceeding to the next one. Participants can download the PowerPoint file of course material in each module as a reference when taking the quizzes. Any queries after joining the assessment, participants can raise questions in the online discussion forum. Online tutors will give teachers guidance to acquire the knowledge.

For the sake of modifying teachers’ thinking or behavior to improve their learning, we design formative assessment quizzes at the end of each module. And the feedbacks should be supportive, timely, and specific. The feedbacks come in a variety of types, such as verification of response accuracy, explanation of the correct answer, hints, and worked examples. If teachers didn’t pass the quiz, they can repeat watching the correspondent video and search for supporting resources from the web to improve their learning.

At the end of the course, we designed two types of summative assessment quizzes for teacher participants. Type one is to finish a quiz with 15 MCQs. Teacher must get a pass with at least 11 correct answers. Teachers will have 3 chances to attempt. The platform will give the prompt feedback to teachers. Type two is to create a WebQuest originally according to the specific KLA and level (primary and secondary) the teachers teach. Teachers who will choose this type of summative assessment are recommended to form a group to discuss how to create, evaluate, adopt and improve a WebQuest. This process achieves the CSCL that teacher will engage in the discussion to form their own construction of learning.

3.2.6 Activities

Instead of merely watching video clips online passively, this MOOC also want to facilitate teachers’ SDL and CSCL and let their online learning actively. We established a wide variety of
learning activities, like hands-on practice and online discussion forum responding reflective and collaborative questions.

In addition, inter-school subject-specific teacher communities are built for users to share good teaching practices.

4. Conclusion

In this WebQuest MOOC, with computer and Internet, teachers have the opportunity to study anywhere regardless of their busy schedule. The principles and flows of design of this MOOC provide educational designers with insights on designing MOOCs for in-service teachers’ professional development training course. Next step, we will evaluate the acceptance and learning experience of teachers who have completed this MOOC. And we will explore if our work can apply to other courses of teacher professional development.

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Learning to create Technological Pedagogical Content Knowledge through distributed leadership: A Case Study of a Singapore Future School

Ching Sing Chai*, Benjamin Wanga and Chun Ming Tanb

*National Institute of Education, Nanyang Technological University, Singapore
bNan Chiau Primary School, Singapore
* chingsing.chai@nie.edu.sg

Abstract: This case study analyzed the forms of distributed leaderships practice in a future school in Singapore. From the technological Pedagogical Content Knowledge (TPACK) framework, the study attests that the various levels of leadership in the school are focused on different aspect of the TPACK and the collective effort in engaging in school reform for future learning can be viewed from the TPACK perspective.

1. Introduction

Current development of Technological Pedagogical Content Knowledge (TPACK) research has documented a variety of methods of developing preservice and inservice teachers’ TPACK (Kramarski & Michalsky, 2010). Most intervention studies that engage teachers and educators in collaborative designing of TPACK report positive outcomes (see Chai, Koh & Tsai, 2013). While substantial research has been carried out under the framework of TPACK among teachers, Chai, Koh, Lim and Tsai (2014) have pointed out the possibility of extending the TPACK research to school leaders. They argue that teachers’ creation of TPACK is enabled through or constrained by higher level instructional decisions made by school leaders. These decisions include the technological environment the school leaders envisage, the pedagogical directions they set and the content areas for lesson design. These decisions shape subsequent TPACK creation among teachers and consequently students learning experiences. How school leaders enact their leadership and thus form the technological pedagogical content environment has however not been research empirically. In addition, Figure 1 below (adapted from Chai et al., 2013) depicts the possible design space where school leaders have to exercise their leadership to create the conditions and directions for TPACK to emerge.

2. Method

The study adopts a case study design in its approach to answer the research question. The research questions addressed in this study is how do school leaders enact their leadership as viewed from a TPACK perspective? The case school is a future school that has devoted itself in several pedagogical initiatives including the building of MyCLOUD (Wong, Chai, Zhang & King, in press) for Chinese language learning; the Idea Garden (Tsai, Chai & Hoe, 2014) to facilitate knowledge creation among student communities for social studies and MyDesk (Tan, 2013) for seamless science learning. The principal, vice-principal, head of department (HOD) for Information and Communication Technologies (ICT), and the social studies subject coordinator from a future school (primary) were interviewed for this study in the context of innovating the social studies through Idea Garden. In addition, records of meeting from 2013-2014 was collected. The data was analyzed using figure 1 as a guide. The data coded situate
the loci of instructional decisions and actions that the school leaders have been devoting their energy for the past two years. The themes formulated below were sent to the participants for members checking to ensure that the researchers have represented their views fairly.

Figure 1: TPACK Design Space for School Leaders

3. Findings

With regards to the leadership practice, distributed leadership emerged naturally as the school leaders were engaged in actualizing the future school effort. The different roles undertaken by the leaders are shaped by institutional norms. The principal assumed leadership in contextualizing school directions towards cultivating 21st century competencies and ensuring learning of good foundational disciplinary-based knowledge. Based on that, he also enabled staff by structuring professional developments activities and sourcing for additional funding. His role is therefore more on interfacing with the external environment and people. The principal articulated his work as follow:

At the beginning of the future school projects, my role is to lead my key personals, including the vice principals and the HODs (head of department) to contextualize the MOE (ministry of education) 21st century competencies framework for our school. This involves looking at what we have in terms of technology capacity, manpower capital and the students’ general learning and family profiles. We went through rounds of intensive discussion and we agree to focus on values and key 21 competencies students need to have without compromising the foundational knowledge. Then we operationalize the framework and put up a proposal to obtain research and development fund for the school. I am also the person to source for potential collaborators from the IHL (institute of higher learning) to provide TPACK training for the KPs (key personals) and later the whole school. I set up collaborations with international researchers, industry partners and researchers from local university to bring in the necessary expertise to work with our teachers.
With the strategic directions set, the vice principal supported the school transformation by working with technology service providers, looking into the infrastructure of the school and ensuring that financial procedures are adhered to. For example, he drafted the documents to call for interested vendors to bid for the services and he reviewed the specification for learning analytics needed for Idea Garden. The vice principal’s is therefore more focused on laying the necessary technological conditions within the school context. He acquired his technological expertise at the infrastructure level through his experience of working as education technology officer in the ministry of education. As for the HOD for ICT, he described his roles as ensuring alignment of school goals with the efforts devoted to ICT integration. He understands his work as guiding curriculum redesign and integrating the efforts for the various subject matters and providing support for the professional development activities. In his words,

I see the need to take a step back and view KB and other projects from the system’s perspective and see how, these projects collectively can enhance the learning experience of the student. The experience with KB reaffirms again the potential ICT has being integrated with the curriculum. Working closely with the co-PI and his team of researchers, project drivers, teachers, curriculum developers and even allied educators provide multiple insights to redesigning the existing curriculum and executing it in lessons. Research serves as an affirmation to delivering the planned redesigned curriculum. Anchored by a sound pedagogy with meaningful integration of the Idea Garden platform, we are experiencing first hand a new way of learning in our students, one that is important for the 21st century.

The PD plan looks into the teacher’s capacity building in three areas i.e. curriculum, pedagogy and technical aspects. In delivering the PD to the teachers, we work closely with Prof C and the curriculum developer and the ICT support staff team.

For the subject coordinator, Mr E, his main role is to ensure that the ministry curriculum goals are not compromised. He views his inputs and leadership for the project as follow:

In creating new practices and procedures in my teaching, there is a rather drastic shift towards student-centered learning as part of 21CC skills. It takes a lot of getting used to especially relinquishing control of the students’ everyday learning. A KB teacher is no longer a ‘vessel’ of knowledge to the students and requires a unique skills set of classroom management in order to have a successful KB classroom. In every lesson, the students are required to use various KB principles in their research and discussions.

In summary, he is responsible in ensuring adherence to the syllabus and at the same time creating the new practices needed for the new technologically supported pedagogy. He is also consolidating his experiences to pass on to his colleagues for future professional development “to equip teachers before they embark in KB”.

4. Discussion

From the perspective of TPACK, the school leaders each occupy mainly a sub-domain of the TPACK factors. The principal established the general pedagogical push towards 21st century learning while the vice principals work mainly on the technological dimension in providing the necessary infrastructure. Building on the pedagogical direction sets the directions for reform. The ICT HOD works are situated in
the sphere of technological pedagogical dimension while the expertise of the subject coordinator lies in content knowledge and pedagogical content knowledge. The distributed expertise was brought to bear on collectively on the creation of the platform and pedagogical practices encapsulated in the form of lesson plans and materials, and also professional development materials for scaling up purposes. The creation of platform, practices and materials can be viewed as knowledge creation efforts in the school context. This becomes the main form of professional development for the teachers to draw upon their existing knowledge and ideas and refine them in collaborative discussion. In other words, the learning processes is in essence a knowledge creation processes (Chai et al., 2014).

School improvement and transformation is complex in nature, especially given the rapid advancement of technology. Multiple levels of leadership have to work synergistically in a coordinated manner. Heck and Hallinger (2014) termed this as “leadership for learning”, which encompasses both instructional leadership and transformational leadership. While the principals in this case study are providing transformative leadership and developing knowledge for the technology and pedagogical dimensions, the HOD and subject head are working on instructional leadership in the technological pedagogical dimensions and the pedagogical content knowledge dimension.

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References


Development and validation of an instrument for exploring Taiwanese undergraduates’ approaches to Internet-based learning

Yu-Chih TSAO*, Chi-Ling WU, & Min-Hsien LEE
Institute of Education, National Sun Yat-sen University, Taiwan
*watsao32@gmail.com

Abstract: Few studies have developed questionnaires that attempt to assess approaches to learning in the context of Internet-based learning. To obtain a better understanding of undergraduates’ approaches to Internet-based learning, this study aimed to develop and validate the Approaches to Internet-based Learning (AIL) instrument which was created by referring to the qualitative results of Ellis’ (2011) research and the structure of Lee et al.’s (2008) Approaches to Learning Science questionnaire. The AIL consists of the six factors of “deep motive,” “criticism and evaluation”, “reflection and integration,” “surface motive,” “collecting and summarizing,” and “replicating information.” In addition, the former three factors could be categorized as “Deep approaches to Internet-based learning” while the latter three could be grouped into “Surface approaches to Internet-based learning.” To establish the reliability and validity of the AIL and to confirm its second-order structure as hypothesized in this study, exploratory factor analysis and second-order confirmatory factor analysis were conducted. A total of 598 undergraduates from seven Taiwanese universities participated in this study. The results support our hypothesized second-order structure of the AIL and indicate that the instrument items have good reliability and validity. We also found that the Taiwanese undergraduates tended to adopt deep approaches to Internet-based learning. The newly developed AIL could provide educators with a valid instrument to examine students’ approaches to Internet-based learning.

Keywords: Approaches to Internet-based learning

1. Introduction

Following the advances in technology and associated innovations, Internet-based learning or online learning has been recognized as an effective way to enhance students’ learning. In one study, 71% of students said that the Internet tended to be the major source of information for their school learning (Lenhart et al., 2001). Additionally, recent research has indicated that enrollment in online courses is growing at a rate approximately ten times that of traditional classroom-based instruction in higher education (Shea & Bidjerano, 2009). Due to the rapid development of Internet technology in education, numerous studies have investigated how students’ characteristics contribute to learning in an Internet-based context. Some studies have attempted to investigate students’ approaches to Internet-based learning. Ellis et al. (2011) investigated students’ experiences of learning through research on the Internet, and identified four categories: “Critical focus and Evaluation,” “Reflection and Integration,” “Collecting and Summarizing,” and “Replicating information.” The four categories seem to reflect the various forms of students’ strategies in the context of Internet-based learning. In addition, Marton and Säljö (1976) found that undergraduates’ approaches to learning could be classified as ‘surface approaches to learning’ and ‘deep approaches to learning.’ In Ellis et al.’s (2011) study, the first two categories could be categorized as deep approaches while the latter two could be categorized as surface approaches.

In the area of learning approaches, several studies have used questionnaires to explore students’ approaches to learning such as Kember et al. (2004) and Lee, Johanson and Tsai (2008). Kember et al.’s (2004) and Lee et al.’s (2008) questionnaires consisted of the four main factors of deep motive for learning, deep strategies for learning, surface motive for learning, and surface strategies for learning, which could also be grouped as deep approaches and surface approaches. However, few studies have
developed questionnaires that attempt to assess approaches to learning in the context of Internet-based learning.

A larger scale quantitative survey might obtain a better understanding of students’ approaches to Internet-based learning. Moreover, second-order confirmatory factor analysis can be used to examine whether the motive for learning and strategies for learning can be framed by higher-order categorization such as surface and deep approaches. By referring to the four categories of Ellis et al. (2011) and the structure of Lee et al.’s (2008) instrument, the aim of this study was to develop and validate an instrument, namely the Approaches to Internet-based Learning (AIL) instrument, for exploring Taiwanese undergraduates’ approaches to Internet-based learning.

2. Method

2.1 Participants

The participants consisted of a total of 598 undergraduates (261 male) from seven universities in Taiwan. All participants responded to the AIL instrument. The participants were then split into two subsets for the exploratory factor analysis (EFA) ($n = 445$) and the second-order confirmatory factor analysis (CFA) ($n = 153$).

2.2 Instrument assessing undergraduates’ approaches to Internet-based learning (AIL)

The AIL instrument was created with reference to the qualitative results of Ellis’ (2011) research and the structure of Lee et al.’s (2008) ALS (Approaches to Learning Science) questionnaire. The AIL consists of the six factors of “deep motive,” “deep strategy A: criticism and evaluation”, “deep strategy B: reflection and integration,” “surface motive,” “surface strategy A: collecting and summarizing,” and “surface strategy B: replicating information.” In addition, the former three factors could be categorized as “Deep approaches to Internet-based learning” and the latter three could be grouped into “Surface approaches to Internet-based learning.”

Through consulting with four experts in this field for the content validity, this study constructed 5 items for each of the six factors, giving a total of 30 items presented in a five-point Likert mode, ranging from “strongly agree” to “strongly disagree.” A detailed description of the six factors, with a sample item for each, is presented below:

- **Deep motive (DM):** The student has a deep motive (e.g., intrinsic interest) for Internet-based learning, e.g., When I learn in the context of Internet-based learning, I feel happy and contented.
- **Criticism and Evaluation (CE):** The student uses critical thinking and information evaluation in the context of Internet-based learning, e.g., When I am learning in the context of the Internet, I check different websites at the same time to judge information.
- **Reflection and Integration (RI):** Knowledge reflection and integration are used in the context of Internet-based learning, e.g., When I use the Internet for learning, I like to create a theory to help me put the fragmented content together.
- **Surface motive (SM):** The student uses Internet-based learning just to pass exams or meet the requirements of the course, e.g., I use the Internet for learning in order to get a good grade.
- **Collecting and Summarizing (CS):** Collecting and summarizing information are the main strategies adopted in the context of Internet-based learning, e.g., When I use the Internet for learning, irrelevant contents do not make sense to me.
- **Replicating information (Rep):** Replicating information is the main strategy used in Internet-based learning, e.g., When I use the Internet for learning, I think the best way to get a good grade is to memorize the answers to related questions.

2.3 Data analysis and procedure

The purpose of this study was to develop and validate an instrument, namely the Approaches to Internet-based Learning (AIL) instrument, for exploring Taiwanese undergraduates’ approaches to Internet-based learning. In order to establish the reliability and validity of the AIL, both exploratory and
second-order confirmatory factor analyses were performed. The reduction of items of the AIL was based on two sets of evidence: an exploratory factor analysis, followed by the use of reliability statistics. In an EFA, only those items with a factor loading of at least 0.40 within their own factor should be retained (Stevenson, 1996). EFA was employed first and then the second-order confirmatory factor analysis (CFA) was performed to analyze the construct validity and structure of the AIL.

Accordingly, the validity and reliability of the AIL were evaluated. In addition, the participants were split into two subsets for the exploratory factor analysis (EFA) \((n=445)\) and for the second-order confirmatory factor analysis (CFA) \((n=153)\).

3. Results and Discussion

3.1 Exploratory factor analysis for the approaches to Internet-based learning (AIL) \((n=445)\)

An exploratory factor analysis with a varimax rotation was performed to clarify the structure of the AIL. As a result, the 445 students’ responses were grouped into the following six factors: Deep motive (DM), Criticism and Evaluation (CE), Reflection and Integration (RI), Surface Motive (SM), Collecting and Summarizing (CS), and Replicating information (Rep). The eigenvalues of the six factors from the principle component analysis were all larger than one, while six items with a factor loading of less than 0.40 were omitted from the instrument. As a result, a total of 24 items were retained in the final version of the AIL (as shown in Table 1), and the total variance explained is 65.62%.

Table 1: The exploratory factor analysis for the AIL factors \((n = 445)\)

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<thead>
<tr>
<th>Factor 1: Deep Motive (Mean = 3.48, SD = .65, (\alpha = .84))</th>
<th>Factor 2</th>
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<td>Factor 2: Criticism and Evaluation (Mean = 3.84, SD = .65, (\alpha = .83))</td>
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<tr>
<td>CE 7</td>
<td>.74</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CE 8</td>
<td>.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CE 10</td>
<td>.83</td>
<td></td>
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</tr>
<tr>
<td>CE 11</td>
<td>.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 3: Reflection and Integration (Mean = 3.67, SD = .65, (\alpha = .81))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI 12</td>
<td>.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI 13</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI 14</td>
<td>.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>RI 15</td>
<td>.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RI 16</td>
<td>.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 4: Surface Motive (Mean = 3.14, SD = .79, (\alpha = .68))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM 18</td>
<td></td>
<td>.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM 20</td>
<td></td>
<td>.61</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SM 21</td>
<td></td>
<td>.68</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 5: Collecting and Summarizing (Mean = 2.92, SD = .80, (\alpha = .81))</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CS 22</td>
<td></td>
<td></td>
<td>.80</td>
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<td></td>
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<tr>
<td>CS 23</td>
<td></td>
<td></td>
<td>.81</td>
<td></td>
<td></td>
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<td>CS 24</td>
<td></td>
<td></td>
<td>.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS 25</td>
<td></td>
<td></td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 6: Replicating information (Mean = 3.00, SD = .85, (\alpha = .79))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rep 28</td>
<td></td>
<td></td>
<td></td>
<td>.82</td>
<td></td>
</tr>
<tr>
<td>Rep 29</td>
<td></td>
<td></td>
<td></td>
<td>.78</td>
<td></td>
</tr>
<tr>
<td>Rep 30</td>
<td></td>
<td></td>
<td></td>
<td>.77</td>
<td></td>
</tr>
</tbody>
</table>

Total variance = 65.62%, overall \(\alpha = 0.87\)
In addition, the reliability (Cronbach’s alpha) coefficients respectively for these factors were 0.84, 0.83, 0.81, 0.68, 0.81, and 0.79, and the overall alpha was 0.87, suggesting that these factors had sufficient reliability in assessing the students’ approaches to Internet-based learning.

### 3.2 Second-order confirmatory factor analysis for the AIL (n=153)

The CFA further confirmed the construct validity and the second-order structure of the 24 item version of the AIL through the 153 students’ responses. In addition, the second-order factor analysis model of the AIL was hypothesized in this study. To examine whether the second-order structure of the AIL can be established, the first-order factors which converged to the second-order constructs were tested. Each factor of the AIL was a first-order construct (i.e., DM, CE, RI, SM, CS, and Rep). The deep and surface approaches to Internet-based learning served as the second-order constructs of the AIL. As shown in Table 2A, the factor loading values for the six factors are significant and larger than 0.4. The ratio of chi-square per degree of freedom = 1.46, RMSEA = 0.055, CFI = 0.95, GFI = 0.84, AGFI = 0.80. Moreover, the results shown in Table 2B support that the first-order factors converge to the second-order constructs. These results suggest an acceptable model fit which supports our hypothesized second-order structure of the AIL and indicates that the instrument items have good convergent and construct validity in this model.

### Table 2: The Second-order Confirmatory factor analysis (CFA) for the AIL factors (n = 153)

**A. Standardized CFA first-order loading**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Number of item</th>
<th>Factor loading</th>
<th>t-value</th>
<th>CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep motive (DM)</td>
<td>5</td>
<td>0.69 - 0.86</td>
<td>8.97 - 11.82</td>
<td>0.88</td>
</tr>
<tr>
<td>Criticism and Evaluation (CE)</td>
<td>4</td>
<td>0.70 - 0.75</td>
<td>7.38 - 7.84</td>
<td>0.81</td>
</tr>
<tr>
<td>Reflection and Integration (RI)</td>
<td>5</td>
<td>0.45 - 0.69</td>
<td>4.51 - 4.80</td>
<td>0.74</td>
</tr>
<tr>
<td>Surface Motive (SM)</td>
<td>3</td>
<td>0.54 - 0.71</td>
<td>4.61 - 4.60</td>
<td>0.66</td>
</tr>
<tr>
<td>Collecting and Summarizing (CS)</td>
<td>4</td>
<td>0.62 - 0.70</td>
<td>6.02 - 6.35</td>
<td>0.76</td>
</tr>
<tr>
<td>Replicating information (Rep)</td>
<td>3</td>
<td>0.48 - 0.91</td>
<td>5.12 - 6.12</td>
<td>0.75</td>
</tr>
</tbody>
</table>

**B. Standardized CFA second-order loading**

<table>
<thead>
<tr>
<th>Second-order factor model</th>
<th>Loading value</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep approaches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM</td>
<td>0.71</td>
<td>7.21&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>CE</td>
<td>0.79</td>
<td>6.81&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>RI</td>
<td>0.88</td>
<td>4.83&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Surface approaches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td>0.61</td>
<td>3.54&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>CS</td>
<td>0.51</td>
<td>3.71&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rep</td>
<td>0.68</td>
<td>4.67&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* p < 0.05; CR: Composite Reliability

### 3.3 Paired-t-test for the AIL (n = 598)

In order to understand students’ learning motive and strategy in the context of Internet-based learning, this study calculated the mean values for deep strategy as combining CE and RI, and for surface strategy as combining CS and Rep. Then, a paired t-test was conducted to examine whether the students tended to use deep or surface approaches to learn in the context of Internet-based learning. As shown in Table 3, significant differences were found. The results seem to indicate that, rather than surface approaches, these Taiwanese undergraduates tended to have deep motives and adopt deep strategies to learn in the context of Internet-based learning.
Table 3: Differences between Deep AIL and Surface AIL (n = 598)

<table>
<thead>
<tr>
<th></th>
<th>Deep AIL (M, SD)</th>
<th>Surface AIL (M, SD)</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Motive</td>
<td>3.52 (0.67)</td>
<td>3.20 (0.79)</td>
<td>9.25***</td>
</tr>
<tr>
<td>Deep Strategy</td>
<td>3.75 (0.57)</td>
<td>2.97 (0.69)</td>
<td>21.96***</td>
</tr>
</tbody>
</table>

***p < .001.

In conclusion, the abovementioned results suggest that the newly developed AIL instrument has sufficient reliability and validity, and could serve as a valid instrument for evaluating undergraduates’ approaches to Internet-based learning.

References


Investigating Chinese University Students’ Perceptions about Blackboard Platform to Support Their Online Learning

Weisheng LIa, Lizhu CHENA, Ge QUa & Yan DONGa*
*Faculty of Education, Beijing Normal University, China
*dongyan98@126.com

Abstract: In this paper, we investigated the current situation of BB (Blackboard) platform using and the Chinese university students’ learning attitudes towards BB platform. Data were collected from 164 students (51 male and 113 female) in Beijing via self-reported questionnaires: Questionnaire of Perceptions about Blackboard platform (PBPQ), including three scales (Ease of Use, Usefulness, Attitude). Results showed that the PBPQ can be used for the Chinese context with good validity and reliability. Further analysis results indicated that different frequencies of using BB platform were related the most to all the three scales except gender, major and grade. The results also showed that students’ learning attitudes can be improved by ameliorating the Ease of use and Usefulness of BB platform, and teachers should encourage students to use BB more frequently if they want to use BB platform for teaching. These results give some advice for future course designs on BB platform.

Keywords: Blackboard platform, perception, current situation, learning attitude

1. Introduction

The BB platform is one kind of network platforms that was developed by the U.S. Blackboard company. In October 2003, it was introduced to China by the Beijing CERNET Blackboard company. BB platform is the largest network teaching platform in the world, which can support millions of users. In the market of network teaching platform, BB platform has occupied 85% of the American market and more than 50% of the global market (Song, 2009). Previous studies (Athena & Maker, 2004; Zhang, 2012; Meng, 2011) mainly paid attention to user experience of BB platform and how to design a course with BB platform. For example, Athena and Maker (2004) introduced many teachers’ use experience and course management results with BB platform. Zhang (2012) did a research on network collaborative learning. Meng (2011) did the research about how to design an interactive mode based on Blackboard platform. However, there was less research on the university students’ learning attitudes towards BB platform. In order to explore about the Chinese college students’ perceptions about BB platform, this study aims to take the PBPQ questionnaire, developed by Tsai, Tsai and Hwang (2012) to make a deep understanding about Chinese students.

In sum, this study included the following research questions:
1) Can this questionnaire be used for Chinese mainland college students to measure their perceptions about BB platform?
2) What is the current using situation about BB platform in China?
3) Is there any difference between different major, grade and gender students’ perceptions about BB platform?
4) Is there any difference among different frequencies of using BB students’ perceptions about BB platform?

2. Methods

2.1 Participants
The participants in this study included 164 college students in Beijing, China. The study took part in the convenience sampling. There were 51 male and 113 female students. They were from different grade (G1: G2: G3: G4 = 54:44:42:24) and different major (Liberal arts: Science: Others = 69:89:8) in a famous university in Beijing, China. All participants were volunteers to complete the questionnaires in one sitting to explore the current using situation of BB platform and their learning attitudes towards BB platform.

2.2 Instruments

This present study used the instrument developed by Tsai (2012). It was validated for Taiwan students, similar to the Chinese context. This instrument employed a multi-dimensional framework to show student' perceptions about Blackboard platform.

This instrument included the following three scales, with a sample item for each scales:

a) Ease of Use: This scale measures perceptions of the extent to which students prefer that BB platform are easy to use. The example item is ‘The search results which are displayed in BB platform are clear and easy to read’.

b) Usefulness: This scale measures the usefulness of BB platform in different students’ eyes. The example item is ‘The use of BB platform would enhance students’ ability to search for information when problem-solving’.

c) Attitude: This scale measures students’ learning attitudes towards BB platform. The example item is ‘I have more willingness to use BB platform than before’.

2.3 Data Collection and Analysis

Before filling the questionnaires, an instructor trained by the research team informed the responding students of the purpose of the study. The process first involved a survey of each participant’s demographic data such as gender and grade. Then, the participant was asked to answer the PBPQ. It took about 15 min to complete this whole survey.

The PBPQ was utilized in this study. Exploratory factor analysis was used to clarify the questionnaire structure. Accordingly, the validity and reliability of the questionnaire was also evaluated. Moreover, an independent t-test was conducted to explore whether there were differences between the two major groups of students. In addition, Pearson’s correlation analysis was performed on the students’ responses to PBPQ for the students.

3. Results

3.1 Factor Analyses

To ensure a well factor structure and reliability of the factors, it is necessary to make a reexamination. The following Table 1 respectively reveals the consequences of factor analyses for the aforementioned three factors: Ease of use, Usefulness, Attitudes. To get the final instrument, items whose factor loading weighs more than 0.5 were retained. Therefore, there are 10 items showed in Table 1 in total, and the total variance explained is 77.121%. For every scale, alpha coefficient was from 0.819 to 0.897, indicating favorable interaction consistency to do the statistical analysis.

Table 1: Rotated factor matrix and the alpha coefficient for the Ease of use and Usefulness of BB platform (N=164).

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use 1</td>
<td>0.83</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ease of use 2</td>
<td>0.85</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ease of use 3</td>
<td>0.78</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ease of use 4</td>
<td>0.80</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Factor 1: Ease of use, α=0.897, mean=2.53, SD=0.41
3.2 The correlation between the frequency of Using BB and the Ease of use, Usefulness, the Attitudes

According to the Table 2, Ease of use was related to both student’s age and frequency of using BB. Usefulness was related to their frequency of using BB while Attitudes were linked to both major and frequency.

Table 2: The correlation between the frequency of Using BB and the Ease of use, Usefulness, the Attitudes.

<table>
<thead>
<tr>
<th></th>
<th>Ease of use</th>
<th>Usefulness</th>
<th>Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.190*</td>
<td>0.063</td>
<td>0.126</td>
</tr>
<tr>
<td>Major</td>
<td>0.049</td>
<td>0.100</td>
<td>0.175</td>
</tr>
<tr>
<td>frequency of using BB</td>
<td>0.318**</td>
<td>0.309***</td>
<td>0.358***</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01

3.3 Step-wise Regression Analysis

After analyzing the correlation between the factors, the study attempts to predict student’s attitudes towards the BB. As following(Table 3), in the regression equation, the coefficients of Ease of use, Usefulness, Frequency of Using BB respectively were 0.403, 0.284, 0.154 while the constant equaled to 0.648.

Table 3: Step-wise Regression Analysis for predicting Students attitudes towards the BB.

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>B</th>
<th>T</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use</td>
<td>0.403</td>
<td>6.140</td>
<td>0.632</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>0.284</td>
<td>4.358</td>
<td>0.689</td>
<td></td>
</tr>
<tr>
<td>Frequency of using BB</td>
<td>0.154</td>
<td>2.173</td>
<td>0.700</td>
<td></td>
</tr>
</tbody>
</table>

3.4 Major difference

The study compared the possible difference between Liberal arts majors and Science majors. As shown in Table 4, Science major students had higher scores than students who majored in liberal arts, especially on attitudes (p<0.05). It means that Liberal arts major students are more likely to accept this platform easily, to get more convenient learning method and better sources.

Table 4: Major comparisons of the scores for all the scale.

<table>
<thead>
<tr>
<th>scale</th>
<th>major(n)</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>Liberal arts majors(51)</td>
<td>2.48</td>
<td>0.97</td>
<td>0.14</td>
<td>0.704</td>
</tr>
<tr>
<td></td>
<td>Science major(105)</td>
<td>2.54</td>
<td>1.00</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>Liberal arts majors(51)</td>
<td>2.80</td>
<td>0.98</td>
<td>0.14</td>
<td>0.107</td>
</tr>
<tr>
<td></td>
<td>Science major(105)</td>
<td>3.06</td>
<td>0.96</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Attitudes</td>
<td>Liberal arts majors(51)</td>
<td>2.72</td>
<td>0.77</td>
<td>0.11</td>
<td>0.014*</td>
</tr>
<tr>
<td></td>
<td>Science major(105)</td>
<td>3.11</td>
<td>0.99</td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

525
3.5 Grade difference

This study also made a comparison between junior grade (including freshman and sophomore students) and senior grade (the third and fourth grade) to look for possible differences. Similarly, from the result of t-test, several significant differences were showed in Table 5. It revealed that senior grade students had better scores on Ease of use (p<0.05) than junior grade students. That is, senior grade students thought it easier to use than junior grade students.

<table>
<thead>
<tr>
<th>scale</th>
<th>grade(n)</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>Junior grade(73)</td>
<td>2.73</td>
<td>1.00</td>
<td>0.12</td>
<td>0.020*</td>
</tr>
<tr>
<td></td>
<td>Senior grade(91)</td>
<td>2.37</td>
<td>0.94</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>Junior grade(73)</td>
<td>3.06</td>
<td>0.93</td>
<td>0.11</td>
<td>0.312</td>
</tr>
<tr>
<td></td>
<td>Senior grade(91)</td>
<td>2.90</td>
<td>1.00</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>Attitudes</td>
<td>Junior grade(73)</td>
<td>3.05</td>
<td>0.96</td>
<td>0.11</td>
<td>0.455</td>
</tr>
<tr>
<td></td>
<td>Senior grade(91)</td>
<td>2.94</td>
<td>0.90</td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

3.6 Frequency of using BB difference

The comparison between high- frequency (frequently or often) and low-frequency (occasionally or sometimes) of using BB also revealed some differences by t-test. What showed in Table 6 is, Students who used BB in high-frequency had more identity on BB than the rest part students, they thought the BB platform were not only easy to use (p<0.01), but also useful (p<0.01), in addition, their attitudes (p<0.01) towards BB were more desired.

<table>
<thead>
<tr>
<th>scale</th>
<th>frequency(n)</th>
<th>mean</th>
<th>SD</th>
<th>T</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of use</td>
<td>high- frequency(59)</td>
<td>2.26</td>
<td>0.84</td>
<td>0.11</td>
<td>0.008**</td>
</tr>
<tr>
<td></td>
<td>low-frequency(105)</td>
<td>2.68</td>
<td>1.02</td>
<td>0.10</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>high- frequency(59)</td>
<td>2.67</td>
<td>0.95</td>
<td>0.12</td>
<td>0.002**</td>
</tr>
<tr>
<td></td>
<td>low-frequency(105)</td>
<td>3.15</td>
<td>0.94</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Attitudes</td>
<td>high- frequency(59)</td>
<td>2.71</td>
<td>0.80</td>
<td>0.10</td>
<td>0.003**</td>
</tr>
<tr>
<td></td>
<td>low-frequency(105)</td>
<td>3.15</td>
<td>0.95</td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

4. Discussion and Conclusion

This study reports the validation of Questionnaire of Perceptions about Blackboard platform (PBPQ). A sample of students joined in reporting their perceptions of all prepared items. The instrument was certified reliable and valid based on three scales for Chinese mainland university students.

In this study, Table 2 indicated that Frequency of using BB was related the most to all the three scales while major, gender and grade had little relation. Table 3 predicted that students’ learning attitudes can be improved by ameliorating the BB platform’s Ease of use, Usefulness and encouraging students to use BB more frequently.

Table 4 and Table 5 uncovered that there were noticeable difference between different majors and grades students in the perceptions of BB platform. It showed that Liberal arts major students were likely to learn by BB more than Science major students were. The probably reason was that BB had stronger function on sharing literal files instead of Science instruments or so. As for the Ease of using BB, the senior grade students considered it easier, and this might be related to their using times or frequency compared to the junior grade students. It was also confirmed in Table 6 that higher frequency of using BB led to better experience. Its reason may be that students found more functions convenient to learn subjects to get a better impression of BB platform.
There were some advises from participants for BB platform such as associating with mobile applications, making friendlier interface, and setting modules of adding online friends and so on. All these results can give those courses designers of BB platform more valuable content.

Acknowledgements

We would like to thank for the funding project from School of Educational Technology, Beijing Normal University in China (No 705105602).

References


Engineering Graduate Students’ Literature Searching Behaviors

Ying-Hsueh CHENG* & Chin-Chung Tsaib

aNational Pingtung University of Science and Technology, Taiwan
bNational Taiwan University of Science and Technology, Taiwan
*sherrycheng85@gmail.com

Abstract: In this paper, we drew on Kuiper, Volman and Terwel’s (2008) three aspects of web literacy skills (searching, reading, and evaluating) and investigated engineering graduate students’ literature searching strategies. Through in-depth interviews and think-aloud protocols, we compared strategies employed by twenty-two engineering graduate students in Taiwan. The findings showed that the students’ literature searching behaviors included searching, reading, and evaluating sources for their research purposes. Implications for enhancing information literacy of engineering students are suggested.

Keywords: Engineering, graduate students, literature searching

1. Introduction

During the past decades, studies have been conducted to examine graduate students’ literature searching behaviors in several disciplines: education (Mose, 2011), humanities (Bronstein, 2007), physics and astronomy (Jamali & Nicholas, 2010), and basic and medical sciences (Hemminger, Lu, Vaughan, & Adams, 2007). However, few have examined engineering graduate students’ seeking behaviors. How engineering students actually search literature and use information for research purposes has been little studied. Thus, this study aims to explore Taiwanese engineering graduate students’ literature searching behaviors in three aspects: (1) how do they seek and obtain online information for research? (2) how do they read and interpret sources? and (3) how do they assess and evaluate those sources for their research tasks?

2. Literature Review

2.1 Graduate Students’ Literature Searching Behaviors

During the past decades, studies have been conducted to understand graduate students’ literature searching behaviors. Some have conducted large-scale studies with the purpose to categorize students’ search behaviors across diverse disciplines (Du & Evans, 2011; Rempel, 2010). However, such approach has been criticized by those who value a discipline-based approach (Grafstein, 2002; Jamali & Nicolas, 2010). These researchers argue that it is equally important to examine skills required for acquiring knowledge or conducting research in a specific subject area (Talja, Vakkari, Fry, & Wouters, 2007). For instance, Barrett (2005) explored humanities graduate students’ seeking practices and found that they used Google to find general information on a topic, and other techniques such as citation chasing, identifying primary sources to validate their theories and hypotheses, having interpersonal contact for guidance, and constantly reading in a subject area.

Thus far, to the best of our knowledge, only one study conducted by Ismail and Kareem (2011) is related. Studying information seeking by Malaysian master’s students in a computer science and information technology program, Ismail and Kareem found that these students had difficulties obtaining relevant information for their research. Unfamiliar with specific scholalry tools, the students relied on Google or Google Scholar for searching but were overloaded with massive information.
Ismail and Kareem’s research demonstrates struggle and strategies novice engineering researchers are likely to encounter when obtaining the required information and it indicates the importance of facilitating them to enhance their searches for academic literature.

2.2 Searching, Reading, and Evaluating Online Information

Several frameworks have been proposed to explore students’ searching practices. Related to this study, Kuiper, Volman and Terwel’s (2008) three aspects of skills: searching, reading, and evaluating, are considered. *Searching skills* refer to the ability to define appropriate keywords and use search engines or library databases. *Reading skills* include the ability to sort through massive information and decide what to use and what to neglect. *Evaluating skills* consist of the ability to assess the authority, relevance, and reliability of Web information. According to Kuiper et al. (2008), these three skills are mutually connected. Considering this study, we adopted Kuipert et al.’s framework and aimed to investigate how graduate students search, read, and evaluate information sources for their research purposes.

3. Methods

3.1 Participants

For the purpose of the study, fifteen master’s students and seven doctoral students from two national universities in Taiwan were recruited. The students’ research-related searching experiences ranged from one to seven years. Their specialized areas varied from material science and engineering, automation and control, to applied science and technology. They conducted academic literature searching for a variety of writing purposes (course assignments, grant projects, conference papers, journal articles, and theses/dissertations) and sometimes for experimental purposes (details of methodology in other studies).

3.2 Data Collection

Data sets included two parts: a semi-structured retrospective interview (30-40 minutes) and a concurrent think-aloud protocol (30-40 minutes). Audio recordings were collected from the interview and screen recordings were gathered from the think-aloud protocol.

3.3 Data Analysis

To answer the three research questions, the analyses were guided by Kuiper et al.’s (2008) three skills. We focused on how the engineering graduate students were engaged in searching, reading, and evaluating research-related information.

4. Findings and Discussion

The findings correspond with the three aspects of web literacy skills raised by Kuiper et al. (2008): searching, reading, and evaluating. In the following, we offer responses to the research questions and discussions of the findings in relation to the literature.

4.1 Searching

The participants reported four strategies they used for seeking and obtaining online information. These strategies included: using search engines and library databases, and networking for retrieving articles or materials.
In this study, seven students reported that they turned to Google or Google Scholar before the library databases because they included major science databases and thus provided sufficient sources related to their research. Frequent use of Google or Google Scholar by graduate students has been reported in the literature. Purposes indicated include conducting broad searches (Rempel, 2010) and using them as a starting point (Du & Evans, 2011) or to acquire new knowledge (Vibert, Rouet, Ros, Ramond, & Deshoulieres, 2007). The finding implies that it is beneficial to begin research by using search engines to browse and construct background knowledge and then use library databases for specific search purposes.

Moreover, networking for retrieving articles or materials was frequently reported by the engineering graduate students in this study. Aligned with previous studies, the finding revealed that engineering literature searching behaviors involve dynamic source-seeker connections for retrieving information efficiently (Xu, Tan, & Yang, 2006). It is suggested that graduate students initiate contacts with colleagues, librarians, or experts inside or outside their programs to request information.

4.2 Reading

The participants reported that they selected main ideas for reading, including browsing the title first and then the abstract, and referring to specific sections in the article (e.g., methods or conclusion). These involve quick decisions to read online or to download an article for in-depth reading. Such practice corresponds with M. J. Tsai and C. C. Tsai’s (2003) finding of selecting main idea strategy regarding how students grasp or summarize the main information provided in each Web page. The engineering students’ practices for online and printed resources are more intertwined and interactive than those observed in Ellis, Cox, & Hall’s study (1993).

The current study also observed that the engineering graduate students assessed the usefulness or relevance of information based on the graphs or images in the methods section. This is similar to Aurisicchio, Bracewell, & Wallace’s (2010) finding regarding aerospace designers’ use of drawings.

Moreover, it was found that to develop a comprehensive understanding of a research topic, the participants were aware that they had to read broadly in a subject area. Such finding is similar to humanities graduate students’ practices (Barrett, 2005) and it indicates the process of building domain knowledge through constant searching and reading.

4.3 Evaluating

Four evaluation criteria were discussed by the participants regarding the usefulness of online sources. These included: relevance, recency, credibility, and authority. Different from the processes of searching and reading, these criteria are considered higher-order thinking skills, facilitating the users to differentiate and sort out online information critically. Without this process, literature searching would not be successful and thus it plays a crucial role in information seeking (Biddix, Chung, & Park, 2011; Currie, Devlin, Emde, & Graves, 2010; Head & Eisenberg, 2009).

5. Limitations and Implications

This study has some limitations and thus draws some implications for future research. In this study, a sample of Taiwanese engineering graduate students enrolled in the master’s and doctoral programs was recruited. It is suggested that the theoretical frameworks and the conclusions of the study can be further explored in other student populations.

Interviews with those (e.g., librarians, peers, colleagues, or advisors) who facilitate the participants to conduct their literature searching may be needed in order to triangulate varied perspectives of their searching processes.

Finally, it is suggested that adopting mixed methods including surveys and interviews could perhaps gather a broad picture of users’ searching perceptions and behaviors.
Acknowledgements

We would like to thank the 22 students for their participation in this study. Without their time and help, this study would not have been possible.

References


Developing an Online Formative Assessment System for a Chinese EFL Course

Chunping ZHENG*, You SU & Jingjing LIAN
School of Humanities, Beijing University of Posts and Telecommunications, China
*zhengchunping@bupt.edu.cn

Abstract: This study aims to develop an Online Formative Assessment System for a Chinese EFL course to support conducting formative assessment activities and further improving learners’ English language skills. Two questionnaire surveys were conducted on 653 participants at the end of the course to explore their attitude toward the course (ATTC) and perceptions of the system (POTS) respectively. The results showed that students held favorable attitude toward the course as it improved their language skills. Students also expressed their preference for the system in terms of its usefulness, ease of use, and their willingness for future use. Besides, stepwise regression analyses indicated consistency between students’ ATTC and their POTS.

Keywords: Online formative assessment, language tasks, EFL, higher education

1. Introduction

Assessment plays a crucial role in the process of education for evaluating and further improving the teaching and learning. With the popularization of online and blended learning in higher education since the 21st century, effective integration of formative assessment in online learning environments was claimed to have the high potential for sustained meaningful interactions among learners and the teacher (Sorensen & Takle, 2005).

Formative assessment is increasingly being implemented through policy initiatives in the Chinese higher education setting (Chen, Kettle, Klenowski, & May, 2013). For instance, Wen (2011) and Zheng (2014) applied formative assessment to Chinese EFL courses. Though there is a refocused emphasis on online formative assessment in order to create learner and assessment centered learning environments (Pachler, Daly, Mor, & Mellar, 2010; Wang, Wang, & Huang, 2008), online formative assessment studies are still less established in Chinese EFL courses.

In the present study, an online formative assessment system was developed for supporting web-based formative assessment activities in an EFL course at a key university in North China. The system provides an innovative approach for guiding teachers to systematically and efficiently assign language learning tasks and supporting students to carry out online formative assessment activities. At the end of the course, two survey questionnaires have been conducted among 653 students who have experienced the course and the system to investigate their attitude toward the course and the system.

2. Development of the online formative assessment system

The online formative assessment system was developed in year 2009 and has been applied in the EFL course at the university for five years. As shown in Figure 1, the structure of the system consists of two major components: an “Online Course Materials Module” and an “Online Formative Assessment Module”.

The “Online Course Materials Module” was designed by teachers, including three sections, namely, “Resources Center for Language Learning Tasks”, “Rubrics for Online Assessment” and “Students’ Demo Work”. “Resources Center for Language Learning Tasks” is a database for 23 categories of language tasks. In total, 280 language tasks were designed meeting the learning objectives of 28 units in four EFL textbooks at different proficiency levels, “Rubrics for Online Assessment” are specific assessment criteria adapted from College English Curriculum Requirements (2007) to assess
learners’ language performance when completing the tasks and “Students’ Demo Work” is for collecting and sharing all the sample works from the students.

The “Online Formative Assessment Module” enables the teacher to assign learning tasks, conduct teacher assessment and recommend students’ demo work. It also provides students with functions for completing the tasks, uploading outcomes of tasks and conducting self and peer assessment.

![Figure 1. The Structure of Online Formative Assessment System](image)

3. Results and Discussion

3.1 Students’ attitude toward the EFL course and related course activities

After the EFL course, a questionnaire survey concerning the learners’ attitude toward the course (ATTC) was conducted. In the questionnaire, students received 27 statements, each of which they rated on a 5-point scale the degree to which they agreed or disagreed (1= most strongly disagree and 5= most strongly agree). The questionnaire was modified based on the perception questionnaire designed by Fang (2010). A detailed description of the six factors is presented below:

- Learners’ attitude toward the EFL course (attitude): assessing students’ general view of the course.
- Perceived usefulness for improving skills (improving skills): exploring effectiveness of the course for improving students’ listening, speaking, reading, writing skills.
- Task completeness: measuring the degree to which students worked to complete the tasks.
- Extra effort: delineating students’ after-class work for improving their language learning.
- Learners’ attitude toward teacher assessment (teacher assessment): disclosing students’ perceptions of teacher assessment activities in class.
- Learner’s attitude toward peers’ demo work (demo work): revealing the degree to which the peers’ demo work is welcomed.

The reliability (Cronbach’s alpha) for each factor is high (i.e., 0.89, 0.77, 0.75, 0.67, 0.84 and 0.75 respectively; the overall alpha coefficient is 0.91), indicating that these factors had sufficient reliability for measuring students’ perceptions of the EFL course and the related student and teacher activities in class.

Students gave the highest ratings (Mean=4.56 on a 1-5 Likert scale) on the “learners’ attitude toward teacher assessment” scale, implying the high importance of timely teacher feedback and assessment on learners’ task performance. In addition, students have positive ratings of “task completeness” (Mean=4.13), “improving skills” (Mean=4.11), and “demonstration” (Mean=4.06), indicating their hard work for completing tasks and the effectiveness of the EFL course and peers’ demo work for improving learners language skills. On the other hand, students gave relatively lower score to “attitude” and “extra effort” (Mean<4), which implied that this EFL course still had a room for improvement and students should be encouraged to make more extra efforts for completing tasks and improving overall performance.
3.2 Students’ perceptions of using the online formative assessment system

The other questionnaire survey was conducted to evaluate the students’ perceptions of the system (POTS). It consists of five factors, presented with strongly agree/disagree statements on a five-point Likert scale. The questionnaire was adapted from the questionnaire by Davis (1989), and Li, Dong, and Huang (2011), based on the TAM (technology acceptance model). Moreover, the researchers invited two experts in the field of online formative assessment to comment on the items of the questionnaire for face validity, and two EFL professionals to clarify the wording of all survey items. The following information is the detailed description of the five factors of the questionnaire.

- **Perceived usefulness (usefulness):** assessing students’ perceptions of the degree to which using the system will enhance their learning performance.
- **Perceived ease of use (ease of use):** exploring perceptions of the degree to which students expect the system to be free of effort.
- **Learner satisfaction (satisfaction):** measuring perceptions of the degree to which students will be willing to use the system and recommend it to peers.
- **Effectiveness of online formative assessment (assessment effectiveness):** delineating students’ perceptions of the system for improving their second language learning skills.
- **Willingness for future use scale (willingness):** disclosing students’ continuous efforts to use the system in the future.

The reliability (Cronbach’s alpha) for each factor is high (i.e., 0.83, 0.78, 0.82, 0.88 and 0.71 respectively; the overall alpha coefficient is 0.92), indicating that these factors had sufficient reliability for measuring students’ views toward the system. Students gave the highest ratings (Mean=4.23 on a 1-5 Likert scale) on the “perceived ease of use” factor, implying that the system has high potential supporting online formative assessment with proper user interface design. In addition, students have positive perspectives of the system and gave high ratings on the factors of “learner satisfaction”, “willingness for future use” and “perceived usefulness” (all scores above 4), implying that the system has high potential for assisting students in completing online formative assessment activities, hence, students are willing to use it, recommend it to the peers and will continue to use it in the future. However, students gave the comparatively lowest score to the “effectiveness of online formative assessment” factor (Mean=3.88), indicating the need to improve the effectiveness of online formative assessment activities for improving their second language learning skills. In sum, this study can conclude that the effectiveness of system is accepted by most of the students but further efforts should be made to improve the effectiveness of online formative assessment activities.

3.3 The relations between students’ attitude toward the course and their perceptions of using the system

In order to find the relationships between the above two surveys, the Pearson’s correlation was conducted. As shown in Table 1, the results of the two questionnaires are highly related.

Table 1: The correlations among the factors of ATTC and POTS

<table>
<thead>
<tr>
<th>Attitude</th>
<th>Usefulness</th>
<th>Ease of use</th>
<th>Satisfaction</th>
<th>Assessment effectiveness</th>
<th>Willingness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving skills</td>
<td>0.66***</td>
<td>0.59***</td>
<td>0.43***</td>
<td>0.49***</td>
<td>0.42***</td>
</tr>
<tr>
<td>Task completeness</td>
<td>0.49***</td>
<td>0.48***</td>
<td>0.50***</td>
<td>0.44***</td>
<td>0.41***</td>
</tr>
<tr>
<td>Extra effort</td>
<td>0.40***</td>
<td>0.26***</td>
<td>0.27***</td>
<td>0.47***</td>
<td>0.32***</td>
</tr>
<tr>
<td>Teacher assessment</td>
<td>0.35***</td>
<td>0.37***</td>
<td>0.42***</td>
<td>0.28***</td>
<td>0.33***</td>
</tr>
<tr>
<td>Demonstration</td>
<td>0.32***</td>
<td>0.25***</td>
<td>0.32***</td>
<td>0.39***</td>
<td>0.34***</td>
</tr>
</tbody>
</table>

Notes: ***p<.001

The regression analysis was performed to evaluate the predictive effects of the POTS factors on each factor of ATTC. As in Table 2, all the POTS factors are positive predictors to their corresponding ATTC factors. In other words, students with higher level of POTS tend to possess higher-level of ATTCs. Among all the POTS factors, “usefulness” could make positive prediction for all factors of students’ attitude toward the EFL course and related course activities (t = 9.72, 14.34, 6.04, 4.53, 3.33, 2.42 respectively). In addition, the POTS factor “willingness” could also make significant prediction for all ATTC factors except “task completeness” (t = 6.96, 3.10, 2.20, 2.07, 4.32 respectively). Hence, we consider POTS factors “usefulness” and “willingness” as two important predictors to ATTC factors.
Table 2 Stepwise regression model of predicting ATTC (n=653)

<table>
<thead>
<tr>
<th>ATTC</th>
<th>Predictors</th>
<th>B</th>
<th>S.E.</th>
<th>T</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
<td>0.41</td>
<td>0.04</td>
<td>0.36</td>
<td>9.23***</td>
</tr>
<tr>
<td></td>
<td>Willingness</td>
<td>0.22</td>
<td>0.03</td>
<td>0.22</td>
<td>3.99***</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>0.19</td>
<td>0.04</td>
<td>0.19</td>
<td>3.75***</td>
</tr>
<tr>
<td></td>
<td>Assessment effectiveness</td>
<td>0.12</td>
<td>0.04</td>
<td>0.12</td>
<td>3.45**</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>0.11</td>
<td>0.18</td>
<td>0.11</td>
<td>0.53</td>
</tr>
<tr>
<td>Improving skills</td>
<td>Usefulness</td>
<td>0.48</td>
<td>0.03</td>
<td>0.51</td>
<td>14.34***</td>
</tr>
<tr>
<td></td>
<td>Assessment effectiveness</td>
<td>0.13</td>
<td>0.03</td>
<td>0.13</td>
<td>3.75***</td>
</tr>
<tr>
<td></td>
<td>Willingness</td>
<td>0.08</td>
<td>0.03</td>
<td>0.11</td>
<td>2.11*</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
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<td>0.03</td>
<td>0.07</td>
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</tr>
<tr>
<td></td>
<td>Constant</td>
<td>1.05</td>
<td>0.14</td>
<td>1.05</td>
<td>9.31***</td>
</tr>
<tr>
<td>Task completeness</td>
<td>Satisfaction</td>
<td>0.20</td>
<td>0.04</td>
<td>0.23</td>
<td>4.32***</td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
<td>0.21</td>
<td>0.04</td>
<td>0.23</td>
<td>4.00***</td>
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<tr>
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<td>Ease of use</td>
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<td>0.04</td>
<td>0.19</td>
<td>4.39***</td>
</tr>
<tr>
<td></td>
<td>Assessment effectiveness</td>
<td>0.10</td>
<td>0.03</td>
<td>0.10</td>
<td>3.16**</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>1.20</td>
<td>0.19</td>
<td>1.20</td>
<td>8.39***</td>
</tr>
<tr>
<td>Extra effort</td>
<td>Assessment effectiveness</td>
<td>0.41</td>
<td>0.05</td>
<td>0.41</td>
<td>8.33***</td>
</tr>
<tr>
<td></td>
<td>Willingness</td>
<td>0.24</td>
<td>0.05</td>
<td>0.24</td>
<td>4.53***</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>0.16</td>
<td>0.05</td>
<td>0.16</td>
<td>2.00*</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>0.22</td>
<td>0.31</td>
<td>0.22</td>
<td>0.56</td>
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<tr>
<td>Teacher assessment</td>
<td>Satisfaction</td>
<td>0.17</td>
<td>0.04</td>
<td>0.23</td>
<td>3.00***</td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
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<td>0.03</td>
<td>0.14</td>
<td>3.33**</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
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<td>0.04</td>
<td>0.13</td>
<td>3.35**</td>
</tr>
<tr>
<td></td>
<td>Willingness</td>
<td>0.09</td>
<td>0.03</td>
<td>0.09</td>
<td>2.07**</td>
</tr>
<tr>
<td></td>
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<td>0.11</td>
<td>1.00</td>
<td>18.01***</td>
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<tr>
<td>Demonstration</td>
<td>Assessment effectiveness</td>
<td>0.20</td>
<td>0.04</td>
<td>0.27</td>
<td>6.20***</td>
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<tr>
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<td>Willingness</td>
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<td>0.04</td>
<td>0.18</td>
<td>4.32***</td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
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<td>0.05</td>
<td>0.11</td>
<td>2.42**</td>
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<tr>
<td></td>
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<td>1.90</td>
<td>0.18</td>
<td>1.90</td>
<td>10.40***</td>
</tr>
</tbody>
</table>

Notes: *p<.05, **p<.01, ***p<.001

4. Conclusion

This paper reports on the development of an Online Formative Assessment System in an EFL course and examines the effectiveness of the course and the system. The research results indicate that the EFL course adopting formative assessment in online learning environment is well received by students. It is also evident that most students find it rewarding to use the system. Besides, students also expressed their preference to the system in terms of its usefulness, ease of use, and their willingness for future use. The regression results reveal that students’ perceptions of the system could make significant prediction for their responses of attitude towards the course. In particular, POTS factors of “willingness” and “usefulness” were significant variables for predicting students’ attitude toward the course. However, it should be noted that the present study mainly employed quantitative measures. More in-depth qualitative studies are recommended to explore the issue further.

Acknowledgements

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References


Role-Play in Computer-Supported Collaborative Learning—An Explorative Study

Yu-Chen HSU\textsuperscript{a} & Yen-Lin CHIU\textsuperscript{b,}\textsuperscript{*}
\textsuperscript{a}School of Public Administration, Sichuan University, China
\textsuperscript{b}Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
\textsuperscript{*}E-mail: erin0825@ms58.hinet.net

Abstract: The role-play has been regarded as an important function which may facilitate effective computer-supported collaborative learning (CSCL). In this paper, we explored undergraduates’ experiences in undertaking team-based task in CSCL environment. The main purpose of this study was to examine the impacts of role-play on CSCL. 90 participants grouped into 18 teams were surveyed. For the team-based analysis level, the results indicated that roles of team members in CSCL teams have relations with their appraisal for CSCL. This finding suggested that teachers and students should be aware of the roles played in CSCL environment and govern the roles to stimulate effective online collaborative learning.

Keywords: collaborative learning, CSCL, performance, role-play, satisfaction

1. Introduction

Nowadays collaboration has been extremely concerned and adopted in learning activities. Collaborative learning is regarded as students’ interaction while they are making efforts to solve problems and accomplish tasks together in learning process (Dewiyanti et al., 2007). In recent years computer supported collaborative learning (CSCL) is viewed as a good way to facilitate knowledge acquisition and to improve learning in online environments (Noroozi et al., 2013; Wecker et al., 2014).

However, it was indicated that putting students together does not necessarily result in effective outcomes of collaborative learning (Weinberger et al. 2005). On the one hand, it was pointed out that assigning roles to students in collaborative learning process has positive effects on learning outcomes (De Wever et al., 2008). Roles can be defined as learners’ responsibilities which may guide individual behavior and govern group interaction to achieve group’s goal (Strijbos & De Laat, 2010). The role concept has attracted increasing attention and become a promising construct for facilitating CSCL (Strijbos & De Laat, 2010; Pozzi, 2011). However, the impact of role-play on CSCL is still an emerging topic which has not been completely studied. This study aimed to explore team members’ roles in CSCL teams and its impacts on team members’ appraisal for CSCL.

2. Methods

2.1 Participants

All participants were undergraduates of Sichuan University in China. The average age of them was 21.52 with a range from 20 to 24. The ratios of gender type were almost equal. Most of the participants majored in public administration and public policy. They were grouped into 18 teams to collaboratively accomplish a team-based task which was part of their assignments related to their study topic. The number of team members ranged from 3 to 7 with an average of 5 members. The roles they played while undertaking team-based task in CSCL environment were conductor (16.7%), information provider (15.6%), active actor (54.4) and general actor (13.3%).
Table 1: Participants’ demographics.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>48</td>
<td>53.3</td>
</tr>
<tr>
<td>Male</td>
<td>42</td>
<td>46.7</td>
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<td><strong>Major</strong></td>
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<td>Public administration and Public Policy</td>
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<td>Land Resource and Real Estate Management</td>
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<tr>
<td>Level 3</td>
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<td>25.6</td>
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<tr>
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<td><strong>Role in CSCL team</strong></td>
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<td>Conductor</td>
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<td>16.7</td>
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<tr>
<td>Information provider</td>
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<td>15.6</td>
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<tr>
<td>Active actor</td>
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<td>54.4</td>
</tr>
<tr>
<td>General actor</td>
<td>12</td>
<td>13.3</td>
</tr>
</tbody>
</table>

2.2 Instruments

In addition to the demographic variables, a self-report instrument for appraising participants’ experiences of CSCL including attitude toward CSCL, satisfaction with CSCL method and satisfaction with CSCL outcome were evaluated. Moreover, the Internet Self-efficacy Scale was also utilized and measured.

2.3 Analysis Procedure

The descriptive statistics were analyzed to explore the demographics of the participants. The exploratory factor analysis was conducted to validate the instruments including CSCL experience survey and Internet self-efficacy scale. Finally, the hypotheses were tested by executing t-test and regression analysis.

3. Results

3.1 Results of exploratory factor analysis

For evaluating the validation of instruments the exploratory factor analyses were conducted. The Kaiser-Meyer-Olkin (KMO) measure and the Bartlett’s test of sphericity were examined to determine whether the sample was appropriate for executing the EFA.

For the Internet Self-Efficacy Scale (ISES), it was reported that the KMO measure had a value of 0.89 with a significant Bartlett’s test (chi-square = 624.30, p < 0.001) showing the EFA was appropriate. As a result, the items were grouped into 2 factors, namely Basic Internet Self-Efficacy (BISE) and Advanced Internet Self-Efficacy (AISE). The Cronbach’s alpha for two factors were 0.77 and 0.85, suggesting that two factors had high reliability. Both BISE and AISE contained 5 items and the total variance explained reached 74.17%, implying the ISES was appropriate for assessing the participant’s Internet-based self-efficacy. With respect to the CSCL experience, the EFA results revealed...
that the KMO measure (0.84) and Bartlett’s test (chi-square = 116.25, \( p < 0.001 \)) were well examined. 65.87% of total variances were explained by two factors namely overall appraisal for method (3 items) and overall appraisal for outcome (3 items) with alpha values of 0.69 and 0.68, respectively.

### 3.2 Comparisons of gender difference

Table 1 shows the differences between genders. It reveals that males have higher frequency in computer usage and Internet usage than females does. However, there are no differences of appraisal for CSCL method and appraisal for CSCL outcome between males and females.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male</th>
<th>Female</th>
<th>( t )-test</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>age</td>
<td>21.71 0.97</td>
<td>21.35 0.86</td>
<td>-1.86</td>
<td>0.066</td>
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<tr>
<td>computer usage (hr/week)</td>
<td>35.83 25.23</td>
<td>23.00 12.81</td>
<td>-3.06</td>
<td>0.003</td>
</tr>
<tr>
<td>Internet usage (hr/week)</td>
<td>28.93 25.05</td>
<td>16.79 11.52</td>
<td>-2.98</td>
<td>0.004</td>
</tr>
<tr>
<td>Satisfaction with performance</td>
<td>3.36 1.12</td>
<td>2.92 1.22</td>
<td>-1.78</td>
<td>0.079</td>
</tr>
<tr>
<td>Satisfaction with communication</td>
<td>4.40 0.66</td>
<td>4.10 0.83</td>
<td>-1.88</td>
<td>0.064</td>
</tr>
<tr>
<td>Attitude toward CSCL</td>
<td>3.71 0.83</td>
<td>3.48 0.92</td>
<td>-1.26</td>
<td>0.211</td>
</tr>
<tr>
<td>Attitude toward cooperation</td>
<td>4.90 0.45</td>
<td>4.85 0.54</td>
<td>-0.46</td>
<td>0.649</td>
</tr>
<tr>
<td>Satisfaction with cooperation</td>
<td>4.76 0.69</td>
<td>4.66 1.03</td>
<td>-0.54</td>
<td>0.588</td>
</tr>
<tr>
<td>Attitude toward online discussion</td>
<td>4.24 0.98</td>
<td>4.07 1.01</td>
<td>-0.78</td>
<td>0.440</td>
</tr>
<tr>
<td>Basic Internet self-efficacy</td>
<td>5.64 0.46</td>
<td>5.59 0.48</td>
<td>0.47</td>
<td>0.643</td>
</tr>
<tr>
<td>Advanced Internet self-efficacy</td>
<td>5.51 0.72</td>
<td>5.02 0.99</td>
<td>2.64</td>
<td>0.010</td>
</tr>
<tr>
<td>Overall appraisal for CSCL method</td>
<td>4.33 0.56</td>
<td>4.21 0.69</td>
<td>-0.84</td>
<td>0.406</td>
</tr>
<tr>
<td>Overall appraisal for CSCL outcome</td>
<td>4.17 0.58</td>
<td>3.89 0.87</td>
<td>-1.78</td>
<td>0.079</td>
</tr>
</tbody>
</table>

*Note:* \( \ast \ p < 0.05; \ast \ast \ p < 0.01 *

### 3.3 Correlations among variables for individuals

As shown in table 2, males have higher computer usage and Internet usage than females; however, males possess higher Advanced Internet self-efficacy than their counterparts. Moreover, it reveals that computer usage has positive relations with attitude toward CSCL, suggesting that raising learners’ computer usage may increase their positive attitude toward CSCL.

### 3.4 Correlations among variables for CSCL teams

Table 3 shows the correlations among variables for team level. It should be noted that all variables were calculated for team level; for instance, the roles (conductor, information provider, active actor and general actor) were counted as ratios in a CSCL team.

As revealed in table 3, CSCL teams have higher satisfaction with communication while they have higher ratio of information provider \( (r = 0.57, p < 0.05) \), suggesting that arrange more information provider in a CSCL team may increase team members’ satisfaction with their communication. However, the teams reveal negative attitude toward CSCL \( (r = -0.51, p < 0.05) \) if the CSCL teams have more general actors in their team; moreover, the teams with higher ratio of general actor tend to possess lower satisfaction with communication \( (r = -0.50, p < 0.05) \), online discussion \( (r = -0.48, p < 0.05) \) as well as overall appraisal for CSCL outcome \( (r = -0.50, p < 0.05) \). Moreover, the teams have more positive attitude toward CSCL \( (r = 0.49, p < 0.05) \), online communication \( (r = 0.71, p < 0.01) \) and appraisal for CSCL method \( (r = 0.62, p < 0.01) \) while these teams have higher average computer usage. Finally, it is indicated that Basic Internet self-efficacy has positive relationships between attitude toward CSCL \( (r = 0.47, p < 0.05) \) and online discussion \( (r = 0.54, p < 0.05) \), showing that improving teams’ basic Internet self-efficacy may increase their attitude toward CSCL.
Table 2: Correlations among variables for individuals.

<table>
<thead>
<tr>
<th></th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<th>9</th>
<th>10</th>
<th>11</th>
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</thead>
<tbody>
<tr>
<td>Gender (male: 1; female: 0)</td>
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<tr>
<td>Satisfaction with performance</td>
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<td>Satisfaction with communication</td>
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<tr>
<td>Satisfaction with cooperation</td>
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<tr>
<td>Attitude toward cooperation</td>
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<tr>
<td>Attitude toward online discussion</td>
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<td>Overall appraisal for CSCL method</td>
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</tbody>
</table>

Note: *p < 0.05; **p < 0.01; ***p < 0.001

Overall appraisal for CSCL method = (attitude toward CSCL + attitude toward cooperation + attitude toward online discussion)/3
Overall appraisal for CSCL outcome = (Satisfaction with performance + Satisfaction with communication + Satisfaction with cooperation)/3

1. Basic Internet self-efficacy
2. Advanced Internet self-efficacy
3. Internet usage (hr/week)
4. Computer usage (hr/week)
5. Gender (male: 1; female: 0)
6. Satisfaction with performance
7. Satisfaction with communication
8. Satisfaction with cooperation
9. Attitude toward CSCL
10. Attitude toward online discussion
11. Overall appraisal for CSCL method
12. Overall appraisal for CSCL outcome
13. Basic Internet self-efficacy
14. Advanced Internet self-efficacy

Overall appraisal for CSCL method = (attitude toward CSCL + attitude toward cooperation + attitude toward online discussion)/3
Overall appraisal for CSCL outcome = (Satisfaction with performance + Satisfaction with communication + Satisfaction with cooperation)/3

<table>
<thead>
<tr>
<th>#1</th>
<th>Ratio of conductor in CSCL team;</th>
<th>#2</th>
<th>Ratio of information provider in CSCL team;</th>
<th>#3</th>
<th>Ratio of active actor in CSCL team;</th>
<th>#4</th>
<th>Ratio of general actor in CSCL team;</th>
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<td>2</td>
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<td>0.04</td>
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<td>10</td>
<td>0.13</td>
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<tr>
<td>11</td>
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<td>0.38</td>
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<td>0.02</td>
<td>0.30</td>
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</table>

Note: *p < 0.05; **p < 0.01; ***p < 0.001.
4. Conclusions

This study indicated that team members’ roles in a CSCL team have relations with their appraisal for CSCL. This finding suggested that teachers and students should be aware of the roles played in CSCL environment and govern the roles to stimulate effective online collaborative learning.

Acknowledgements

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References


Exploring the Interactive Use of Video Cases in Scaffolding Prospective Teachers in Learning Clinical Interview Method

Yu-Ling Hsu*

*Graduate Institute of Digital Learning and Education,
National Taiwan University of Science and Technology, Taiwan
*Yuling.Hsu.NY@gmail.com

Abstract: Numerous studies have shown that the clinical interview method has played an important role in helping educators and researchers to gain deep insight into children’s mathematical thinking, and thereby improve their classroom teaching. However, very little research has been done on the development and design of such training. Therefore, the purpose of this study was 1) to explore the possible benefits of using a new approach to teach clinical interviewing skills, and 2) to investigate how an expert commentary feature can help prospective teachers to learn clinical interview methods. Forty prospective teachers participated in this study and completed a series of carefully designed lessons involving video case analysis with expert commentary. A mixed of qualitative and quantitative method was used to analyzed all the data. The results showed that the prospective teachers found this new approach helpful in learning to conduct clinical interviews.

Keywords: clinical interview, video analysis, case-based learning, early childhood education, mathematics education, teacher education, instructional technology

1. Introduction

Clinical interview has played an important and powerful role in helping pre-service and in-service teachers to gain deep insight into their students’ mathematical thinking, and has thereby enabled teachers to assist their students in constructing meaningful mathematical knowledge and enhancing their mathematical learning potential (Baroody & Ginsburg, 1990; Buschman, 2001; Confrey, 1980; Doig & Hunting, 1995; Ginsburg 1981; Ginsburg, 1997; Ginsburg, Jacobs & Lopez, 1998; Ginsburg, Kaplan, & Baroody, 1992; Ginsburg, Kossan, Schwartz & Swanson, 1983; Hunting, 1997; Kaplan, King, Dickens, & Stanley, 2000; McDonough, Clarke & Clarke, 2002; Peck, Jencks, & Connell,1989; Rowland, 1999; Schorr & Ginsburg, 2000; Schorr & Lesh, 1998; Wright & Ellemor-Collins, 2008; Zazkis & Hazzan, 1999.)

Although there is growing evidence of the need to teach clinical interviewing techniques to both pre-service and in-service teachers, very little research has been done on the development and design of such training. With the use of videos, case-based discussion has been found to be a useful tool for both engaging pre-service teachers in observing, noticing, interpreting, discussing, reflecting, and transforming ideas about a complex or ill-structured teaching situation and capturing such change (Hatch & Grossman, 2009; Kinzer & Risko, 1998; Sherin & Han, 2004; Sherin & Van Es, 2005; Van Es & Sherin, 2002). Yet studies documenting the ways and means of teaching and training clinical interview methods are still very limited, and there is no literature on how the instructional design of a video case-based learning environment could help pre-service or in-service teachers to develop clinical competency of this type.
2. Methods

2.1 Participants

Participants in this study were 40 graduate students from Teachers College, Columbia University enrolled in “Development of Mathematical Thinking” course. The students in this course were pre-service teachers pursuing Master degrees in early childhood or mathematics education.

2.2 Measures

The task (which is also referred as clinical interview expert commentary video lesson) used in this study was embedded in a Web-based application called VITAL (Video Interactions for Teaching and Learning), which was designed to support prospective teachers in studying early childhood mathematical education. Therefore, this study used 3 different kinds of data: (a) students’ analyses of videos and comments on the lesson (which will refer to pre and post-commentary answers later on); (b) students’ answers to the survey questions; and (c) students’ clinical interview final project scores from the class.

2.3 Analysis Procedure

A mix of qualitative and quantitative data analyses were used in this study. The development of the coding schemes began with an extensive content analysis of the pre and post commentary answers as well as the open-ended answers in the end-of lesson survey, for a total of 400 video analysis answers. Eight sets of coding schemes were developed to analyze the participants’ responses. There are three major categories: a) coding schemes for all pre-commentary responses, b) coding schemes for all post-commentary responses, and c) coding schemes. All the responses were coded by the author and another independent researcher. The kappa value for the inter-rater reliability of all the pre-commentary questions is k=0.80 and of all the post-commentary questions is k=0.81.

3. Results

3.1 Helpfulness of the Expert Commentary Video

<table>
<thead>
<tr>
<th>Rating scale</th>
<th>Frequency (counts)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Helpful</td>
<td>20</td>
<td>50%</td>
</tr>
<tr>
<td>Helpful</td>
<td>16</td>
<td>40%</td>
</tr>
<tr>
<td>Somewhat Helpful</td>
<td>4</td>
<td>10%</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100%</td>
</tr>
</tbody>
</table>

The data was obtained at the end of the video lesson, when the participants were asked to give a four level rating (very helpful, helpful, somewhat helpful, and not helpful). Overall, all the participants (N=40) in this study reported that this video case analysis lesson with expert commentary, was helpful in varying degrees in learning clinical interview. Specifically, 50% of them rated it as “very helpful”, 40% said it was “helpful” and only 10% reported it “somewhat helpful”. “Not helpful” was not found (see Table 1).
3.2 Video Case Analysis Comparison Within Pre-Commentary Questions

Table 2. Paired T-Test Results For the Two Pre-Post Question Sets Within the Pre Commentary Questions

<table>
<thead>
<tr>
<th>Question set</th>
<th>Mean</th>
<th>SD</th>
<th>df</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 vs. Q3</td>
<td>-3.00</td>
<td>.853</td>
<td>39</td>
<td>-2.223**</td>
</tr>
<tr>
<td>Q7 vs. Q9</td>
<td>-3.50</td>
<td>1.027</td>
<td>39</td>
<td>-2.156**</td>
</tr>
</tbody>
</table>

** p<.02 (1-tailed)

Since Q1 and Q3 need participants to apply similar concepts to evaluating clinical interviewing techniques, and Q7 and Q9 require similar clinical reasoning methods for the case, we were able to use Q1 and Q3 as a pre-post comparison set, and Q7 & Q9 as another set. As shown in Table 2, the results suggest that there was a significant difference in these prospective teachers’ pre and post video analysis levels for both question sets (Q1 & Q3, t=-2.223, p<.02 and Q7 & Q9, t=-2.156, p<.02). Therefore, the prospective teachers did show significant differences in their video case analysis in these two pre-post question sets within the pre-commentary questions (Q1 vs. Q3 & Q7 vs. Q9). More details about what factors could contribute to this difference will be discussed later on.

3.3 Video Case Analysis Level on All Pre-Commentary Questions

Table 3. Frequency and Percentage of Video Analysis Level on All Pre-Commentary Questions (N=40)

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q3</th>
<th>Q5</th>
<th>Q7</th>
<th>Q9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>6 (15%)</td>
<td>2 (5%)</td>
<td>6 (15%)</td>
<td>11 (27%)</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>Level 2</td>
<td>16 (40%)</td>
<td>12 (30%)</td>
<td>33 (83%)</td>
<td>14 (35%)</td>
<td>16 (40%)</td>
</tr>
<tr>
<td>Level 3</td>
<td>18 (45%)</td>
<td>26 (65%)</td>
<td>1 (2%)</td>
<td>15 (38%)</td>
<td>21 (53%)</td>
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<tr>
<td>Total</td>
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</tr>
</tbody>
</table>

The frequencies and the percentages of each video analysis level for individual questions are shown in Table 3. As we can see, Q3 has the highest frequencies (and percentages) in Level 3 among all the pre-commentary questions; followed by Q9. Most of the prospective teachers did not do so well in Q5, but did better in Q3 and Q9. The frequencies (and percentages) in Q1 and Q7 are spread out among all three levels, though the Level 2 and Level 3 have a slightly higher percentage in Q1 than in Q7.

Acknowledgements

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The Effectiveness of Reducing State Anxiety by Digital Counseling Tool - Mind Collage

Yu-Jen Hsu*, Ju-Ling Shih

*Department of E-learning Design and Management, National University of Chiayi, Taiwan
bDepartment of Information and Learning Technology, National University of Tainan, Taiwan
*yuren925@gmail.com

Abstract: This research aims to investigate the effectiveness of digital counseling tool, Mind Collage, to reduce participants’ state anxiety. Mind Collage is a digital tool designed based on expressive art therapy, Landscape Montage, to project users’ inner self image onto the paintings they made. STAT-S inventory was used to compare the participants’ change of state anxiety. From behavioral observations and interviews, the researcher found that Mind Collage can provide a relaxing space for the participants, and effectively reduce their state anxiety. At the same time, they highly trust the tool, and are more willing to reveal themselves on the digital system.

Keywords: Digital Counseling Tool, State Anxiety, Mind Collage

1. Introduction

In the modern society, human beings are living in a much faster pace, receiving more information, facing more challenges, and feeling more pressures. As a natural consequence, invisible anxieties exist deep inside each individual. From the counseling perspective, expressive art therapy is a way to restore emotions, and thus reduce anxiety.

In order to approach the individuals with ease, this study strive to seek a commonly used tool to do the work. Reviewing the nature and features of technology, from the 20th century on, Internet and information technology have brought about the formation of virtual world which intrigued thousands of young people to be its loyal citizens. The virtual environment has greatly influenced people’s living and learning style since it has opened the possibility of linking people with others and their environment.

Counseling is a professional work that counselors aim to assist their clients to effectively deal with their problems with effective ways (Egan, 2007). It is based on assisting the clients’ to develop into mentally healthy individuals who can work independently and self-guidedly. Traditional counseling model provides personal psychological assistance to the client face-to-face, but it often discourages some young people to seek for help due to the mental confrontation of revealing oneself to strangers. Therefore, many counseling groups have begun to provide Internet counseling services, and have led counseling into a new era.

Existing digital counseling tools are becoming more diverse. Many counseling groups have begun to provide Internet counseling services, but limited to mechanisms such as message boards, E-mail, online psychological tests, real-time chat, and so on. Related studies showed that the Internet has advantages such as anonymity, virtuality, convenience, escape, and so on. Therefore, web-counseling can provide clients a high degree of freedom and privacy so that they can directly express their feelings; at the same time, the counselors can create better counseling relationship with the client, and easily record and manage the process of treatment.

With the advantages of counseling in the digital forms, the purpose of this study is to use a self-developed digital counseling tool, Mind Collage, to reduce clients’ anxiety. The development of Mind Collage integrated digital technology and counseling theories, with two special features. First, digital expression of mental images. Users project their mental images onto the pictures, which is a non-verbal communication medium. Second, mental images as treatment. As the users conduct the
painting, they enter a space where they face themselves, without external pressure or burden. They have little emotional confrontations, and enhance perceptions and awareness. Both features strengthen Mind Collage as the bridge to connect the users’ inner self with the outside world.

2. Literature Review

2.1 Anxiety

Anxiety can be categorized as state anxiety and trait anxiety in terms of its nature (Spielberger, 1971). Trait anxiety refers to the anxiety that comes from inside of an individual. It is a long-lasting and fixed personality that no matter what circumstances the person is in, trait anxiety would stay. On the other hand, state anxiety refers to the emotional responses when the individual faces certain situations, for example, work pressure; however, as long as the situation does not last, the anxiety disappears as well. Thus, state anxiety has temporary and transitional characteristics (Pintrich & Schunk, 2002).

Anxiety makes people feel tension and nervous. It comes from intangible and unobvious sources and threatens. It is a defensive emotion that helps people deal with the environment, and stay away from danger; at the same time, it transmit communicative message of acquiring help and protection. It stimulates the individual’s willingness to take action, and do things better. Nevertheless, it influences the work of cognitive function. Pekrun (2000) pointed out that emotion has three major sources, namely, genetic dispositions, physiological processes, and cognitive appraisals. The most commonly seen emotions seen in the psychological therapy include anger, sadness and distress, fear and anxiety, shame, as well as the pleasant emotions. Anxiety is generated from the uncertainty and fragile inner self, which make one feels repressed from self-expectation, afraid of rejection and failure. One would be influenced by the stereotype of the society, and experience anxiety through anger or sadness.

Expressive art therapy can reduce the anxiety that is generated from the first encounter of counseling. Expressive art therapy also helps the participants to establish relationships with the counselors, and be submerged in the counseling process. Since mental image projection create a psychological safe distance of the participant and the issue, the participants can reveal their subconscious feelings and thoughts from the project and make it a part of their self-perception.

Ellis (1998) thought emotion is the result of complex interaction of human behavior responses and perceptions; therefore, emotion is a kind of cognitive perception. There are three levels of emotion expression guidance (Greenberg, 2006). The first level is Dialogue Level which refers to the process of using simply language with experience-focused questions to guide the clients to express their emotions. The second level is Processes-oriented Level in which counselors direct the client’s emotional focus onto a specific experience or behavior, and increase his awareness to the aroused emotions. The last level is Stimulate Level which is to create a new experience through activities for the client to generate new emotions.

From this point of view, the participants’ emotion responses monitored in this research involve those of process-oriented level and stimulation level. Therefore, the aim of this research is to use a digital tool to guide them through specific emotions, and even through the activities to create more peaceful emotions.

2.2 Expressive Art Therapy

Art activities can provide a concrete and non-verbal medium for people to deliver their subconscious thoughts and to raise their awareness. It can be the drive for people to make therapeutic changes (Dalley, 1984). Because that we are very isolated, inhuman, and over-intellectualized that it is rather important to increase the connection with their inner selves (Moreno, 1975). Therefore, non-verbal counseling methods such as art therapy are used more in the counseling arena in the non-verbal domain. Expressive art therapy is a medium of expression, which can present visual image from sub-consciousness. In this way, people can display outside their hidden thoughts and affection. Ellis thinks that the expressive art therapy emphasizes players’ creative process. This treatment assumed that the individual’s inner reality of can be presented by creation. Therefore, the expression of the creative process makes the players experience expanding human experiences, self-balancing, whole life, and increasing self-awareness, and get feelings from inner world.
Expressive art therapy is a medium of expression, which can present visual images from sub-consciousness. In this way, people can display their hidden thoughts and affections. Egan (2007) thinks that expressive art therapy emphasizes players’ creative process. This treatment assumes that the individual’s inner reality can be presented by creation. Therefore, the expression of the creative process makes the players experience expanding human experiences, self-balancing, whole life, and increasing self-awareness, and get feelings from within. As Withrow (2004) said, art therapy can more effectively reach the therapeutic goals than dialogue because it provides experiences exceeding language. Expressive art therapy allows the clients to recover from their negative emotions through images, and reach the deeper self.

Expressive art therapy is a medium of expression, which requires the individual to present his visual images from the sub-consciousness (Malchiodi, 2007). Landscape montage technique, also called landscape composition, was proposed by Mr. Nakai in 1969. It is one of the methods of expressive art therapies. There are 12 landscape objects, such as river, mountain, farmland, road, house, tree, people, flower, animal, stone, bridge, and sun. Each one of them has its counseling implications.

1. River: unconscious life progress, the flow of energy.
2. Mountain: focus, direction.
3. Farmland: integration of the picture.
4. Road: the shape, form, type, and so on.
8. Flower: vitality, hope, and life which means the subjects’ implicit sense of life and affection.
9. Animal: The outside ways getting energy and life. The performance of inside energy and drives from individual’s sub-consciousness.
11. Bridge: contact and communication.
12. Sun: vitality or strength.

3. Digital Counseling Tool System Description

Mind Collage was built with Unity 3D game engine. Adobe PhotoShop was used to create and generate various graphic styles for the users to use. From the previous counseling experiences, Landscape Montage drawing is difficult to people with lower painting skills. They would worry about whether they can complete the picture as the counselor hoped. Since this research wanted to solve this problem, the digital system was designed to use easy-to-manipulate techniques. The features include, 1) there is graphical user interface (GUI) to increase user friendliness; 2) objects are provided to minimize users’ worryness to painting fright; 3) drag-and-drop is enabled to allow minimal manipulation complexity; 4) expert knowledge database analysis to allow users to receive instant feedbacks.

Expert Knowledge Base refers to the database to generate counseling feedbacks. It is the brain of the system which was built with the Sequence of the 12 elements for Landscape Montage, Definitions of the elements’ placements, and Content Experts’ Interpretations. During the process of working on Mind Collage, the participants were asked to draw a landscape following counselor’s step-by-step instruction. (Figure 1). Users can choose their own picture frame and background. The sequence and definition of the 12 elements of Landscape Montage were defined according to Akira Kaito’s book (2010) Landscape Montage: A Pictorial Psychological Therapy. Our digital counseling game modifies such a method and allows users to perform it on a platform. On the game menu, clients place 12 objects onto the canvas. They place the visual images by simply drag-and-drop the pictorial icons in the zoom-in/zoom-out mode in the virtual environment. The completed landscape can not be changed or modified after they complete the project. The 12 Landscape Montage elements were grouped into three clusters, including background group, center group, and foreground group. Then the system would generate automatic counseling responses according to the definitions of the kinds, styles, sizes, quantity, and placements as the user finishes the game. These steps will constitute the picture that can sufficiently represent users’ inner thoughts and feelings. In this way, we can help players to fine their hidden selves and diagnose the situations they are in.

When the client finishes the picture, the counselor discusses with the client, and gives suggestions to the client in aspects of the sense of integration, richness, uniqueness, spatial depth, and so forth; and at the end, concludes the feedbacks with the interpretations of individual meanings (Figure 2).
4. Methods

This research invited twelve adults randomly chosen, 2 males and 10 females, aged 25 to 40 years old, to participate the experiment. Pretest and posttest of participants’ state anxiety were conducted for comparison to understand the effectiveness of expressive art therapy. Instant feedbacks to the participants’ Mind Collage final product were given. Desktop recordings were done for the analysis of participants’ inner image projections. The experiment process is as Figure 3.

In order to investigate whether expressive art theory based digital counseling tool can allow the participants to calm their minds, be more peaceful, relaxed, and obtained positive action goals. In order to know the effects, the research tool used in this research is State-Trait Anxiety Inventory (STAI) proposed by Spielberger (1983). The inventory is appropriate for measuring the anxiety levels of teenagers to adults. The inventory involves two parts, State Anxiety and Trait Anxiety, with total of 20 questions. This research only uses state anxiety for measurement. State anxiety refers to the temporarily emotional state, which includes nervous, anxious, autonomous nerve system excitements, and conscious perceptions. Therefore, state anxiety would be different according to time and context. Questions in the inventory are mostly about current emotional feelings and self-perceptions. For example, I now feel peaceful; I feel I am confident; I am always alerted; etc. The point of Mind Collage is to allow participants to place their focus on making the pictures, and during this time, to calm down, lower down the defense, forget about the pressures from the outside world, look into their inner selves, and reduce state anxiety.

The scale uses four-point Likert with 4 points for strongly disagree, 3 points for disagree, 2 points for agree, and 1 point for strongly agree. The lowest score is 20, and highest score is 80. The lower the scores represent that the participants have more anxiety. The inventory has a retest reliability of 0.737 with Cronbach’s α of 0.898.

The Mind Collage was done in a small room which had only the researcher and one participant and no external interferences. Every participant had 40 minutes of time. During the process, behavior observations were conducted to document participants’ digital counseling process in order to find out
the factors of participants’ emotional changes. After the experiment, focus group interviews were made with the participants to know their use experiences, feelings, counseling effectiveness, and motivation changes. During the process, the researcher would place a mirror behind the participants which would reflect the actions of the computer desktops. In the front, there was a camcorder which recorded the participants’ facial expressions. The setup is to conduct synchronous observations, document the working process. The experiment setup is as Figure 4.

5. Results

The occurrence and intensity of state anxiety is related to individual’s subjective perception to the stimulation, and changes as the situation change. As the stimulation of state anxiety disappears, state anxiety would return to normal. STAT-S inventory shows the results of individual’s responses to the certain environmental condition, and whether they feel safe, nervous, or anxious. The score of state anxiety of all twelve participants have risen after using Mind Collage (Table 1). All the posttests are higher than the pretests (Figure 5). It shows that this digital counseling tool has positive influence on the participants’ state anxiety that their feeling of anxiety is reduced.

To further investigate the results, the participants can be categorized into two major types: those with obvious variation of state anxiety (Variation > 5) and those of stable variation of state anxiety (Variation < 5). Type I include 7 participants: W01, W02, W05, W06, W07, W08, W10; Type II include 5 participants: M01, W03, M02, W04, W09.

<table>
<thead>
<tr>
<th>Subjects</th>
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<th>Posttest</th>
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<tr>
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Type I: Obvious variation of state anxiety

A typical example of Type I is W02. The complete picture made by W02 in Mind Collage is as Figure 6. Her pretest score of STAT-S is 49 points, and posttest score is 65 points. It shows that Mind Collage has obvious effectiveness to reduce the participants’ state anxiety. From behavior observations, W02 held her chin during the whole process and was immersed in thinking. When she encountered the river placement, she moved her eyes around the canvas and showed uncertainty. As she was placing mountain, she asked whether she can try again, can turn the object around, or can move the object forward or backward. As she is placing the field, she leaned forward; and when it came with the tree step, she was focused and seemed very determined. When she was dealing with the people and bridge, she showed smiles. Overall speaking, she was indulged in the process, and felt pleasant for this activity.

Other participants had similar experiences. They all felt more peaceful after doing Mind Collage, that completing the picture is to project their inner mind without consciously aware of emotional changes. They felt more satisfied (W06), calmer (W01), felt joy instead of cranky (W02), relaxed (W05) (W04) (W06) (W09), comfortable (W07) (W08), etc. Other than that, they felt that they understand themselves more than before (W02), can now see themselves from the other aspects (W08), and feel surprised to the results (W10). It shows that Mind Collage has spoken for itself about having the functions of visualizing self-images and creates emotional changes.

Type II: Stable variation of State anxiety

A typical example of Type II is M02. The complete picture made by M02 in Mind Collage is as Figure 7. His pretest score of STAT-S is 60 points, and posttest score is 61 points. From behavior observations, M02 held his chin during the whole process and was immersed in thinking. When he encountered the river placement, he moved his eyes around the canvas and showed uncertainty. As he was placing mountain, he asked whether he can try again, can turn the object around, or can move the object forward or backward. As he is placing the field, he leaned forward; and when it came with the tree step, he was focused and seemed very determined. When he was dealing with the people and bridge, he showed smiles. Overall speaking, he was indulged in the process, and felt pleasant for this activity.

Other participants had similar experiences. They all felt more peaceful after doing Mind Collage, that completing the picture is to project their inner mind without consciously aware of emotional changes. They felt more satisfied (W06), calmer (W01), felt joy instead of cranky (W02), relaxed (W05) (W04) (W06) (W09), comfortable (W07) (W08), etc. Other than that, they felt that they understand themselves more than before (W02), can now see themselves from the other aspects (W08), and feel surprised to the results (W10). It shows that Mind Collage has spoken for itself about having the functions of visualizing self-images and creates emotional changes.
observations, M02 had been immersed in the activity showing not much facial expression changes. He was much focused, and was indulged in thinking. From the whole process, he chose to block the objects or move them to outside of the frame he found the results to be inappropriate, especially during the steps of mountain and road placements. In the tree placement step, he pondered on the positions and number of trees; and when he moved the house, he showed slight movement of his mouth; as he finished placing the stones, he took a deep breath; last, he pouched on bridge construction and moved his body slightly during the sun placement. When he reviewed the system feedbacks, he held his chin and sunk into deep thoughts. He said after the Mind Collage activity that he completed the analysis in the natural and fun atmosphere, and he felt calm and relaxed without burden (M02).

Although the participants in Type II have not shown big variations in state anxiety, they expressed highly trust to the digital counseling tool, and acknowledged Mind Collage to stimulate positive emotions, and lead to fair adjustments. Other participants also gave positive feedbacks during interviews. W03 expressed that exploring oneself through playing and doing activities is innovative and interesting. Her mind stayed in the pictures she composed and wanted to do more (W03). W04 said she saw the system feedbacks as self-reminders to make her better (W04). The system had gained trust from the users. Also, W01 used Mind Collage as self-examiner for psychological status (W01), so as W03. W05 stated that Mind Collage gave her something for self-reflection, and would encourage her to do or think more for the future (W05). Mind Collage can bring to the users so many functions that show it to have made a big leap to digital counseling.

6. Conclusion

The goal of digital counseling is to assist the participants to deal with emotional issues. Since the digital tools can allow the users to immerse in the environment, be relaxed, release the sub-consciousness, and explore the true personality, their emotions can be relieved in the meanwhile. Therefore, the participants of this research stated that they were relaxed, felt interesting, and thought the tool is innovative (W03)(W04)(W07). Also, the participants both said that they can be more focused on the counseling process. The interactions between the participants and the system was quite smooth, especially the background music helps them to be relaxed (W03). Since the interactions with the digital technology was safe and full of trust, they can easily recognized with the system feedbacks about mental analysis (W10). W02 thought the system feedbacks can guide her to positive thinking, and she felt that the system was very professional (W02). As the positive counseling relationships can be established, they had less emotional connections between each other, and can focused on the counseling goals and tasks. The participants generally felt they were more in control of the counseling process, and were surprised at the freedom they have, and felt empowered. They had more equal relationship with the counselors, and can deal with their emotions they hardly touch. These were the advantages they would not have in the traditional face-to-face counseling sessions.

In the research, the participants also gave suggestions to the future improvement of the system. They thought the design of the graphics and paintings can be more delicate (W03), and can satisfied with the need of revealing one’s inner self in some way. One can seriously face to self alone (W06). Also, for those who are not good at painting, using graphical representations to reach the goal is a nice way (W07). It saves time (W08), but hoped the graphics in each categories can be increased to suffice more preferences.

In the future, the development of digital counseling tool can be more truly project one’s mental images, create a channel for the integration of inner mind and outside world. More importantly, expressive art therapy has the functions to reduce one’s emotions by reaching to the inner mind due to its ability of privacy. Their emotions can be completely accepted by the digital tool, and can calm down their negative emotions during the process. It is of great importance to found that digital counseling tool can has such functions that it can be used for everyone to create a daily happiness through various kinds of expressive art therapy techniques.

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References
Math Island: Designing a Management Game of Primary Mathematics for Facilitating Student Learning

Charles Y.C. Yeh a, Hercy N.H. Cheng b, Zhi-Hong Chen c & Tak-Wai Chan d

aabdGraduate Institute of Network Learning Technology, National Central University, Jongli, Taiwan
bcInformation Communication, Yuan Ze University, Jongli, Taiwan

cdCharles, Hercy, Chan@cl.ncu.edu.tw
zhchen@saturn.yzu.edu.tw

Abstract: In Taiwan, primary mathematical education currently adopts teacher-centered learning. Teachers are the main source of course and students must be engaged in the same activity in the same place at the same time. In this study, we designed a digital game-based learning system which called “Math Island” to help students’ mathematics learning by themselves. In the system, we produced 488 mathematics interactive materials, videos and games into a management game and combing “knowledge map” help students to understand the relationships of mathematic concepts. In the system, students can learn mathematics by their own pace by a variety kinds of learning tasks to learn different types of mathematical materials. Moreover, we also collection all user data toward the system and examine how the Math Island system influences on students learning performance and progress. The preliminary results showed that the Math Island may help students make a good progress. In the future, we will In-depth analysis in the further research and implement a diagnosed mechanism to help students learning.

Keywords: knowledge map, knowledge structure, mathematics learning

1. Introduction
In recent years, digital learning has become a more and more popular issue. Digital learning is the use of electronic media, information and communication technologies in education. In addition, it includes game-based learning, intelligent systems, virtual classrooms and digital collaboration. Digital learning will bring new revolutions and learning approaches to education (Evans, 2008; Liaw, 2008). Among all digital learning approaches, game-based learning is a famous one. This may be caused by the fact that there are many research indicating that game-based learning has some benefits to improve learner’s motivation and learning effects (Papastergiou, 2009; Huizenga, Admiraal, Akkerman, & Dam, 2009; Liu & Chu, 2010; Paraskeva, Mysirlaki, & Papagianni, 2010; Huizenga, 2009; Paraskeva, 2010; Liu & Chu, 2010; Prensky, 2001; Kiili & Ketamo, 2007; Van Eck, 2006; Kiili, 2005). More specifically, Traditional learning is absorbing knowledge passively. Conversely, digital games provide control and challenge that can make player feeling fun (Prensky, 2001; Crawford, 1982). Some findings are in agreement with the result of Kiili (2005) which indicating that game-based learning environments can inspire students’ learning and provide students with a great deal of learning opportunities to improve their learning. Additionally, many studies have shown that game-based learning has positive effects on student’s spatial abilities and attention (Barlett, 2009). Moreover, a digital game also has a specific goal which motivates players to complete their task (Terborg, 1976). Furthermore, some research such as situated learning, problem solving, and learning motivation are also reported in the digital game-based learning (Li & Tsai, 2013; Tüzün, Yılmaz-Soylu, Karakuş, İnal, & Kızılkaya, 2009). Due to such diversity, there is a possibility that digital game-based learning will bring new learning methods.

Digital game-based learning can occur in the classroom or out of campus because learners can use mobile devices. As a matter of fact, digital game-based learning can also be employed to support education in any environment and give an opportunity for students to choose what they want to learn, and understand how well they learn. Thus, the learning and assessment method need to be changed because the information technology introduction in education. There are many previous studies indicate that mathematics is a very
useful skill in daily life and impact learning on science (Espy et al., 2004). However, students learning mathematic are passives (Downes, 2005). In Taiwan, primary mathematical education currently adopts teacher-centered learning. Teachers are the main source of information, while students are required to be engaged in the same activity in the same place at the same time (Hwang et al., 2012). However, personal differences exist in every student. It is important that let students choose what they want to learn (Barr & Tagg, 1995). Among a variety of mathematical knowledge method, knowledge map is a useful method because it can affect how students associate the relationship with their prior knowledge. There are some prior studies showed that knowledge maps can help learners to memorize knowledge and connect the relationship with concepts (Davenport, 1998). A famous learning platform which called “Khan Academy” is also used knowledge maps and portfolio to help learners learn. Knowledge maps could help students to understand the relationships of mathematic concepts between course units and chapters. For this reason, knowledge maps could improve student’s learning performance (O'Donnell, 2002).

If we imported digital learning into learning environment, it may be brings many possibilities. Students can control their own learning progress and use all kinds of tools for learning. Therefore, teachers can be converted to the role of mentor and learning materials can be shared for each teacher (Hwang et al., 2012). Moreover, in the digital environment, it can record all students learning portfolio to show students learning effects. To this end, we try to design a digital game-based learning system which allows students control their learning by their own pace and provide a complete learning content with game-based model to enhance students’ motivation for learning. Based on the above background and motivation, this research develops a digital game-based learning system which called “Math Island” to help students learning. This system provides a variety of mathematical learning materials in a game-based knowledge map that allows students to choose learning contents and adjust learning directions by themselves. In other words, students can decide what they want to learn by their own-pace and reach self-regulation in this system. In addition, students’ learning situations are all recorded in the system. The system not only provides a visual city which using visible surface features such as building, people, and money to motivate students learning, but also have a learning portfolio to show students learning effects. In this way students can guide their own learning and achieve the learner-centered design. Finally, this study wants to explore Influence of students’ mathematical learning effect and motivation in the "math island” system.

2. Literature Review

2.1 Knowledge Map

The knowledge maps include concepts and relationships between concepts indicated by a connecting line linking two concepts. It can provide guidance for students to explore concept (Davenport & Prusak, 2000). A study by Patterson et al. (1992) indicates that training benefited students” performance with knowledge maps. Novak (1990) investigated the concept maps are graphical tools for categorizing and representing knowledge. The other study by “SDC Learning and Networking” indicating that “A knowledge map is a useful tool for presenting what knowledge resides where (e.g. people, media, organizational units or sources of knowledge) and for demonstrating the patterns of knowledge flow”. Casonato（2000）consider that that knowledge map is a guidance that shows what resources can be used to help users in the shortest time to find the necessary knowledge. The main purpose of knowledge map is to present a variety of knowledge sources and guide users to use. Holsapple (2002) indicating that using a graphical presentation of a knowledge map can help users to understand and explore knowledge. In addition, O'Donnell (2002) research on the use of knowledge maps has consistently shown benefits for students with low verbal ability or skills. The aforementioned research shows that knowledge maps could improve student’s learning performance. To this end, this study attempt to transfer the curriculum to the knowledge map and evaluating the knowledge map design for student’s mathematic learning.

2.2 Self-regulation

Self-regulation refers to individual monitoring, controlling and directing aspects of their learning for themselves. Nowadays, students catch their own learning more effective with learning technology. After digital content has been imported in learning, students have the opportunity to decide what to learn. As a result, student Self-regulation learning becomes a new learning way. Self-regulation means that students
can refer their own personal learning portfolio to decide personal learning goal and plan learning plan, then do self-paced learning. After learning, they can improve and adjust their individual learning (Bandura, 1986). In general, self-regulation is widely used in the learning situations because it can explain individual learning portfolio, monitoring individual effectively, and catch corrective self-reactions during learning. On the one hand, using technology to develop self-regulation learning is helpful for students to re-organize knowledge (Winne et al., 1998). As a result, students’ learning and motivation are interdependent via self-regulation (Zimmerman, 1990). Furthermore, developing students’ ability and skill about improving learning performance with self-regulation in school education and family education is an important thing. Moreover, the Self-paced learning also related to the self-management learning. Self-paced means that there are no group assignments or peer review and that learners are able to move with their own speed. Accordingly, using technology to help developing self-paced learning allows students to explore new forms of self-regulation learning and helps students re-organizing knowledge (Winne and Hadwin, 1997). In addition, another important approach is that learning and motivation of students is interdependent (Zimmerman, 1990). The study by Pintrich and Schrauben (1992) examined students are active while learning rather than being passive to accept information. Indeed, it’s the best learning method for students that students are active in looking for learning opportunities and after finding learning opportunities, they learn with passion. Moreover, they try to find solutions themselves like setting goals and self-reflecting to adjust their learning method. As in section 1, students were often seemed as passive role in learning process and their learning methods and learning outcomes had a parallel relationship with the teacher teaching way (Kember, 1997). In brief, teacher not only was an assistant but also the protector of class order. Thus, students should leaded their own learning and it was meaning that they has a choice in their learning.

2.3 Learning Portfolio

Traditional approaches of learning, teaching, and assessment need to change after technology imported (Birgin & Baki, 2007). In the current learning environment, learning process should be more emphasized because the traditional test assesses student learning difficulty. Portfolios can be a valuable research tool to gain understanding about personal accomplishments (Tillema, 2001) and displaying student problem solving process, learning attitude, and the growth after learning (Lin, P.J. & Tsai, W. H., 2001). Student learning portfolio is a complete record which collecting information about learner purposely and keeps all student activity processes to understand the student’s efforts, growth and achievements (Arter & Spande, 2005). More specifically, learning portfolio can be a useful tool to help student reflection and display their learning outcomes. In addition, the extracted portfolio data can present students’ learning performance clearly for teachers, parents, and themselves.

Digital learning has developed rapidly in recent years, which is digitizing learning processes and use internet to store in a database to help recording, searching, organizing, and analyzing the learning portfolio (Chen, 2002). Learning portfolio let students grasp learning processes, as well as help students reflecting and reviewing all learning processes and learning outcome. Furthermore, the learning portfolio gave appropriate feedbacks to support student learning (Chang, 2001). Hence, the Math Island integrates learning portfolio concept to give students immediate feedback and reflection. Moreover, the Math Island also provides teachers with information to focus students’ problems. So the Math Island wishes to help students reaching in meaningful learning.

3. System Design: Math Island

3.1 Learning process

The object of this system mainly used in elementary school’s mathematics learning. All students play the role of a master who is the owner of the "Math Island". In the system, every student must manage their virtual island and attracts other virtual resident to living in the island. The business model of the Math Island built from a new ground. Each ground has a variety of construction projects (or learning task). The learning process of the Math Island as showed in figure 2. Students can plan their own construction projects which indicate that students could choose a learning task by themselves. In other words, students can do a mathematical learning task to advance their house. Students will get reward form system when they are completing a learning task. Then, the building will grow up by their learning effect. The visible surface features on building represent a portfolio for students. Finally, the island will be personalized because students can purchase some unique building to develop theirs island.
3.2 Learning content design

In recent years, the educational institution which called “Ministry of Education” promotes slight regulation for nine-year joint curriculum of elementary school and junior high school in Taiwan. The Ministry of Education indicators five-ability index of mathematics which are “Number and quantity”, “geometric”, “algebra”, “Statistics and Probability”, and “link”. For this reason, the interface and learning content of the Math Island system is according to this five-ability index. However, the index about “algebra” and “link” are not adapted to be an index of the math island system. As a matter of fact, among the contents of the elementary school and junior high school, most of the “algebra” units are in the junior high school’s curriculum. Furthermore, the index of “link” units contains many elements such as perceived transformation, problem solving, communication, and analysis. More specifically, it is difficult to define “link” and “algebra” be an index that these elements relate to many mathematic units. Accordingly, the index of “algebra” and “link” units are integrated with other units in this system. Besides, the index of “Number and quantity” in the system are divided into two indexes which called "Numeral and Computing" and "Quantity and Measure" because the “Number and quantity” are covering a wide range of curriculum in elementary school.

To this end, this study draws a mathematical knowledge map which was including four indexes: “Numeral and Computing”, “Quantity and Measure”, “geometric”, and “Statistics and Probability” (see Figure 2). To begin with, these four indexes are depending on the nine-year joint curriculum and divided into a variety of units and sub-units. Then, each unit contains many sub-units and has principles to connect these sub-units. Finally, these units and sub-units have been classified into some roads in the system. Hence, there are many different roads which named by relate units in the math island system. Thus, the indexes of “Numeral and Computing” are containing a very large part of the Math Island because it plays an important role in the primary mathematic curriculums. Basically, the student can do learning tasks in different areas to perform mathematics learning. Table one show the design of knowledge map's structure on the Math Island. We are implementing a great amount of learning task in the system.

![Figure 2. The knowledge map structure.](image)

![Figure 3. System interface in the system.](image)

There are much different learning content in the math island. In the system, we design three types of task, such as prior concept review, concept teaching, and mastery learning for students' learning. However, the subject of mathematics learning was usually limited by student’s prior knowledge (ex. If a student wants to learn” single-digit addition”, he/she must understand the concept of “single-digit” and “addition”). Therefore, this course has been structured to operate in a self-paced manner. In addition, in order to
confirm that students really learn a knowledge in self-paced, we set a mechanism which classified the prior concept review task and concept teaching task as “key task” to regulation on students learning. Students must have been completed the “key task” for fear that students have enough prior knowledge to do the next task. In other words, Students must get a passing “key task” to move to the next course.

The learning content of each task has referred to a variety of publishing house and re-design by many experts. The learning contents are included graph, text, and instructional videos to guide students learning. Besides, it provides a scratch paper and visual numeric keypad for students to answer questions. More specifically, the system also has a variety of materials which including crosswords, multiple choice, fill in the blank, matching, true or false of questions. These different kinds of questions can support students to learn different concepts. Finally, when students are answering a question, the system will calculate accuracy immediately. If students can get higher accuracy they will earn more rewards. Furthermore, the system will give students positive feedback when students respond a correct answer. Conversely, the system will give students hint to guide students when they respond a wrong answer. There are some learning content examples shown in the figure 4.

The other tasks are mastery learning task which using two digital games to appearing in the system. One is “Happy Farm”, and the other is “Fishing Expert”. These games have some game elements to enhance students’ motivation for their learning. All of learning tasks in the math island develop in accordance with this mechanism.

3.3 System mechanism

When students login into the system, an arrowhead would be displayed on the monitor and guide them to choose a learning unit (see Figure 6). In addition, if students click a building, the scenario will transfer to “learning lobby”. The lobby will present many learning tasks for students to choose. The task with blue color means that it can be performed. On the contrary, the gray means students need to complete the prior key task to open the task.
In addition, as shown in figure 8, the system also provides immediate feedback mechanism to help students answer a question. More specifically, when students input a correct answer, the system will show “√” message to represent the correct answer. In contrast, when students input a wrong answer, the system will give immediate feedback or hints to help student’s reflection. The rewards for students are according to their accuracy rate in the task. Besides, in the system, each student can construct the map individually and giving feedback for teacher on the level of understanding of every student. Within the option of individual construction of the map, the students can be allowed to visit the other student’s island where students are able to share information. The system provides this mechanism for students to interact with others and enhance their learning motivation.

![Figure 8. Snapshot of the learning task with immediate feedback.](image)

According to task completion, the buildings can be divided into four grades in total. As show in figure 9, students’ learning outcomes will be presented in these buildings to show students learning progress in the Math Island system. In addition, students can understand their learning situation and reflection themselves by their own-paced.

![Figure 9. Four grades in the buildings.](image)

4. Case Study
4.1 Participants and Data collection

The participants were 217 second-grade students of a primary school in Taiwan. All participants have a tablet PC to conduct a digital environment. At the beginning, we held a typing training program and system introduction course in order to make sure that all participants could control the prerequisite skill. At the end of the training program, the participants’ can login the Math Island system to do a learning task by their own-pace. The systems will collection all user data in the database.

4.2 Preliminary results

According to the system data, some students not only reached the standard progress in semester 1 but also reached the second-grade progress by using the system. Furthermore, the data in Table 1 demonstrates the progress in different mathematic units of all students. The standard curriculum...
pace is 101-1 and more than 210 students can reach the next semester curriculum. The preliminary shows that some students have a good progress by self-learning but it also need to In-depth analysis in the further research.

Table 1: The results of the student’s task data.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
<th>Class 6</th>
<th>Class 7</th>
<th>Class 8</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>26</td>
<td>28</td>
<td>27</td>
<td>28</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>217</td>
<td></td>
</tr>
<tr>
<td>Complete task number</td>
<td>123</td>
<td>138.1</td>
<td>121.1</td>
<td>134.3</td>
<td>130</td>
<td>129.7</td>
<td>128.0</td>
<td>141.6</td>
<td>130.72</td>
</tr>
<tr>
<td>Average accuracy</td>
<td>88.26</td>
<td>90.28</td>
<td>88.33</td>
<td>89.52</td>
<td>87.83</td>
<td>88.26</td>
<td>89.16</td>
<td>87.97</td>
<td>88.701</td>
</tr>
<tr>
<td>Less than 101-1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Reached 101-1</td>
<td>25</td>
<td>26</td>
<td>24</td>
<td>28</td>
<td>27</td>
<td>27</td>
<td>26</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Reached 101-2</td>
<td>9</td>
<td>22</td>
<td>11</td>
<td>17</td>
<td>18</td>
<td>15</td>
<td>16</td>
<td>22</td>
<td>130</td>
</tr>
<tr>
<td>Reached 102-1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Reached 102-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

5. Conclusion and discussion
In this study, the Math Island system with knowledge map and self-regulation design was developed for students in learning mathematics by their own-paced and self-reflection in an easier way. We produced 488 mathematics interactive materials, videos and games and conduct a management game to motivates students’ learning. Meanwhile, the aims of this study not only examined whether the Math Island system is useful to improve students’ learning motivation, but also investigated how students’ learning progress in the system. The preliminary results show that elementary students may be able to learn in the self-regulation learning environment and learning well themselves. However, although students’ progresses were increasing at this time, how the influence on the system should be further evaluated and discussed. In the future, we will do more detailed data analysis of the system, support more learning materials and implement a diagnosed mechanism in the system to help students learning.

Acknowledgements

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References


The Change of Interpersonal Relationship for Group Development in Digital Game-based Adventure Education Course

Chang-Hsin LIN*, Yu-Jen HSU, Ju-Ling SHIH, & Chia-Chun TSENG

Department of Information and Learning Technology
National University of Tainan, Taiwan
*arthur1379@hotmail.com

Abstract: The development of physical adventure education activities has existed for a long time. However, there was little research concerning its applications and developments with technology. This research designed a digital game-based adventure education course with Tuckman’s stages of group development. Six traditional adventure education activities were chosen to be developed into digital forms by Unity3D and were developed into three different platforms: desktop computers, tablets, and motion-sensing devices. Bales interaction process analysis was used to observe the development of group interactions of the participants during the experiment. The results showed that the interpersonal relationships between participants in groups can be effectively improved after the course.

Keywords: Adventure education, Digital game-based learning, group development, interaction process analysis.

1. Introduction

Adventure education is formed by risky and challenging activities experienced by students. The connotations of adventure education were thought and internalized through the personal experiences to the activities and group reflections after the activities led by the facilitators. For several decades, the activities of adventure education have been implemented in the physical form. Students have been grouped up and experienced the activities in the wild for a few days or even weeks. Group members had face-to-face contacts, went through the courses with members, and experienced their missions of activities from being strangers to partners. Goals for the activities were learned in the reflection sessions with the facilitators after each activity. Group members could use the lessons they learned in the daily life situations. However, few studies have presented insights of adventure education with digital games.

With the advance of technology, more and more teenagers are interested in digital games. Traditional adventure education activities are seldom their learning or leisure options. Conversely, teenagers are more apt to show themselves in the virtual world of games in terms of their real personalities, creative ideas, and internal emotions. Therefore, this research aims to investigate whether digital games can effectively become the medium for adventure education, and whether teenagers can establish interpersonal relationships more successfully.

The study aims to design a digital game-based adventure education course base on Tuckman’s stages of group development. Six traditional adventure education activities that are difficult to be implemented due to location or weather limitations were chosen to be digitized into digital games and were integrated in accordance to the five stages of Tuchman’s stages of group development. Bales interaction process analysis was used to observe the development of group interactions of the participants during the course experiment.

The game engine Unity3D was used as the development tool. With the advantages of cross-platform, high-simulation, and easy-manipulation, researchers transformed the six traditional adventure education activities into two computer games, two tablet games, and two motion-sensing games. After the course, students can not only learn positive interactive relationship of adventure education, but also have fun with digital games.
2. Literature review

2.1 Adventure Education

The courses of adventure education which takes days or even months to finish were originally long and extensive. In 2001, the essences of adventure education were devised into small-size courses which only took a few hours (Glass & Myer, 2001). Glass and Myer (2001) thought the learning effectiveness of adventure education courses should not only be analyzed with questionnaires. Research should increase observations and interviews to investigate students’ learning effectiveness. They thought students’ behaviors in groups would be affected by the individual state of mind. Consequently, they observed the performance of each student in the reflection session from the individual psychology side. For several years, studies in adventure education area were based on thematic course or activities. In company with Baldwin, Persing, and Magnuson (2004), Brown (2006) indicated that the difference between pre-test and post-test have been over-focused in those studies. Those studies ignored the change of students’ behaviors and learning styles in the process of activities. In 2009, a detailed account of using qualitative research method, such as interviews and observations, was presented to explore the change of peer relationships, interpersonal skills, and students’ self-concept during the process (Zmudy, Curtner-Smith, & Steffe, 2009).

In recent years, the design of adventure education course has been a fixed process in Taiwan and other countries. The course design was always based on Tuckman’s stages of group development (Tuckman & Jensen, 1977). The five stages of group development were combined with suitable activities into the adventure education course. Through those activities, every group was developed to be a high-performance team. However, there were only a few studies that investigated the interaction details in the process. Therefore, this study aims to present a detailed analysis to the interaction process.

2.2 Digital games in counseling area

Digital game-based learning (DGBL) has been gradually emphasized in recent years. The purpose is to improve students’ learning motivation and effectiveness through digital games. Face to face interviews were usually used in the traditional counseling which may build up intangible stress to the participants that were unhelpful to bridge the communication gap. It always took lots of time to drop one’s guard that only can be done by counseling psychologists. Without proper temptations, teenagers kept losing their interests when doing activities in a confined room. It is supposed that digital games can help the counseling activities to be carried out smoothly. Taking the advantages of digital games can lower down the stress to them and help them to focus on the counseling issues. To help people to have in-depth understanding to themselves and are willing to make necessary changes are the purposes of counseling. It is worth to try to unload the defenses of participants and achieve the purposes of counseling.

In the last two years, many digital games were developed based on adventure education and counseling activities were developed by our team (Hsu & Shih, 2013), and were used in the individual and group counseling. Their research results show that the learning effectiveness of digital counseling games perform equal or even better than the traditional ones, as well as the attention and motivation of the students in participating of the adventure education activities. It is proved to be feasible to implement the teaching methods of digital game-based learning in the courses of adventure education or counseling area.

2.3 Interaction process analysis

Bales interaction process analysis (IPA), which is widely used and is especially suitable to analyze problem-solving groups, is an analysis tool about group interactions. Task dimension and socio-emotional dimension were the two dimensions of interactive behaviors that IPA considers. The two dimensions are opposite to each other (Bales, 1950). In the recent years, studies range from group efficacy, parent-child relationships, and counseling were focused on observing the physical group activities. Some studies explored about the use of technology to help researchers to record game dialogs. Interaction observations were recorded by computer-assisted tools (e. g. Nam, Lyons, Hwang,
Those studies all indicated that communication is easy to observe and record with computers, but the on-line group interactions are less effective than face-to-face ones. There were some studies of adventure education using IPA to observe group members’ interaction process. However, observations to the group interactions in the digital games were rare to find.

3. The digital game-based adventure education course

Tuckman (1977) thought the groups development go through stages sequentially, thus, the theory described the process in five stages. However, members’ negative behaviors such as bad communications and misunderstandings in the storming stage would hinder group development. In this situation, group members had to face and solve their problems in order to move forward to the next stage, and thus become high-performance groups. Table 1 describes the individuals and groups situations for each stage of group development.

| Table 1: Situations of group development in Tuckman’s five stages (Tuckman, 1977) |
|---------------------------------|---------------------------------|
| **Forming** | **Group interaction situations** |
| 1. Explore, feel strange to everything. | 1. All members are not familiar with each other. |
| 2. Both individual and group goals are not clear. | 2. Finish personal works without group work. |
| 3. Look for his position in the group. | |
| **Storming** | **Storming situations** |
| 1. Look for the individual goals | 1. Form small groups. |
| 2. Have personal opinions, dealing with works from their own angles. | 2. Groups have abilities to divide the works to each member, and can complete simple missions. |
| 3. Have influence in group. | |
| **Norming** | **Norming situations** |
| 2. Accept others’ opinions and views, and make adjustments. | 2. Groups work on the same rhythm. Understand personal roles and values. |
| 3. Personal motivation. Members take roles in groups. | |
| **Performing** | **Performing situations** |
| 1. Identify with group goals. Have personal ideals. | 1. Have great interactions and work skills. |
| 2. Look for further growths and changes. | 2. Have great group climate. Cover and support each other. |
| 3. Help partners to grow from each other. | |
| **Adjourning** | **Adjourning situations** |
| 1. Share self-reflections and experiences. | 1. The cycle ends. Review and share the process of group development, common experiences, and memories. |
| 2. Produce common memories in the development process. | |

Two books about adventure education, “Experiential education- learning from 150 games” (Hsieh, Wang, & Chuang, 2008) and “Experiential education: theory and practice” (Kuo, Liao, & Shih, 2009), were used to identify suitable activities for the digital counseling games. The activities were designed to be conducted in groups of five members. The design of the digital game-based adventure education course was based on Tuckman’s stages of group development. The five group development stages are described as follows.

**Forming:** Members meet each other for the first time. Everything is strange for them. The warm-up activities are chosen to let them share, communicate, and give opinions frequently so that the members can be familiar with each other. The initial group relationship is built by group members. The purpose of the first stage activity is to create group relationships, breaking fixed conceptions, and making reflections. The game which is chosen to digitize for this stage is Polar Bear and Hole (Figure 1). At the beginning, a story which provides hints for the task is presented in the game. The facilitator throws dices three times for giving hints. After that, members observe, discuss, and induce for correct answers following the logistics of the story.

**Storming:** The activities which need deep communications between members to finish the
missions are contained. In this stage, all members have to discuss the group problems with their internal dialogues and work together to complete the tasks. The group problems and personal weaknesses are improved by themselves. After this stage, groups can become high-performance teams. The purposes of the activities in this stage are cooperation, communication, respect, breaking fixed conception, problem-solving, trust, and reflection. Cooperative Puzzle (Figure 2) and Chessboard Maze (Figure 3) are used in this stage. In Cooperative Puzzle, three puzzle pieces out of total of fifteen puzzle pieces are distributed to each member. All five members in the group have to work together to assemble five equal-size squares with puzzle pieces. Members can exchange puzzle pieces with others without discussion. They can only give out puzzle pieces and may not ask from others. The purpose of the game is to make members pay attention to others’ needs and realize their roles in the group. In Chessboard Maze, only one person can play at a time. Each member has to pass the 9x5 chessboard which is full of landmines with only one path. The member has to start over again when he goes through the wrong path. Every failure leads to point deduction. To generate gaming strategies together through members’ experience, challenge obstacles, break fixed conceptions, and trial-and-error, and to build the trust between members are the goals of the game.

Performing: Members now are in great interactions and have skilled cooperative strategies after going through the frustrations and difficulties in the previous activities. The goals of the activities in this stage are trust, cooperation, leadership, communication, and reflection. Group Balance (Figure 5) is used in this stage. Three people are required to play the game. One member keeps his balance on the board and the other two members keep pushing the board upward on the two opposite sides until reaching the top. To increase members’ cooperation strategies, reliance, and face the challenges are the purpose of the activity.

Adjourning: Group development process comes to the end. Members encourage each other and share their experiences. Having existing members to leave, new members to join, and start a new cycle, are the situations the members in the group must face. The goals of the activities are communication, trust, leadership, cooperation, and reflection. Calculator (Figure 6) is used in this stage. Thirty ladybugs are marked from numbers 1 to 30 in a garden on the screen. The goal is to catch the bugs serially as fast as possible. Five seconds would be added as punishments rules were violated. Four chances were given to each group and the best one would be the final score of the group. To train members to solve problems and communicate are the purposes of the activity. It strengthens group concepts and identifies their roles.

Those games in this study were devised for adventure education which required highly interactions and simulations. Therefore, Unity3D game engine was used to develop those games. With its great performance of simulation, members can become immersed as if they were in the real scene. The game engine also provides cross-platform publication such as IOS, XBOX360, Android, Web, Wii, and PC. Because physical activities vary, the digital games designed for this course had to be presented in different formats and platforms to fulfill the needs. Using Unity3D to make cross-platform games also saved time.
4. Experimental Design

In this research, six digital games were included in the course that adults or teenagers were ideal targets for. Therefore, thirty college students aged between 19 and 25 from Taiwan were randomly recruited to participate in the course. The experiment was divided into three sessions in three different days. Two groups, with five members in each group, were guided by a facilitator to take the course in a day; the whole course lasted for six hours. Audio and video recordings were made during the experiment for later observations with Bales interaction process analysis (Figure 7).

According to IPA, members have to solve group problems in two dimensions. 1. Task dimension. The contents of dialogues were the situations which group members have to ask, solve, guide, order, and suggest. Task-oriented interactions were classified in this dimension. 2. Socio-emotional dimension. The contents of dialogues were the situations which concern the acceptances, coordination, conflicts, and opinions in group members. Socio-oriented interactions were classified in this dimension. During the process of group development, all interactions and dialogues were recorded according to the schemes stated in Table 2. With the data which are recorded by IPA, the group development problems can be resolved and identified (Bales, 1950).

Table 2: Bales interaction process analysis (Bales, 1950).

<table>
<thead>
<tr>
<th>Functional dimension</th>
<th>Content categories</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Research Results

The changes of interpersonal relationship of the group members were shown in this section. All the results were analyzed by encoding the dialogues occurred during the experiment sentence by sentence with Bales interaction process analysis.

According to Tuckman’s thesis, groups had to go through four group development stages before becoming high-performance teams. Differences of values and concepts that caused conflicts between members occurred during the group development process. Those conflicts were solved after personal adjustments, interpersonal communication, leader’s coordination, and members’ compromises, and the groups would start to become effective ones. The needs for coordination and communication increased when the groups undergone the stage of storming. Facilitators should encourage the group timely when the groups hesitated. Facilitators played an important role in every stage of group development. Members reached consensus on mission completions or problems solving after the stage of storming. Therefore, the frequency of group interactions peaked at the stage of storming and started decreasing when the members were on the same wavelength at the stage of norming and performing.

The interactions of Group 1, 2, 3 and 4 were mainly distributed into the dimensions of positive reactions, attempted answers, and questions defined in Bales interaction process analysis in every stage of the course. The groups faced and solved the problems positively with positive communications, and caused less negative interactions that might affect the group developments. Negative reactions mostly occurred when the groups were solving the Chessboard Maze in the stage of storming. The frequency of negative reactions in stage of storming was more than other stages. It was because the game was designed to let the members experience frustrations and failures.

Although the distributions of interaction contents of all groups were similar, the frequency of interactions of Group 5 and 6 were much less than the former groups. These two groups finished the mission of Chessboard Maze in the stage of storming smoothly without a great amount of trials and errors that they had no chance to build up the cornerstone of positive interactions and group understanding. Consequently, the frequency of interactions of the activities in the stage of adjourning which need great understandings and strategies to get better scores sprang up to finish the work that should be done before.

The interaction frequencies of group 1, 2, 3 and 4 were shown in Figure 8. The frequencies of interactions of the four groups reached a peak in the stage of storming. After a great amount of adjustments, communication, and coordination, better scores were reached easily with excellent understandings to each other. The interactions of group 2 and 3 in Calculator in the stage of adjourning were more than in Chessboard Maze in the stage of storming. From the observations of the researchers, the reasons that caused the differences might be the lack of the explicit strategies and the guidance of a leader. The members needed further discussions on the execution of strategies to get better score in the stage of adjourning.
Figure 8: the line graph of interaction frequencies of Group 1, 2, 3 and 4.

As shown in Figure 9 below, the frequencies of interactions of group 5 and 6 in the stage of storming were lower than the former groups. The performances of the later stages would be affected without sufficient adjustments, coordination, and compromises in the stage of storming. Therefore, that would be worth discussing.

Figure 9: the line graph of interactive frequency of Group 5 and 6

6. Conclusion

Six theory-based traditional adventure education activities that were difficult to be implemented due to limitations of bad weathers, restrictions of rules, and documenting problems were developed into digital games with Unity3D. Unlike commercial games, those digital games which were combined with Tuchman’s stages of group development aimed to put considerations to provide joy to the learners, and at the same time to reach the purposes of adventure education. The research questions were set to observe the process as digital games were used as the medium of adventure education, and the interaction patterns of interpersonal relationships in digital game-based adventure education course.

The purpose of this study was to investigate whether the members in each group can turn strangers into a high-performance team after taking the course designed in this study. After the analysis by Bales interaction process analysis, the results showed that no matter how fast the group developed, all six groups had become positive high-performance teams after the course. Group development efficacy was heavily depended on the adjustments, communication, and coordination they experienced in the game.

Acknowledgements

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References


Designing Educational Computer Game for Human Circulatory System: a Pilot Study

Jatuput LOKAYUT\textsuperscript{a} & Niwat SRISAWASDI\textsuperscript{b}\textsuperscript{*}

\textsuperscript{a}Science and Technology Education Program, Faculty of Education, Khon Kaen University, Khon Kaen, Thailand

\textsuperscript{b}Division of Science, Mathematics, and Technology Education, Faculty of Education, Khon Kaen University, Khon Kaen, Thailand

*niwsri@kku.ac.th

Abstract: Recently, digital games have been becoming popular and integral part of our society. The benefit of digital games is not only for fun but also for supporting learning by adding educational purpose into the games called educational games. In this study, we identified 12th grade students’ alternative conceptions of human circulatory concept by using two-tier test to design a game served as their alternative conceptions-based learning material. The tests consist of multiple-choice and confident scale. The results show that the students hold alternative conceptions (false-positive and false-negative group) in every concept of human circulatory system, especially homeostasis. From students’ alternative conception findings, in this study, an educational computer game was designed and developed, for example the Blood Donor game. To study the effectiveness of Blood Donor game, we explored the 11th grade students’ motivation and perception of learning before providing them game (pre-test) and perception after taking game (post-test). The results show that game can enhance students’ perceptions. Moreover, students’ motivation did not correlate to their perception, indicating that the developed game could be used for students who have low or high motivation in science.

Keywords: Game-based learning, digital games, alternative conceptions, science motivation, perception to learn

1. Introduction

Digital games or computer games are programs or software that created for entertainment purpose (Rollings and Adams, 2003). Recently, digital games have been becoming popular and integral part of our society, especially children or younger generation who like to play game as a favorite activity. To apply the game to educational system, teachers and educators have attempted to find the new ways of teaching by adding educational purpose into the games which is called educational games, this approach namely game-based learning (Tang, Hanneghan and Rhalibi, 2009).

The benefit of digital games is not just for fun, it can be used to support learning. Papastergiou (2009) reported that using game in high school can promote students’ of computer concepts and more motivational than non-game approach. Another study also reported that educational games can promote engagement and learning for students with special learning needs (Ke and Abras, 2013). The comparison effect of games indifferent course showed that students and teachers in the game-based course provided more reasons for student motivation along with more desirable, more helpful and less hindering aspects than students and teachers in the non-game-based course (Gunter and Hess, 2013). In addition, students who play an educational video game expressed all of the projected twenty-first century skills while being engrossed in the embedded science content (Annetta, Cheng and Holmes, 2010).

Human circulatory system, which is one topic in biology course, is difficult to learning due to its complex, too much information, and sometimes students’ alternative conception come from textbook illustrations (Buckley, 2000). This is a reason why educators have attempted to seek a new approach to teach biology, such as active learning and student-centered pedagogy (Armbruster, Patel, Jhonson and Weiss, 2009). Oblinger (2003) suggested that actively engaged students insist that education must be more than the conventional PowerPoint classroom lecture where information is poured into their heads.
and regurgitated onto worksheets. To this end, knowing students’ alternative conception is useful when designing the learning material. Consequently, students’ alternative conceptions of human circulatory system are needed to investigate for served as an input to designing a digital game. The developed game is served as a tool for supporting students’ learning on human circulatory system topic. Therefore, the students’ perception and the correlation between students’ science motivation and perception are challenging to examine in this study.

2. Study 1

2.1 Participants

A total of 31 students in the twelfth grade from local public school at the northeastern region of Thailand were recruited to respond their conceptual understanding about human circulatory system by taking a conceptual test including 16 items for 40 minutes. All of them are women and age ranging from 18-19 years old. They learned about human circulatory system before participating in this study. They did not prepare themselves for taking this test. Such that, it is reasonable for seeking their alternative conception on the topic.

2.2 Research Instrument

The two-tier concept test about human circulatory system was used in this study. We developed first tier as a multiple-choice by applying the study of Sungur and Tekkaya (2003) to investigate students’ alternative conceptions. The second tier is confidence scale (McClary and Bretz, 2012), ranging from 0% (just guessing) to 100% (absolutely confident), to examine students’ confident in their response and facilitated an analysis about students’ alternative conceptions. Our concept test consists of 16 items and main concept is classified into 4 concepts including blood, heart, blood vessels, and homeostasis.

2.3 Data Collection and Analysis

To design and implement the games, we investigated students’ alternative conceptions about human circulatory system at first step. Students were tested by taking two-tier conceptual test including 16 items for 40 minutes without preparing themselves for taking an examination. The students have to select only one correct answer form four options and make “X” mark on the scale to assign their confidence about answer in each item. Students’ answer and their confidence were classified into 4 groups, true-positive (TP) for correct answer with confidence more or equal 50%, true-negative (TN) for correct answer with percent of confident below 50%, false-positive (FP) for incorrect answer with confidence more or equal 50%, and false-negative (FN) for correct answer with percent of confident below 50%.

2.4 Results and Discussion

The aim of developing two-tier test is to identify alternative conceptions in which students have about human circulatory system concept. The results from this test show that the students hold alternative conceptions for every concept such as blood, heart, blood vessels, and homeostasis. List of students’ alternative conceptions was shown in Table 1. Considering Table 1, students’ alternative conceptions about blood concept shows that 80.65% of them hold alternative conceptions in which biconcave shape allows red blood cells to be in close contact with body cells, 32.26% of them believed that some of the blood stays inside blood tube and some of it leaves the blood tubes and baths the cells. In other concepts, 38.71% of them thought that blood goes into the heart on one side and leaves the other sides and goes to all parts of the body, low blood velocity in capillaries is due to material exchange through capillaries (58.06%), in systemic circulation, percentage of blood volume in the arteries and capillaries is equal, which is greater than that of veins (29.03%), all plasma proteins catalyze reactions in blood under normal physiological conditions. Similar to the study of Özgür (2013), he found that student hold
alternative conceptions about blood circulatory system, such as heart, blood, blood circulation, and blood transfusion.

Table 1. List of students’ alternative conceptions about human circulatory system.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Students’ alternative conceptions</th>
<th>% (n=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood</td>
<td>Fat is not found in plasma.</td>
<td>22.58</td>
</tr>
<tr>
<td></td>
<td>Vitamins uric acid is not found in plasma.</td>
<td>29.03</td>
</tr>
<tr>
<td></td>
<td>Uric acid is not found in plasma.</td>
<td>16.13</td>
</tr>
<tr>
<td></td>
<td>Biconcave shape allows red blood cells to hold more hemoglobin.</td>
<td>16.13</td>
</tr>
<tr>
<td></td>
<td>Biconcave shape allows red blood cells to be in close contact with body cells.</td>
<td>80.65</td>
</tr>
<tr>
<td></td>
<td>Serum is plasma to which necessary nutrients for a patient.</td>
<td>16.13</td>
</tr>
<tr>
<td></td>
<td>Serum is storage from of plasma.</td>
<td>29.03</td>
</tr>
<tr>
<td></td>
<td>Serum is house’s plasma.</td>
<td>12.09</td>
</tr>
<tr>
<td></td>
<td>Blood stays inside blood tubes that go to and from the cells.</td>
<td>22.58</td>
</tr>
<tr>
<td></td>
<td>Blood leaves the blood tubes and bathes the cells.</td>
<td>3.23</td>
</tr>
<tr>
<td></td>
<td>Some of the blood stays inside blood tube and some of it leaves the blood tubes and bathes the cells.</td>
<td>32.26</td>
</tr>
<tr>
<td>Heart</td>
<td>Ventricular filling occurs mostly during atrial contraction.</td>
<td>35.48</td>
</tr>
<tr>
<td></td>
<td>Ventricular filling occurs mostly during contraction of atrioventricular valves.</td>
<td>25.81</td>
</tr>
<tr>
<td></td>
<td>Blood goes into the heart on one side. Blood leaves the other side and goes to all part of the body.</td>
<td>38.71</td>
</tr>
<tr>
<td>Blood vessel</td>
<td>Low blood velocity in capillaries is due to their small diameter.</td>
<td>9.68</td>
</tr>
<tr>
<td></td>
<td>Low blood velocity in capillaries is due to material exchange through capillaries.</td>
<td>58.06</td>
</tr>
<tr>
<td></td>
<td>Low blood velocity in capillaries is due to their long distance from the heart.</td>
<td>22.58</td>
</tr>
<tr>
<td></td>
<td>In systematic circulation, percent of blood volume in the arteries, capillaries, and veins is equal.</td>
<td>9.68</td>
</tr>
<tr>
<td></td>
<td>In systemic circulation, percent of blood volume in the arteries and capillaries is equal, which is greater than that of veins.</td>
<td>29.03</td>
</tr>
<tr>
<td></td>
<td>In systemic circulation, the percent of blood volume in the arteries is the highest, while the blood volume in the veins is the lowest.</td>
<td>25.81</td>
</tr>
<tr>
<td>Homeostasis</td>
<td>Under normal physiological conditions, all plasma proteins are used to meet cells’ amino acid needs.</td>
<td>6.45</td>
</tr>
<tr>
<td></td>
<td>Under normal physiological conditions, all plasma proteins help material transport across capillaries.</td>
<td>19.35</td>
</tr>
<tr>
<td></td>
<td>Under normal physiological conditions, all plasma proteins catalyze reactions in blood.</td>
<td>38.71</td>
</tr>
<tr>
<td></td>
<td>Glucose leaves the blood in capillary mainly by diffusion through endothelial cells.</td>
<td>29.03</td>
</tr>
<tr>
<td></td>
<td>Glucose leaves the blood in capillary mainly by fluid movement through endothelial cells at arteriole end.</td>
<td>41.94</td>
</tr>
<tr>
<td></td>
<td>Glucose leaves the blood in capillary mainly by diffusion through narrow opening between endothelial cells.</td>
<td>19.35</td>
</tr>
</tbody>
</table>

From analysis of students’ answers shown in Table 2, we found that 18.55% and 33.07% were classified as FP and FN group respectively, this suggests that half of students hold alternative
conceptions and 14.49% hold incomplete scientific conceptions about blood concept. In the same way, more than half of students hold alternative conceptions about heart, blood vessel, and homeostasis concept.

Table 2. Students report self-confidence in each item on multiple-choice and scale of 0% to 100% of confident.

<table>
<thead>
<tr>
<th>Content</th>
<th>Item</th>
<th>TP N</th>
<th>TP %</th>
<th>TN N</th>
<th>TN %</th>
<th>FP N</th>
<th>FP %</th>
<th>FN N</th>
<th>FN %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4</td>
<td>12.90</td>
<td>6</td>
<td>19.25</td>
<td>9</td>
<td>29.03</td>
<td>12</td>
<td>38.71</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>22</td>
<td>70.97</td>
<td>3</td>
<td>9.68</td>
<td>3</td>
<td>9.68</td>
<td>4</td>
<td>9.68</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>16.13</td>
<td>7</td>
<td>22.58</td>
<td>6</td>
<td>19.35</td>
<td>13</td>
<td>41.94</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>11</td>
<td>35.48</td>
<td>2</td>
<td>6.45</td>
<td>5</td>
<td>16.13</td>
<td>13</td>
<td>41.94</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>33.87</td>
<td></td>
<td>Mean</td>
<td>14.49</td>
<td>Mean</td>
<td>18.55</td>
<td>Mean</td>
<td>33.07</td>
</tr>
<tr>
<td><strong>Heart</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>8</td>
<td>8</td>
<td>25.81</td>
<td>4</td>
<td>12.90</td>
<td>11</td>
<td>35.48</td>
<td>8</td>
<td>25.81</td>
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<td></td>
<td>9</td>
<td>6</td>
<td>19.35</td>
<td>3</td>
<td>9.68</td>
<td>10</td>
<td>32.26</td>
<td>12</td>
<td>38.71</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>3</td>
<td>9.68</td>
<td>8</td>
<td>25.81</td>
<td>3</td>
<td>9.68</td>
<td>17</td>
<td>54.84</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>17</td>
<td>54.84</td>
<td>2</td>
<td>6.45</td>
<td>11</td>
<td>35.48</td>
<td>1</td>
<td>3.23</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>27.42</td>
<td></td>
<td>Mean</td>
<td>13.71</td>
<td>Mean</td>
<td>25.81</td>
<td>Mean</td>
<td>30.65</td>
</tr>
<tr>
<td><strong>Blood vessel</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
<td>3.23</td>
<td>1</td>
<td>3.23</td>
<td>25</td>
<td>80.65</td>
<td>4</td>
<td>12.90</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>6</td>
<td>19.35</td>
<td>3</td>
<td>9.68</td>
<td>10</td>
<td>32.26</td>
<td>12</td>
<td>38.71</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>2</td>
<td>6.45</td>
<td>1</td>
<td>3.23</td>
<td>11</td>
<td>35.48</td>
<td>17</td>
<td>54.84</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>3</td>
<td>9.68</td>
<td>8</td>
<td>25.81</td>
<td>3</td>
<td>9.68</td>
<td>17</td>
<td>54.84</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>9.68</td>
<td></td>
<td>Mean</td>
<td>10.49</td>
<td>Mean</td>
<td>39.52</td>
<td>Mean</td>
<td>40.32</td>
</tr>
<tr>
<td><strong>Homeostasis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>3.23</td>
<td>10</td>
<td>32.26</td>
<td>4</td>
<td>12.90</td>
<td>16</td>
<td>51.61</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1</td>
<td>3.23</td>
<td>1</td>
<td>3.23</td>
<td>11</td>
<td>35.48</td>
<td>18</td>
<td>58.06</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>3</td>
<td>9.69</td>
<td>3</td>
<td>9.68</td>
<td>22.58</td>
<td>18</td>
<td>58.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>1</td>
<td>3.23</td>
<td>3</td>
<td>9.68</td>
<td>8</td>
<td>25.81</td>
<td>19</td>
<td>61.29</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td>4.85</td>
<td></td>
<td>Mean</td>
<td>13.71</td>
<td>Mean</td>
<td>24.19</td>
<td>Mean</td>
<td>57.26</td>
</tr>
</tbody>
</table>

3. Study 2

3.1 Participants

To examine student’s science motivation and perception, the participants were 50 eleven-grade students who never learned about human circulatory system before and lack of experience of learning through educational computer game.

3.2 Material about Game

To construct a game as a learning material, we classified the main concept into 3 concepts such as heart, component and flowing of blood, and blood group. We have developed a digital game for assisting learning in each concept. The Blood Donor is an example of game in this study. The overall of this game is shown in Figure 1. In this game, the students get the mission to find who can give their blood for the patient in the scenario. Patient’s blood group is random at the beginning of the game. Students have to type blood group everybody in the hospital to know and decide whether the patient can receive blood from this person by dropping blood into test tube of which antibody. Students can click at the test tube for get more details of molecular level. After typing blood group, the students have to check a list of name of people in the hospital with the nurse. The mission will be completed until the students can check list of name for all blood donor correctly.
Figure 1. Illustrate example of game “Blood Donor” for teaching about concept of blood type: (A) shows home screen of the game; B shows people in the hospital that need to know their blood group; (C) shows typing blood by dropping blood into test tube; (D) shows checking list of people in the hospital.

3.3 Research Instruments

3.3.1 Student’s Perception

To study students’ perception of the educational computer game, we develop the questionnaire with 6 scale, such as perceived learning (PL), flow (FL), enjoyment (EJ), ease of use (EU), usefulness (UF), and satisfaction (SA) (Cheng, 2014, Barzilai and Blau, 2014), see Table 3.

Table 3: Scale and sample items of the perception questionnaire.

<table>
<thead>
<tr>
<th>Scale</th>
<th>α</th>
<th>Example of item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceive learning (PL)</td>
<td>0.80</td>
<td>I learned a lot from the game. The game added to my knowledge.</td>
</tr>
<tr>
<td>Flow (FL)</td>
<td>0.82</td>
<td>I learned a lot from the simulation. The game added to my knowledge.</td>
</tr>
<tr>
<td>Enjoyment (EJ)</td>
<td>0.75</td>
<td>I enjoyed the game. I had fun playing the game.</td>
</tr>
<tr>
<td>Perceive ease of use (EU)</td>
<td>0.74</td>
<td>It is easy for me to learn how to use game. The user interface of game is easy to use.</td>
</tr>
<tr>
<td>Perceive of usefulness (UF)</td>
<td>0.84</td>
<td>Game can help me learn more effectively. Game can improve my course performance.</td>
</tr>
<tr>
<td>Perceive of satisfaction (SA)</td>
<td>0.77</td>
<td>I feel comfortable to use game. I enjoy the experience of using game.</td>
</tr>
</tbody>
</table>
Participants were required to consider each possible reason for educational game and rate how important it was for them by using a 5-point Likert scale (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; 5-strongly agree). For overall items have a very good reliability.

### 3.3.2 Student’s Science Motivation

A science motivation questionnaire was developed from the study of Glynn, et al. (2011) by translated into Thai version. They are 5 categories of this questionnaire and 5-point Likert scale, such as intrinsic motivation (IM), self-determination (SDT), self-efficacy (SEC), career motivation (CM), and grade motivation (GM). Reliability of the questionnaire was tested Cronbach’s alphas in each category which were 0.79, 0.81, 0.89, 0.81 and 0.85 for IM, SDT, SEC, CM and GM, respectively, indicating that Thai version’s Science motivation questionnaire was found a good reliability.

### 3.4 Data Collection and Analysis

#### 3.4.1 Students’ Perception

Students were investigated by perception questionnaire before providing the educational games (pre-test). After that, students were asked to play the game Blood Donor for 20 minutes and were investigated perception again by using the same questionnaire (post-test). To compare both pre- and post-test, the pre- and post-test scores were analyzed by using pair \( t \)-test using SPSS program.

#### 3.4.2 Students’ Science Motivation

To explore students’ science motivation, the questionnaire was used before providing the educational games. There are 25 questions on the questionnaire and each item rates the students’ perceptions of the game using five-point scale ranging from “least” (1 point) to “most” (5 points). Students’ science motivation was determined the correlation with post-test of students’ perception by using the educational computer game.

### 3.5 Results and Discussion

#### 3.5.1 Students’ Perception

After playing game, students’ perception before and after were analyzed by using pair \( t \)-test. The result shows that post-test score is higher than pre-test significantly in each scale as shown in Table 4.

Table 4: Students’ perception in each scale.

<table>
<thead>
<tr>
<th>Scale</th>
<th>IM</th>
<th>CM</th>
<th>SDT</th>
<th>SEC</th>
<th>GM</th>
<th>PL</th>
<th>FL</th>
<th>EJ</th>
<th>EU</th>
<th>UF</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM</td>
<td>0.49**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDT</td>
<td>0.56**</td>
<td>0.52**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEC</td>
<td>0.63**</td>
<td>0.34*</td>
<td>0.43**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM</td>
<td>0.52**</td>
<td>0.42**</td>
<td>0.22</td>
<td>0.43**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>-0.26</td>
<td>-0.12</td>
<td>-0.20</td>
<td>-0.09</td>
<td>-0.11</td>
<td>1</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>FL</td>
<td>-0.10</td>
<td>-0.23</td>
<td>0.02</td>
<td>0.10</td>
<td>0.15</td>
<td>0.61**</td>
<td>1</td>
<td></td>
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<tr>
<td>EJ</td>
<td>-0.22</td>
<td>-0.07</td>
<td>-0.25</td>
<td>-0.01</td>
<td>-0.36</td>
<td>0.77**</td>
<td>0.57**</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>EU</td>
<td>0.07</td>
<td>0.18</td>
<td>0.14</td>
<td>0.08</td>
<td>-0.03</td>
<td>0.24</td>
<td>0.43**</td>
<td>0.16</td>
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<tr>
<td>UF</td>
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<td>-0.28</td>
<td>-0.14</td>
<td>0.07</td>
<td>0.03</td>
<td>0.42**</td>
<td>0.55**</td>
<td>0.47**</td>
<td>0.20</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SA</td>
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<td>-0.26</td>
<td>-0.22</td>
<td>-0.01</td>
<td>-0.14</td>
<td>0.33*</td>
<td>0.40**</td>
<td>0.56**</td>
<td>0.15</td>
<td>0.57**</td>
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</tr>
<tr>
<td>Mean</td>
<td>17.36</td>
<td>16.28</td>
<td>15.72</td>
<td>14.00</td>
<td>16.76</td>
<td>13.90</td>
<td>15.96</td>
<td>10.60</td>
<td>9.45</td>
<td>10.14</td>
<td>10.82</td>
</tr>
<tr>
<td>SD</td>
<td>3.15</td>
<td>2.87</td>
<td>2.42</td>
<td>2.55</td>
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<td>1.81</td>
<td>2.10</td>
<td>1.77</td>
<td>1.73</td>
<td>1.44</td>
<td>1.76</td>
</tr>
</tbody>
</table>

\*p < 0.05, \**p < 0.01
3.5.2 Correlation between Students’ Science Motivation and Perception

Pearson’s correlation was used to investigate correlation between science motivation (IM, SDT, SEC, CM, and GM) and perception (PL, FL, EJ, EU, UF, SA) in this study as shown in Table 5. Regarding Pearson’s correlation analysis of each scale in science motivation, we found that all scale related together except self-determination which do not relate to grade motivation. This results reveal that grade in science subject is important for them even though they have different level of self-determination. From the analysis of perception, perceived learning showed significantly related to flow, enjoyment, usefulness, and satisfaction. In addition, students’ perception of flow was positively related to their change in enjoyment, ease of use, usefulness, and satisfaction.

The analysis of correlation between students’ science motivation before playing the developed educational computer game and perception after playing the game showed that intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation were related to their perceived learning, flow, enjoyment, ease of use, usefulness, and satisfaction. These results indicate that the developed game, The Blood Donor, could be used for all students who have low or high motivation in science. In addition, game tasks can improve students’ motivation, engagement, and problem-solving performance (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014).

Table 5: Descriptive statistic and correlation for perception and science motivation

<table>
<thead>
<tr>
<th>Scale</th>
<th>Mean (SD)</th>
<th>t</th>
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<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
</tr>
<tr>
<td>Perceived Learning</td>
<td>11.52 (2.37)</td>
<td>13.90 (1.81)</td>
</tr>
<tr>
<td>Flow</td>
<td>14.04 (2.59)</td>
<td>15.96 (2.10)</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>9.06 (1.92)</td>
<td>10.60 (1.77)</td>
</tr>
<tr>
<td>Ease of use</td>
<td>8.18 (1.99)</td>
<td>9.52 (1.79)</td>
</tr>
<tr>
<td>Usefulness</td>
<td>8.70 (2.10)</td>
<td>10.14 (1.44)</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>9.04 (2.47)</td>
<td>10.82 (1.76)</td>
</tr>
</tbody>
</table>

* p < 0.01

4. Conclusion

This study surveys students’ alternative conception about human circulatory system. After that the educational computer game was designed and developed based on those alternative conceptions. The finding of this study show that (1) students still hold alternative conception about the concept of human circulatory system even if they learned before; (2) our educational computer game, the Blood donor, can be used for improving students’ perception to learn; (3) students’ perception dose not relate to science motivation. To this end, the Blood Donor game which is designed based on students’ alternative conceptions can assist students who have low or high motivation in science to learn. However, to address students’ learning performance we are going to study about the effect of using educational computer game on students’ conceptual understandings.

Acknowledgements

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The Curriculum Design of Nutrition and Food Safety Game for Elementary School Students

Chun-Heng Lin¹, Tsung-Yen CHUANG², Chung-chiann Chuang³, Fang-Ying Tu⁴ & Hua-Hsiang TSENG⁴

¹ Department of Information and Learning Technology, National University of Tainan, Tainan
² Department of Early Childhood Education, Taiwan Shoufu University
³ chuangyen@mail.nutn.edu.tw

Abstract: Because of food serves energy and nutrition for human, human beings extremely rely on food. Furthermore, micronutrients help our bodies function normally and keep us healthy. Without micronutrients, we may lose our lives. Recently, as many food safety issues revealed, we really should pay more attentions on how to eat healthily. Because tainted food caused by dishonest or ignorant men may damage our health even severely. On account of those reasons above, this study basically aims at K-5 and K-6 elementary school students, the important stage of human lifestyle building, to develop a RPG game played on mobile device. Hope the children can enjoy the game and easily applied what they’ve learned in the game to their daily lives.

Keywords: Nutrition education, food safety education, game-based learning, mobile learning, RPG game

1. Introduction

Food is essential to keep us alive. Recently, the scandals about illegal ingredients and additives of food are exposed one after another in Taiwan. In addition to the tainted food, there are also many dishonest food business were revealed. In order to make a profit, the food industry owners reduce the production cost by replacing high-quality elements with low-quality ones. Yet, even worse, some of them use harmful substitutes to reach their goals. Those food safety incidents passed down a message that people who run the food business have put morality far behind. This is a serious problem because human beings can’t live without food. The contaminated food affects children more greatly (Meysenburg, Albrecht, et al., 2014). Under the threat of food safety problems, children should equip with sensible discernment in their choice of food and good nutrition education to fight for their own healthy growth.

2. Background

2.1 Nutrition Education for Elementary Students

Except for energy, human begins also needs to get nutrients from food to stay healthy. According to the amount of nutrition which human body needs, the nutrient falls into two groups. One is macronutrient, the other is micronutrient. Macronutrient, which provides calories, mainly contains carbohydrate, protein and fat. Micronutrients, including vitamins and minerals, are essential for human body (Crowe, et al., 2011). Human being only needs a little micronutrient. They can regulate physical function, but cannot be produced by our own bodies. The knowledge of micronutrient is extremely important for us to live healthily. Micronutrients can be found in variety of food. Nevertheless, only intake of micronutrients from fruit and vegetable leads to less burden to human bodies (Herrero, 2011).

Most of nutrition curricula are in elementary school for K-5 and K-6 Students. Those students are at the mental and physical growth stage (Wu, 2012). They have tenacious memory at the same time.
Also, they have enough capability to understand the systematic structure of nutrition knowledge. Some research indicated that the habit or thought students built in this stage will affect and last the rest of their lives most (Fu & Jien, 2012). There are many types of micronutrients with various sources and different functions. In existing materials, micronutrient knowledge is represented by text description, table with text or adding pictures in table beside the text. However, neither of them is easy for students to memorize and build the concept of micronutrients. In order to get the students’ attention, this study is trying to develop the effective way to teach them micronutrient knowledge and to ease their fear with fruits and vegetables.

2.2 Food Safety Education

However, there’re some studies indicate that it’s risky to get nutrients form natural crops (Martin-Bellos & Fortuny, 2011). According to these studies, there may be toxic residue left on the plants. As we have the fruit or vegetable for health, those contaminants could come with the food to enter our bodies. Some of them may make us feel physically uncomfortable. Even worse, they may cause death. In light of the situations above, food safety is a significant problem when people try to eat healthily. It is possible that people who are not in the food producing process pollute food the most. Some factories were built near by the farmland. But they didn’t deal with the pollution they made well. This is a serious problem because pollution form factory usually contain heavy metals, which can’t be metabolized by human body (Marshall et al., 2007). The factory managers may not notice that they also have the responsibility to agricultural production, yet their emissions cause immeasurable damage to the crops. Therefore, we think everyone should pay attention on this issue and treat this issue with morals.

According to the study of Haapala and Probart (2004), they found the middle school students are not with enough knowledge, perceptions and behaviors of food safety. Once students get into adolescence, their chance of accessing to the drugs, tobacco and alcohol will increase (Choquet et al., 2004). That’s why we think K-5 and K-6 students are the ideal learners of food safety curricula. Before they become teenagers, they should learn how to live a healthy life. After all, everyone only have one chance to become adult. So growing with health is crucially significant. Instead of abstruse knowledge about food safety, we think that the upstanding mind is which they need the most. They should learn to put themselves in anyone else’s shoes. The characteristics mentioned above could be cultivated by simulation. Students can get their own experience when undergo the simulations in the game story. Moreover, we hope that they may adopt the experience on their real lives.

2.3 Game-based Learning

Micronutrient knowledge is something abstract to children. Food safety is also something hard for them to realize. To overcome the abstraction and complication of learning content, we must find the way to concretize it and maintain learner’s attention on it at the same time. Before solving those problems above, there is one thing we would face first. How to attract K-5 and K-6 students to learn these contents? The “motivation” leads us to game. There are many cases we can follow (Papastergiou, 2009; Prensky, 2003). Combine teaching with game can always gain more interests from children. Using game to teach can bring them fun and reduce their stress when learning (Kanthan & Senger, 2011). Especially, the RPG game can pull students into the game world easily. They will be the super mayor character of a game. They’ll treat what they face in the game extremely important. Therefore, we think the RPG game is better than other candidates. Like a simulation, children meet some events that happened in real life when playing game. They learn how to deal with them by the guidance of assignments. It is a good method to keep danger away and save resource such as time, money and so on when simulating in the game (Pidd, 1992).

The main point of instructional game is the learning content. There is a model of games and learning showed in Figure 1 (Garris, Ahlers & Driskell, 2002). At first, we should put learning content and game features together. Design a reasonable and joyful game. Once students get into the game, they start the game cycle. They receive stimulus from game and produce their own views. Then, they’ll reflect the thought in mind on their behavior. After catching the stimulus from player’s behavior, the game also responses back. Students will undergo the game cycle again and again and get their own
experience. We evaluate their performance to reach their learning outcomes. This is the model that gave us confidence to teach our subject by game. Although the content in the subject is not friendly at all, we still can make it adorable to children. Blend them into the game and intersperse some charming stories with lovely game scene. In contrast of the fantastic image, the knowledge students would learn in game is true in real world. Instead of memorizing the contexts in the book, we believe this is a good way for students to realize numerous micronutrients and their various source and function (Kiili, 2005).

Figure 1. The games and learning model.

3. Method

3.1 Game Design

Our goal is to equip children with enough nutrition knowledge and clear-sighted view of food safety issues. At the same time, attracting children to keep learning the content is our challenge. That is why we tried to pass off the instruction as game. Children can enjoy the fun and feel less pressure when learning by game. Especially when they played the RPG games, they only focused on their missions and the role they played. Totally immerse in the game, enjoy characteristics of game. Children will see the game as their second life. Therefore, we developed the game described below to meet our goal. In the game system part, we’ll talk more about the entertainment which can distract people's attention from learning. The game story is the background we create to match the subject. The last is the part of integration, explaining those ideas we use in embedding the learning content.

3.1.1 Game System Development

We build a RPG game by Unity 4.3.4. In addition to basic RPG game features such as role training, level bonuses, interactions with NPCs and game tasks solving, we added duel and collecting book. Basic features can challenge players and invite them to play. The collecting book is another shot at the game for players. Once children meet the fruit or vegetable in the game and prevail it, it will be recorded in the book automatically. Collecting the items in the book all is the motivation for players to continue the game. Besides, the duel gives the game more appeal and excitement. We need to sustain children’s interest, so the RPG game is our choice to involve players in learning content. We want children to forget they’re learning and enjoy totally fun. For this purpose, we create a lovely world which can be seen in Figure 2 and decide to run our game on mobile devices. M-learning (mobile learning) means that learning will no longer be limited by time or location (Hwang & Chang, 2011). There are two main properties in mobile learning. One is arbitrary learning place, the other is short time interval. With these two properties, children can play the game anywhere and anytime.

Figure 2. The world in the game.
They don’t need to stay steadily. With mobile devices, they could learn anytime, anywhere. They could lie down or sit casually when holding light device and learn. They play the game in their daily lives and easily connect what they’ve learned to their real lives (Chu, Hwang, Tsai, & Tseng, 2010). They may be interrupted by others when playing game on mobile device. But the features of RPG game could pull the players back fast. The familiarity of plants could urge students to try them for food. Meanwhile, the short time interval could also reduce the learning burden of children. For example, they could play the game when taking a break in the school or waiting for dinner prepared by mother. Give them more flexibility to connect the content of the game to real world.

3.1.2 Game Story Design

To close the distance between children and plants, the background of our game is a kingdom lived on fruits and vegetables. There are soldiers called “armed-grape”, whose duty is saving people’s life and health. They’re trained by the government since the incredible event changed the kingdom dramatically. Some of plants can move like animals. They started to protect their own kind from human. People couldn’t get essential micronutrient from them, so the weakness and disease rage on. “A-Ni” is the hero of our game. At the beginning, A-Ni is one of new recruits undergoing training and sees fighting for people as his or her own destiny. After the training, A-Ni steps on the journey to help people and enhance the ability. A-Ni will be promoted as more and more assigned tasks being solved. For this reason, A-Ni has more power to deal with classified problems. In the meanwhile, some secret and evil plans of government are available to A-Ni, too. At the end, we could only rely on players to lead A-Ni to make wise decision and do sensible action.

We use the tasks to guide players. For instance, players may receive three assignments first. One is to collect the material, such as vitamins. Another might ask them to satisfy the NPC’s needs. And then they meet some plant monsters on the road. They have to prevail the monster to take the material and record the plant into the collecting book. The material form that monster may just meet the NPC’s need. Therefore, players solve the tasks at the same time and continue their trip. Of course, they still receive another assignment in the following adventure. Analyze the example mention above, there’re three types of assignments, material or plant collecting, the requirements of NPCs and achievement making. We cross these assignments to build the situation in the game. Players will be required to fight or pick the plants on the road and follow the guidance to interact with NPCs. Players will need to collect something for NPCs, or heal them by knowledge and experience. As for achievement making, players can know their own state, like the ability of the role, the progress of collection and journey.

3.1.3 Learning Content Integration

Children will play the hero of the game to help the kingdom back to placidity. Follow the assignments, we set micronutrient knowledge and food safety issues in the story. Children need to organize the information and use those items in their hands to solve the problems. Every assignment is designed for learning contents. The assignments of material or plant collecting are mainly related to micronutrient knowledge. The interaction with NPCs is the most flexible part. It can embed in the food safety cases and the events of micronutrient deficiency or excess. In addition, children should understand their learning pace or condition in the game. That’s why we design the assignments of achievement making for a short-term target. The achievement reminds children that they have already had some knowledge or experience. By the similar cases in the story, players can realize the reason behind and know the key points they should put their eyes on when facing food safety problems. The simulations are merged into game tasks to teach children the skills to find out the solutions of food safety cases step by step.

Further, we would prefer to see them adopt those skills on their realistic life and prevent people from the threat of unsafe food. To increase micronutrient learning effects, collecting book and fighting effect are designed. Players can record the plants they have met. There is much information in the collecting book, such as the name and the short introduction of the plant, the micronutrient in the plant and the effects they provide to human body. The description above can be displayed more clearly by Figure 3. The content of collecting book is edited by the real information of those plants. In the game, it could also help player to look for solutions of the assignments. By this way, children could know much about fruits and vegetables and understand how to get healthy with
them. The other design to help children learning micronutrient knowledge is the fighting effect, like Figure 4. Players should fight to the plant monsters to get the micronutrients they need. As fighting, once the player hit the plant monster, the micronutrients which the plant contains will appear and drop down from it. The micronutrients are showed by text. The times of every text showed in fight are set on their percentage in the plant.

![Figure 3. The schematic drawing of collecting book.](image1)

![Figure 4. The schematic drawing of fighting effect.](image2)

3.2 Design of Experiment

The target of our game is K-5 and K-6 students. We want to get more details about children’s learning in our game, so the questionnaire comes to us. There are two parts in the questionnaire. One is about the performance of students’ learning, the other is the system usability scale. In the game, we try to build the knowledge and concepts of micronutrient and food safety. Therefore, the questionnaire of students’ learning performance is divided into two themes, micronutrient and food safety. Students will do this questionnaire before and after playing the game to evaluate the effect of our learning game. The system usability scale will be done only after the game to collect students’ thoughts of the game and understand that if the game actually can help students to learn something. We want to know whether or not the results meet our previous expectation.

The experiment will be implemented in the Health and Physical Education class of K-5 and K-6 students. The duration is about one month. We’ll occupy two time HE & PE class time. One is at the beginning of the experiment. We must to introduce our game, tell students how to play the game and let them do the pretest. Then, they can play the game whenever and wherever they want in the next month. After one month, we’ll let them do the posttest in the class. In addition to questionnaire, we’ll do some interviews with students who had participated in experiment. We believe that children will give us more feedback in the interview.

4. Conclusion

K-5 and K-6 students are at the critical stage of lifestyle building. As we mentioned previously, our plan is to equip children at that stage with the knowledge and concept of micronutrient and food safety. To reach the purpose, game becomes our conclusion. Game can make fun for people. There are many types of games. The RPG game is our choice to combine with the learning content we prepared. Students can solve assigned tasks and learn something through game. Base on the real food safety cases, we design
tasks in the game story. Students can do the simulation in the game world. They enrich their own experience when playing the game. Give them the capability to protect themselves and anyone else. The information of fruits and vegetables is also something true in the game. We hope students to be close to plants for food and have correct micronutrient knowledge about plants. There are some ideas being developed to aim our target, such as collecting book and fighting effect. Help students to improve their learning effects.

Everyone lives on food. It is important for us to care more about something we get into our bodies. This game is the brainchild of everyone in our team. We try to deliver some useful knowledge and information about food to K-5 and K-6 students. It is our hope that they could learn these serious things, realize them and deal with them. Further, learning by mobile devices could help them practice all they learn in game to daily life more flexibly. The final goal of ours is to help people to guard their own health and others. At the end, we all have a clean, safe and healthy life.

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Thinking as a Pleasure: 
Tactics to Design Digital Educational Games from the Perspective of Board Games

Hercy N.H. CHENG
Collaborative & Innovative Center for Educational Technology, Central China Normal University, China
*hercycheng.tw@gmail.com

Abstract: Board games provide players with not only pleasure but also thinking. More specifically, it is observed that digital games tend to ask players to make quick judgment, demanding less consideration, while board games allow players to think more thoroughly in reasonable time. For this reason, this paper attempts to capture the features of board games, from which most modern digital games originate. When designing digital educational games, designers may consider the features so that players can have both pleasure and opportunities for thinking. Finally, this paper also suggests three design tactics to design digital educational games.

Keywords: Digital educational games, board games, choices

1. Introduction

Salen and Zimmerman (2004) defined a game as a system in which players engaged in an artificial conflict, resulting in a quantifiable outcome. Furthermore, the conflict was purposely produced by game rules with a goal that players attempted to achieve. Crawford (1984) described that conflicts were obstacles preventing players from easily achieving their goals. A puzzle, for instance, provides static and passive conflicts, while games have more dynamic and actively responsive conflicts, which come from the interactions between players and the other entities (e.g. interactive objects, non-player characters, human opponents or collaborators) in the game world.

From the perspective of education, however, a difficult conflict does not guarantee players’ learning. As a matter of fact, most digital games adopt immediate conflicts, which may encourage players’ fast reactions but hinder their thinking without sufficient time. Such digital games require players’ skills of hand-eye coordination (Crawford, 1984), which can be improved by gaming over and over again rather than strategic reflection.

Unlike digital games, although board games lack well-simulated environment, most players still consider board games full of interactivity and interesting conflicts. On the other hand, board games have been widely adopted in classrooms as a part of curriculum (Hinebaugh, 2009), implying the essence of educability. Mayer and Harris (2010) also indicated that the board games might fit the abilities of the 21st century learners defined by American Association of School Librarians (2009). In practice, many recent studies have showed that board games may help students learn in various courses, for instance, mathematics (Raman, & Siegler, 2008), physics (Smith, & Munro, 2009), health education (Lennon, & Coombs, 2007), and financial accounting (Gamlath, 2007).

Board games, according to their game goals, can be roughly classified into three categories: war games, race games and alignment games (Hinebaugh, 2009). The first one is war games, in which players aim at capturing and/or destroying opponents’ units (Woods, 2012). Obviously, chess and go are both war games; so are some digital games like Age of Empires. Just like a war, the conflicts emerge if the units of two parties fight against each other. At this time, survivability becomes the first thing that players should consider. Moreover, players have to figure out how to avoid being attacked effectively and make choices to overcome enemies’ defense.
The second category is race games, in which players aim at reaching a destination the fastest, such as *Chinese checkers* and *Chutes and Ladders*\(^1\). Alternatively, a variation of race games is to score the highest when the game ends. For example, *Monopoly*\(^2\) can be considered as a race game because the player who has the most money in the end wins the game. Most strategy board games adopt such a game type, such as *Puerto Rico*\(^3\) and *Agricola*\(^4\). These games usually allow players to obtain resources and transform them into scores. Such a transformation mechanism is basically a model of economy (Rollings, & Adams, 2003), facilitating players to consider which actions may provide an efficient way to transforming the least resources into the highest scores.

The third category of board games is alignment games, which require players to make a particular pattern, such as a line of pieces in *tic-tac-toe* or *Gomoku*. Another typical alignment game is *Mahjong*. For winning, players have to collect resources and decide whether the resources are needed or not. If necessary, players have to discard some resources, which involves lots of decisions.

Among the three categories, there is a common characteristic, which is to provide choices so that players may make decisions for their own. With choices, players may start to think which option is better than the others. After making a decision, players are motivated to expect its consequence and attached to the gameplay. In other words, the provision of choices may make players enjoy the thoughtful pleasure of board games.

However, media somehow limits the game type. Most digital games are skill-and-action games rather than strategy games because of their aims at massive popularity (Crawford, 1984; Rollings, & Adams, 2003). Although digital games allow players to make decisions immediately, players usually do not have sufficient time to think. On the contrary, lots of board games, especially German games or eurogames (Woods, 2012), are strategy games, taking advantage of turn-based mechanism and allowing players to think more when they make decisions. It turns out that well-designed choices potentially facilitate players to think and have fun at the same time in games.

Therefore, this paper aims to study the feature of board games, choices, which may facilitate both pleasure and learning. The feature may be helpful to design digital educational games. Perhaps digital media may tempt or deceive game designers into overemphasizing fantasy without noticing the real enjoyment and potential educational functions. It is a good idea to explore the possibilities of board games in education.

### 2. Choices

Sid Meier, the game designer of *Civilization* series, believed that a good game was a series of interesting choices (see Rollings, & Morris, 2000), suggesting the importance of choices in a game. This section will introduce the concept of choices and discuss how choices may facilitate both thinking and pleasure.

#### 2.1 Choices facilitate thinking

An opposite concept of choices is linearity. A game with no choices is merely a story with linear facts (Crawford, 1984). Furthermore, without meaningful choices, the outcome of a game becomes predetermined (Salen, & Zimmerman, 2004). Choices imply the possibility of different results after players invest their efforts, making a game dynamic. When players make choices in a game, they actually explore the relationship between the chosen actions and their results. In terms of computer science, the rules of a game construct a state machine, which describes the aforementioned relationship (Juul, 2005). If all possibilities of choices are considered, a game may be like a tree structure with a

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1. *Chutes and Ladders* originated from an India game, *Snakes and Ladders*, in the 16\(^{th}\) century. In the game, on the way to the destination, ladders made players approach the destination while chutes made them away from it.

2. *Monopoly*, originating from *The Landlord's Game* in 1904, was patented in 1935 by Charles Darrow and published by Parker Brothers.

3. *Puerto Rico* was designed by Andreas Seyfarth and first published in 2002. The game required players to produce resources, which may be transformed into money and scores.

4. *Agricola*, a farm-theme board game, was designed by Uwe Rosenberg and published in 2007. Players as farmers use resources to build their own farms, grow crops and keep animals, which may be transformed into scores in the end of a game.
result on every leaf node (Crawford, 1984). In a sense, playing a game is interacting with the state machine as well as exploring the tree of game results (Juul, 2005).

Such a game structure suggests that players should predict the results before choosing an action. Prediction may involve a series of cognitive process: a first and straightforward thought is to evaluate the value of every legal action. In other words, without other consideration, players tend to choose an action that may bring the greatest benefits. In an extreme case, if a game only offer obvious choices, the game has actually no choices at all and thus no challenges for players. For this reason, a game should provide players with choices that need think.

For offering comparable choices, a game can assign different costs to every action. By doing so, players may start to consider the values and their respective costs. An action with high value and high cost is not a necessarily better choice than that with lower value and lower cost. The costs include risks, which are outcomes aware of likely happening (Epstein, 1977; Salen, & Zimmerman, 2004). Risks are usually negative and so inexplicit that players need to deliberate any possible situations before making decisions.

Besides, human opponents provide more factors that should be considered in decision-making. In a competitive multiplayer game, more specifically, players also need to conjecture opponents’ actions, which likely influence choices. An experienced player can successfully predict and avoid the harm from opponents’ actions. With the consideration of opponents, even obvious choices may change. Especially in a strategy game, players usually need make a long-term plan, consisted of a series of actions. Human opponents with similar abilities may easily interfere a player’s plan, resulting in unexpected results. When this happens, the player may need to adjust his/her plan. Therefore, by providing various difficult choices with dilemma, a game may become non-linear and start to facilitate players to think.

2.2 Choices facilitate pleasure

Previous research has shown that the provision of choices will increase the feelings of intrinsic motivation because choices allow people a feeling of autonomy (Ryan, & Deci, 2000). Choices, as a concept against constraint, may free people’s mind and satisfy what they need under rules. For this reason, Malone and Lepper (1987) have advocated providing learners with explicit choices may facilitate their perception of control, an individual element of intrinsic motivation. In particular, learners can construct, select and name the features of fantasy to have a personalized learning and playing experience. As a matter of fact, Cordova and Lepper (1996) have showed that, in an education game, learners with choices and personalized fantasy may report obvious pleasure, including higher favor of the game and more willingness to stay after class.

The previous paragraph concluded that choices influenced pleasure. Interestingly, research also found that pleasure may influence choices. More specifically, Mellers, Schwartz, and McGraw (1999) showed that choices were associated with anticipated pleasure. In other words, people tend to select an option with greater pleasure they perceived. Furthermore, Mellers and McGraw (2001) also identified an outcome effect that anticipated pleasure rose with the increase of anticipated outcome. These results suggested that people may make decisions based on the higher anticipated outcome as well as pleasure.

Although it seemed that the aforementioned research upheld as more choices as possible, some studies also revealed the negative consequences of too many choices. For example, Iyengar and Lepper (2000) showed that people with extensive choices (up to 30 choices in this case) reported less satisfaction than those with limited choices (6 choices in this case). Furthermore, when those people made a decision with too many choices, they felt both pleasure and frustration at the same time. This phenomenon was termed as “choice overload” or “paradox of choice” later by Schwartz (2005).

The possible reasons were that too many choices brought large-scale comparisons as well as the regret of the second best options (see Scheibehenne, Greifeneder, & Todd, 2010). Comparison the anticipated outcome of the chosen options with possibly positive outcomes of an un-chosen option may result in regret, yet if the outcome of an un-chosen option was negative, such a comparison would be pleasure (Mellers, & McGraw, 2001). Therefore, it should be more careful to design choices in a game-based learning environment, as Malone and Lepper (1987) suggested.
3. Design Tactics to Facilitate Thinking and Pleasure

From the perspective of board games, this section enumerates three design tactics to facilitate both thinking and pleasure of learners in a game-based learning environment. The three tactics are introduced in order of complexity.

3.1 Tactic 1: Choices

As a basic design tactic, choices, referring to selecting one option from several ones by definition, are widely adopted in board games. Board games usually allow players to choose one action in their own turn. A recent board game Love Letter\(^5\) requires players to play a card from two cards in their hands. Although the action is very simple, players may focus on deducing which is the best option with a little chance. Because the game brings so much fun, the game received best card game, best family board game, best innovative board game, and best party game awards in 2013.

For enhancing strategic thinking, board games usually limit the amount of resources. Another board game Puerto Rico, for example, requires players to choose one from six actions in order to obtain limited buildings, plantations, workers, and spaces for selling. The player may execute the chosen action first with a privilege (e.g. to pay 1 dollar less or to get 1 resource more, depending on the chosen action); the rest of players execute the same actions in order without the privilege. Without sufficient resources, even simple selection may become seriously careful and tactical.

However, without choices, insufficient resources do not necessarily lead to strategic thinking. For example, Monopoly is a well-known family board game without sufficient resources and choices. In the game, a player plays as a landlord, aiming at buying properties to make a fortune. In one’s turn, one has to roll a dice, which may randomly determine one’s moves from 1 to 6. If one stays at an unoccupied property, one may buy it as one’s own asset; however, if one stays at an opponent’s property, one has to pay the rent. Although the game provides limited properties, players’ actions are essentially determined by randomness (no choices), making the game linear and non-strategic.

In order to facilitate players to think and have real pleasure, the game should empower players to decide their actions. A good example is a digital educational game, Joyce, designed to incorporate educational quizzes in Monopoly (Chang, Yang, Yu, & Chan, 2003). Although the general game rule of Joyce was based on Monopoly, the designers modified the rule of moves for enabling players to choose their moves. More specifically, when players collect two random numbers by rolling dices, they were allowed to move with three choices: (a) the sum of the two numbers, (b) the larger one minus the smaller one, or (c) the smaller one minus the larger one (i.e. moving backward). Instead of moving randomly or freely, such a choice may force players to figure out optimal solutions, to take responsibility and to enjoy any possibilities of a non-linear game.

3.2 Tactic 2: Combination

Combination refers to mixing several parts for creating an assigned pattern according to the game rule. Some board games adopt the design of combination even if one action is chosen at a time. Mahjong is a typical example to demonstrate the combination tactic in a single action. In the game, players are required to draw a tile and then to choose a tile to discard from seventeen titles in hands in their own turn until anyone makes a legal combination of hands and wins the game. Although the action is simple, the action is actually a difficult decision to discard the most useless tile for increasing his/her probability of making a legal combination as well as decreasing the others’ probabilities.

Thinking about combination is never easy for players, because it involves enumerating all possibilities. In other words, combination demands the ability to recognize, specify, and generalize patterns. In Mahjong, players first have to classify the tile types and sort the tiles of the same type physically or mentally. Then, as the rule of legal combination requires, they need to group every three tiles of the same or successive figures into a pattern. Experienced players can create several grouping ways on purpose in order to increase their own winning probabilities. Sometimes players need to give up one of the grouping ways because these ways are mutually exclusive.

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\(^5\) Love Letter is a card game, designed by Seiji Kanai and published in 2012.
On the other hand, combination can also be considered as a complex set of choices, requiring players to make several decisions at the same time. A popular poker game, Big Two, uses this tactic. Players in their turn have to decide to play single card, pairs, triples, or five-card hands. In a sense, the action can be decomposed as multiple decisions on whether they play each card or not. Alternatively, it can also be considered as decisions on how many and which types of cards should be played. In either way, players have to evaluate all conditions of the combination and their consequence.

The tactic of combination can also be adopted in educational games, such as Numbers League\(^6\), a mathematical card game. In this game, players take the role of superhero leagues, whose goals are to capture aliens. More specifically, each alien has a certain number (e.g. from 3 to 26 in the easiest mode) while the value of each superhero is the sum of the numbers on their heads, bodies, and legs. If a superhero is equipped with a weapon (e.g. +5, -10, or \(\times 4\)), the player may decide to use it or not. In order to capture an alien, the player has to specify he/she use which one or more superheroes and whether the heroes use their weapons. For doing so, the players have to consider as many combinations of arithmetic expressions as they can. For example, if a player has a superhero of 4 with a weapon +10 and another superhero of 8 with a weapon -5, he/she could capture aliens of number 3, 4, 7, 8, 12, 14, 17 and 22 in all combination of his/her superheroes with/without their weapons.

### 3.3 Tactic 3: Creation

In a spectrum of choices, from controlled to free actions, creation is perhaps the most implicit but imaginative way to making decisions. It is true that creation involves a plenty of choices. In drawing, for example, people actually have to decide the theme, perspective, tools, colors and so forth. Besides drawing, creation can be a writing, a song, a dance, or an artifact. Although real world enables people to produce creations at will, a game never allows players to create works totally freely. Instead, it provides rules to constrain players’ creation to a certain extent.

There are many board games about creation. DIXIT\(^7\) is one of them and popular. This game is consisted of a deck of cards with undefined pictures, so that every player may interpret these cards in their own way. In one player’s turn, he/she plays the role of a question poser, who need to secretly select a card in hand and to give it a subjective meaning. The meaning can be a word, a phrase, a sentence, a story, a song, or even on a motion. According to the meaning, the other players also have to secretly select a card in their own hands as a distracter. After revealing all selected cards, the players except the question poser score if they can correctly choose which card belongs to the question poser. More interestingly, the question poser cannot score if all of the other players choose the correct or wrong cards. This scoring rule facilitates the question poser to pose a moderately ambiguous question, not too straightforward or too difficult to guess.

Without doubts, DIXIT may facilitate players’ creativity and imagination. Besides understanding the relation between the meaning and the correct card, the pleasure of playing DIXIT is devising an ambiguous meaning. The aforementioned scoring rule for question posers may transform the creativity of the question poser into a simple choice. As a matter of fact, such a rule is also used in several board games of creativity, such as Barbarossa\(^8\) and Ask Anything\(^9\). While the former requires players to create clay artifacts, the latter requires them to pose yes/no questions.

Not very many digital games take advantage of human’s creativity as a part of games. A mobile app game, Draw Something, which was downloaded extensively two years ago, allowed every two players to guess each other’s drawing. With the connectivity of network, this game may link friends or people across the world regardless of the constraint of time and space. However, although the painter may draw a picture creatively, the guesser actually solves a puzzle according to the hint of the picture the painter made. For the guesser, the conflict of the game is passive, making the game too linear. A possible solution is to provide some choices for guessers.

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\(^6\) *Numbers League*, designed by Ben Crenshaw and Chris Pallace, was published by Bent Castle Workshops in 2007.

\(^7\) *DIXIT* was designed by Jean-Louis Roubira and published in 2008.

\(^8\) *Barbarossa* was designed by Klaus Teuber and published in 1988.

\(^9\) *Ask Anything* was designed by C. C. Hung and published by TwoPlus Games in 2013.
4. Concluding Remarks

In order to design digital educational games, this paper attempts to study the design tactic of board games owing to their potential for facilitating both thinking and pleasure. Historically, digital games originate from board games, and thus they may share the same core about thoughtful pleasure. Unlike digital games, which have additional fantasy, board games have pure design of game rules, worthy of thorough investigation.

This paper preliminarily identifies players’ choices in games as the route to both thinking and pleasure. Based on this argument, this paper also proposes three tactics to design digital educational games. Furthermore, when the aforementioned design tactics are applied to a digital educational game, computing power should not restrict the game play. Rather, in terms of Crawford’s definition of games (1984), computers ought to reflect the representation of reality or fantasy, to reinforce the interactions between human and computers or among players regardless of time and space, to enrich the conflict in any forms of exciting challenges, as well as to ensure the safety cognitively, emotionally and socially.

References


**VocaMono: An Online Multiplayer English Vocabulary Learning Board Game**

Jia-Jiunn LO* and Chin-Kun Hsin

Department of Information Management, Chung-Hua University, Taiwan, R.O.C.

*Jlo@chu.edu.tw

**Abstract:** It is imperative to construct a learning environment to make EFL (English as a Foreign Language) learners have an engaged vocabulary learning experience to enhance their learning interests. Recently, digital game-based learning suggests a new learning paradigm of learning by playing within visual and interesting environments. As a consequence, this study developed an online multiplayer English vocabulary learning board game, named **VocaMono** (short for Vocabulary Monopoly), for English vocabulary learning. Adapted from the famous games **Monopoly**, **Unscramble**, and **Scrabble**, this study developed **VocaMono** by effectively integrating the gameplay and pedagogy designs for vocabulary learning. **VocaMono** has been designed to have unique educational game characteristics that should be of interest to vocabulary learning. It enhances learners’ motivation for learning and memorizing English vocabulary. By playing this educational game, players are able to enhance their vocabulary acquisition abilities not only for correctly spelling taught vocabulary but also for discovering spelling patterns. This game can fit players’ vocabulary levels by selecting words from the word scope. Furthermore, this game is possible to be used to correspond to the class progresses.

**Keywords:** English vocabulary learning, game-based learning, online game, multiplayer game

1. Introduction

In the globalized society, English communication competence is indispensable so that learning English has become a part of lives in many non-English speaking countries. Learning another language is not easy at all (Turgut and Irgin, 2009). It is important to find the threshold for language learning. Vocabulary is the foundation of a language and the core of learning and communication. They are the cornerstone of a language, from which sentences, paragraphs, and articles are formed. Laufer (1986) noted that there would be no text comprehension without understanding the text’s vocabulary. It has been suggested that vocabulary competence has more contributions to language comprehension than the components of reading (Chen, 2011). Increasing vocabulary abilities can effectively enhance reading comprehension and vocabulary learning has been recognized as a central part in language learning (Chen, 2011). Language development, therefore, is highly dependent on learners’ vocabulary acquisition abilities (Carol, 2001).

The most serious obstacle is not lack of various reading strategies but insufficient English vocabulary (Chen, 2011). Without knowing enough words, people cannot acquire fluent language competences neither for listening, speaking, reading, nor writing. Therefore, EFL (English as a Foreign Language) learners, particularly beginners, should be given explicit instruction to memorize and practice the basic level words through the repeated exposure so that they can automatically recognize words and enjoy reading (Chen, 2011).

To enhance vocabulary acquisition abilities, practice is indispensable. Shemesh and Waller (2000) even said that for vocabulary learning, “No practice, no learning!” Chen (2011) mentioned that “for beginners, it may be more appropriate and effective to learn English (vocabulary) in a direct and explicit way.” However, vocabulary acquisition is usually the most difficult part during the learning processes for most EFL learners.

Most English vocabulary practicing activities are based on monotonous and tedious approaches so that many learners lack motivation to learn spelling words repetitively and do not learn English vocabulary effectively. For most learners in Taiwan, vocabulary learning is a terrible experience even though they spend much time. They usually think it is boring and even hate to memorize vocabulary.
The learning outcome is often limited and even frustrating (Chen, 2011). Therefore, how to improve learners’ English vocabulary abilities has become an unavoidable issue and it is imperative to construct a learning environment to make EFL learners have an engaged vocabulary learning experience to enhance their learning interests.

Contemporary students are digital natives who grew up with the computer. Applications of information technologies on educational contexts are increasingly getting popular for them. Among the computer applications, educational games have got more interest by integrating learning materials into computer games to promote student-centered learning activities to help students drill facts, connect ideas, or synthesize discrete knowledge (Nettleton, 2008). Many studies have found that games can stimulate learners’ motivations and enhance their learning experiences across multiple disciplines and ages (Chen, 2011). Digital educational games suggest a new learning paradigm of learning by playing within visual and interesting environments to capture learners’ interests, encourage active learning, develop learning by doing, and trigger motivation and enjoyment (Regueras et al., 2009). While playing games, learners as players take control of the learning processes so that they are more willing to learn actively (Chen, 2011). One characteristic of computers is their “patience” in repetition and recycling tasks which conform to the repeated exposure and practice requirements of effective learning so that educational games can be particularly effective in learning boring materials such as vocabulary learning (Chen, 2001; Prensky, 2001).

Competition is one of the game characteristics to stimulate players’ motivation. Regueras et al. (2009) stated that learners can achieve better comprehension, retain the information longer, and enjoy learning more with active learning methodologies which can be structured to force learners to compete each other in multiplayer games. The nature of multiplayer games can take the advantages of competitive learning to stimulate learners’ motivation which in turn promote learning and sometimes shorten the whole learning processes (Burguillo, 2010; Regueras et al., 2009).

As a consequence, this study aims to develop an online multiplayer educational game, named VocaMono (short for Vocabulary Monopoly), for English vocabulary learning. It is expected to enhance learners’ motivation for learning and memorizing English vocabulary.

2. VocaMono Game Design

Garcia et al. (2008) suggested that the easiest way to ensure entertaining value of educational games is to adapt existing popular games to be integrated with the learning goals. VocaMono integrates the gameplay and pedagogy designs by being adapted from three popular games, Monopoly, Unscramble, and Scrabble.

Monopoly is selected as the base because it is a well-known, classic, and popular amusing board game with broad target audiences. It is one of the board games into which different content domains can be integrated. Many computer games have been adapted from it and people are familiar with this game. Unscramble and Scrabble are both spelling games of word knowledge to stimulate players to rapidly retrieve appropriate words from memory through the visualization of spatially aligned alphabets (Halpern and Wai, 2007). They can enhance players’ vocabulary abilities not only by recalling words on their current spelling list but also by constructively finding new words. Scrabble defines alphabets’ points based on their possibilities to form words so that players are encouraged to spell more difficult words. The points of a spelled word are based on the sum of each alphabet’s point and its location on the Scrabble game board.

VocaMono is developed under the client/server architecture. Being adapted from the famous game Monopoly, though being added with vocabulary learning activities, VocaMono is designed as a competitive multiplayer game which has similar gameplay rules with which players are familiar. Each player has two attributes: money and credit. The ultimate game goal of a player is to become the richest player. Figure 1 illustrates the VocaMono game board interface.
This game is turn-based. Players take turns in order. Each turn, the player complete his/her actions such as using cards or spelling a word within 30 seconds and these actions are sequentially listed in History box. The player first click two rolling dices to show the number of steps which his/her token moves forward along the path on the game board. The vocabulary learning activities are integrated into the gameplay rules by requiring the player to find a correctly spelled word by dragging and dropping a series of alphabet tiles which are selected according to the defined pedagogical scopes. Spelling words correctly can increase players’ credit points. Players can find words either by recalling from memory or by trial and error with any combination of alphabets. A system embedded dictionary can facilitate players the trial and error process. If a word is correctly spelled, the word’s Chinese translation and type (noun, verb,…) will be shown and the player’s credit points increase based on the sum of each alphabet’s point. Points and selection probabilities of alphabets are adopted from the famous spelling game Scrabble (Table 1). In this game, the default number of alphabet tiles is seven. In each turn, the system firstly randomly selects a word from the vocabulary database, whose length does not exceed seven alphabets. If the length of a selected word is less than seven, the remaining tiles are randomly chosen. These selected alphabet tiles are then presented with a random order. For example, if the word PLAY is selected and the remaining three alphabets I, G, and E are randomly selected with the presenting order A₁, P₃, Y₄, G₂, E₁, I₁, L₁ (the subscript is the credit point of each alphabet). Players can find words with any combination of alphabet orders. With this design, players can find the target word, PLAY (3+1+1+4=9 points), or other words, e.g. LIP (1+1+3=5 points).

Table 1: The alphabet points and selection probabilities.

<table>
<thead>
<tr>
<th>Point</th>
<th>Alphabet(Probability)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A(.09), E(.12), I(.09), L(.04), N(.06), O(.08), R(.06), S(.04), T(.06), U(.06)</td>
</tr>
<tr>
<td>2</td>
<td>D(.04), G(.03)</td>
</tr>
<tr>
<td>3</td>
<td>B(.02), C(.02), M(.02), P(.02)</td>
</tr>
<tr>
<td>4</td>
<td>F(.02), H(.02), V(.02), W(.02), Y(.02)</td>
</tr>
<tr>
<td>5</td>
<td>K(.01)</td>
</tr>
<tr>
<td>8</td>
<td>J(.01), X(.01)</td>
</tr>
<tr>
<td>10</td>
<td>Q(.01), Z(.01)</td>
</tr>
</tbody>
</table>
When a player’s token moves forward along the path and stops at or passes a space, several options may be available to him/her depending on the definitions of that space. In VocaMono, a space can be a property, *Shop*, *Chance*, *Hospital*, *Jail*, or *Intersection*. Properties are the only spaces that can be bought and developed by players to collect rents as opponents stop at. If a player’s token stops at a property that no one owned, this player can buy the property with the listed purchase price. If a player’s token stops at his/her own properties, this player can construct a house, or develop the level for a constructed house to this property, and its rent will be increased accordingly. A house can have at most five levels. If a player’s token stops at a property already owned by another player, this player pays the owner a given rent, depending on its level of development and whether the property is part of a set. A property set includes properties with the same color. If several properties within the same set are owned by the same player, the total rent to pay is the sum of rents of these properties. During the gameplay, the player can exchange credit and money at *Bank* anytime and trade a variety of cards with different credit points as he/she stops at *Shop*. Two types of cards are designed to increase the playfulness: Self-reinforcement and *Trap* cards. Self-reinforcement cards are those cards to increase self-competitiveness (e.g., “controlling dice numbers”). On the other hand, *Trap* cards can be used to attack others (e.g., “destroying one opponent’s house”). The player can check the list of currently owned cards and use cards before spelling words. If a player’s token stops at *Chance*, a random event, with different probabilities, will be triggered. Events include actions needs to occur (e.g., “go to *Jail*”, “backward 3 steps”), obtaining bonus cards, etc. If a player stops at *Hospital* or is injured, whether by events triggered at *Chance* or by being trapped by another player, his/her token moves to *Hospital* wherever the token is, and ceases moving for three turns. A player’s token moves to *Jail* and ceases moving for three turns when his/her token stops at *Jail*, the “go to *Jail*” event is trigger at *Chance*, or he/she is trapped by another player. The difference between dwelling at *Hospital* and *Jail* is that this player can collect rents while dwelling at *Hospital*, however no rent collection is allowed during dwelling at *Jail*. An *Intersection* is any space that has multiple directions to move forward. If a player’s token stops at or passes “*Intersection*”, the moving direction will be randomly assigned to increase the uncertainty of gaming to increase players’ motivation (Lo et al., 2008).

In addition to luck and gameplay skills for playing games, knowledge skills in pedagogical content must be considered in educational games. VocaMono integrates the word scope corresponding to the learning goal into gameplay rules to enhance learners’ vocabulary acquisition abilities with joyful experiences. Three pedagogical scaffolding tools, *Class vocabulary book*, *Personal vocabulary book*, and *Dictionary*, are developed to facilitate learning (see Figure 1). *Class vocabulary book* includes target words corresponding to class progress and the current learning goal is to facilitate players to acquire these words. The selection probabilities of words in *Class vocabulary book* are much higher than other words to make players have more opportunities to practice. Furthermore, to encourage players to practice words in *Class vocabulary book* to achieve the learning goal, if a word in *Class vocabulary book* is correctly spelled, double credit points will be rewarded for this word which yields high point values. All players share the same *Class vocabulary book* and they can always look up *Class vocabulary book* as references to find words. *Class vocabulary book* lists the target words to be learnt and raises players’ interests by doubling the credit points, hence enhance their adherence to learn target words. Unlike *Class vocabulary book* is shared by all players, *Personal vocabulary book* records the correctly spelled words of an individual player during the gameplay. The player can review his/her own *Personal vocabulary book*. At the end of the gameplay, *Personal vocabulary book* provides summary of players’ learning report, which can be used to estimate their competence of vocabulary learning. *Dictionary* is designed to facilitate players to implement the trial and error process in spelling and recognizing words.

3. Pedagogical Contributions of VocaMono

VocaMono has been designed to have unique educational game characteristics that are of interest to vocabulary learning. First, Ang and Zaphiris (2006) mentioned that in educational games, there are two types of winning rules: macro and micro. Macro rules define the ultimate goals. Oriented toward macro rules, the player devises individual micro rules to achieve the goal. Micro rules can be important in
educational games in that they can function as guidance to steer players toward the learning goals. Word spelling practices in *VocaMono* are embedded micro winning rules to achieve the ultimate goal of becoming the richest player (macro winning rule). Players are motivated to find higher-point words, which are target words to be learnt and are usually more difficult than words with lower points.

Second, players need to simultaneously integrate four cognitive abilities to successfully play the game within limited time: verbal, visuospatial, numerical, and strategic abilities. Verbal ability can be enhanced because *VocaMono* requires players to rapidly retrieve appropriate words from memory or trial and error. Players find words by dragging and dropping alphabets from a series of random ordered titles which is related to visuospatial ability. Players also use their numerical ability to play *VocaMono* because they need to rapidly calculate the points a word can earn. In such a competitive game like *VocaMono*, players need to apply strategic ability to make skillful thinking and planning to defeat their opponents.

Third, one of the fundamental language skills is to organize and remember the correct order of the alphabets in a word (Shemesh and Waller, 2000). In *VocaMono*, the vocabulary acquisition practice is integrated into the gameplay rules by requiring the player to find a correctly spelled word by dragging and dropping from a series alphabet tiles. It is consistent to the results as surveyed by Halpern and Wai (2007): most *Scrabble* players, both experts and novices, think about forming words by physically moving the tiles.

Fourth, requiring players to form words from a set of alphabets can facilitate players to tell apart words and non-words hence find spelling patterns. Shemesh and Waller (2000) proposed that teaching vocabulary with the idea of spelling patterns can be effective and students like to acquire vocabulary through spelling patterns. Through playing *VocaMono*, players enhance their vocabulary acquisition abilities not only for correctly spelling taught vocabulary but also for finding new vocabulary and spelling patterns. As addressed by Halpern and Wai (2007): “the visualization of spatially aligned letters that create partial word combinations using implicit rules of how letters combine in English to create words (e.g., *thr* is a common alignment of letters; *rht* is not)…”.

Fifth, Garcia et al. (2008) suggested that a key design concern for spelling games is to avoid showing wrongly spelled words. Therefore, spelling games based on question answering, which remind testing by presenting correct and wrong spellings, could undermine both the entertaining and learning goals. *VocaMono* requires players to find a word from a set of disordered alphabet tiles. The alphabets must be arranged in correct order. Though the alphabet tiles are disordered, incorrect words are not shown to players. It fulfills the design requirement, suggested by Garcia et al. (2008), to avoid visual learning of misspellings.

Finally, it has been recognized that fitting players’ knowledge levels and class progresses is a critical criterion to select educational games for maintaining players’ motivation and enhancing their learning (Chen, 2011; Uzun, 2009). The design of *Class vocabulary book*, *Personal vocabulary book*, and *Dictionary* conforms to what Halpern and Wai (2007) addressed that in the context of vocabulary learning, most people learn and retrieve words by relying on their stored lexicon of word meanings and they have relatively few words in their lexicon. Furthermore, it fulfills principle of challenge for motivation (Malone and Lepper, 1987) to allow players to be challenged at their current skill levels (Alessi and Trollip, 2001). It also conforms to the flow theory (Kiili, 2005; Lin et al., 2010) in that the balance between players’ skills and game challenges are successfully balanced by the predefined word scope. It includes the players’ prior knowledge and class progress and gives them appropriate challenges to help them construct new knowledge. During the gameplay, to win the game, players do their best to find correctly spelled words in a very involved, focused state. They can effectively enhance their vocabulary acquisition abilities from the gaming experience.

4. Conclusions

Vocabulary is the foundation of a language and the core of learning and communication and language development is highly dependent on learners’ vocabulary acquisition abilities (Carol, 2001). However, vocabulary acquisition is usually the most difficult part during the learning processes for most EFL learners. Therefore, it is imperative to construct a learning environment to make EFL learners have an engaged vocabulary learning experience to enhance their learning interests. Recently, digital
game-based learning suggests a new learning paradigm of learning by playing within visual and interesting environments. As a consequence, this study developed an online multiplayer English vocabulary learning board game, named VocaMono, for English vocabulary learning. Adapted from the famous games Monopoly, Unscramble, and Scrabble, this research developed VocaMono by effectively integrating the gameplay and pedagogy designs for vocabulary learning. VocaMono has been designed to have unique educational game characteristics that should be of interest to vocabulary learning. It enhances learners’ motivation for learning and memorizing English vocabulary. By playing this educational game, players’ are able to enhance their vocabulary acquisition abilities not only for correctly spelling taught vocabulary but also for discovering spelling patterns. This game can fit players’ vocabulary levels by selecting words from the word scope. Furthermore, this game is possible to be used to correspond to the class progresses.

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References

The Application of Game-Based Learning in Early Childhood Acquisition

Sanko Lan*, Joni Tzuchen Tang**, Yie-Su Hwang***

*APP Department, Kizi Lab Inc., Taiwan
**Graduate School of Curriculum and Instruction, National Taipei University of Education, Taiwan.
***The Department of Early Childhood Care and Education, Cheng Shiu University, Taiwan.

*lan@allproducts.com
**jttang0@gmail.com

Abstract: In this paper, we addressed the issue on application of game-based learning in early childhood acquisition. Accordingly, the new game design company, Kizi Lab Inc., had implemented the theoretical background of game-based learning and early child acquisition into the developed process to make the games playable, enjoyable and learnable for 2-8 years old children. Kizi Lab Inc. had found children can play kids’ tablet, Kizipad, individually and automatically with highly motivation and interests of learning, and the games also showed children are able to learn from the games effectively.

Game Play Video: https://docs.google.com/a/tradeserv.com/file/d/0B8673eHDKiOPaGRrNFVuT3B1dzQ/edit

Keywords: Game-based learning, Early Childhood Acquisition, Kizipad.

1. Introduction

Kizi Lab Inc. is a new game-design company for early childhood education area. The rationality of this company is to develop mobile games for 2-8 years old children. The newest released product in Kizi Lab Inc. is called Kizipad (http://www.kizipad.com/). Kizipad is a kind of children tablets, which allow 2-8 years old children to have their own responsible toy and motivate children to play and learn automatically.

2. Theoretical Background

2.1 Early Childhood Acquisition

First, we need to clarify the differences between “learning” and “acquisition”. According to Brown (1989), learning happens when students have awareness, whereas acquisition is an unconsciousness and automatic process. Different theory showed different ideas of early childhood acquisition.

Table 1: Theoretical Framework

<table>
<thead>
<tr>
<th>Theory</th>
<th>Belief on early childhood acquisition</th>
</tr>
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<tbody>
<tr>
<td>Behaviorism</td>
<td>Learning can be acquired by stimuli, reinforcement, and operation (Skinner, 1945).</td>
</tr>
<tr>
<td>Cognitivism</td>
<td>Learning acquisition goes through the meaningful process. Learners would revise their intrinsic to understand the external environment (Piaget, 1926).</td>
</tr>
<tr>
<td>Humanism</td>
<td>Learning acquisition is entirely innate. It is the potential of human development; it is a spontaneous progress (Chomsky, 1993).</td>
</tr>
<tr>
<td>Social constructionism</td>
<td>Society itself would provide the experience; the society can scaffold learners’ thought (Vygotsky, 1978).</td>
</tr>
</tbody>
</table>
Kizi Lab believes early childhood acquisition can be nature and innate, learning can occur in a provided game.

2.2 Game Based Learning

Game-Based learning (GBL) is a game play which has defined learning outcomes. The idea of Game-Based Learning believe that if we can motivate children and allow them to develop an awareness of consequentiality, children can learn and acquire knowledge and information automatically (Van Eck, 2006).

Why do we need Game-Based learning in early childhood acquisition? There are several reasons. First, children are interested at games. If we can provide games in learning, we can gain children’s learning motivation. Second, mobile devices can carry games; therefore, we can provide ubiquity of learning for children. Third, game-based learning believed learning can be automatically, which is related to our belief in early childhood acquisition.

3. The Road Map of Kizi Lab

3.1 Develop a Curriculum Map

In order to provide a curriculum map, Kizi Lab Inc. had several educational consultants to develop the map together. The curriculum map followed the learning objectives, predicted outcomes, and related research.

Right now, Kizipad had followed seven main areas from the curriculum map, which is: English as Second Language, Mathematics, Science, Life and Society, Creative Tools, Stories, Songs, and Screening Test.

3.2 Design the Practical Games

All of the games have followed the curriculum map, and design the practical and learnable contents. The games had been justified by several tests to ensure 1) Does the game meet the curriculum map? 2) Can children play the games individually? 3) Do children like the games? 4) Can children learn from the games?

All of the justified tests had been recorded, which allowed games designers to revise and rethink how to make the game become more practical and learnable.

3.3 Test Each Games Reliability and Validity

By ensuring the games had reliability and validity, all the games went through educational consultants to meet the games’ validity, and all the games had been tested by 2-8 years children to meet the reliability needs.

The game went to circle process, and each test had been recorded to allow the games to meet the users’ reliability, and educational validity.

3.4 Released the games

After the games meet all the criteria, the games can be released; however, the process had not been ended.

3.5 Adjusted the games

All of the games had recorded from the players. By the recording statistics, we can know how the players like the games and what are the norm for the players’ ability to finish the game. If we find the games are too hard for most of players, we would adjust the games to make it easier.
4. Kizipad

Kizipad is a kind of kids’ tablets, which design for 2-8 years children. Kizipad had 83 games, and users can download games monthly. All of Kizipad now is in Chinese, and later may release different language version in the future.

Figure 1. Kizipad’s appearances

Figure 2. Coloring Games from Kizipad

Figure 3. Sorting Games from Kizipad
5. Contribution

Kizipad had opened a new view in early childhood area. By doing the several tests, we found 2-8 children enjoy playing Kizipad, and many of our researches and tests had found games can enhance children learning individually, automatically, and effectively (Tang, Hwang & Lan, 2013).

References


Correlation of Professional English Reading VS. Eye Gazing and Frequency of Rereading Eye Movement

Hong-Fa HOa, Guan-Yu HOUB, Chen-Ku LINC, Chen-Hsiung LIND, and Soh O-KEd

aDepartment of Electrical Engineering, National Taiwan Normal University, Taiwan (R.O.C.)
bPh.D. Graduate Institute of Political Science, Taiwan Normal University (R.O.C.)
cDepartment of Industrial Education, National Taiwan Normal University (R.O.C.)
dSchool of Languages & Linguistics, University Kebangsaan Malaysia

*3rr168@gmail.com

Abstract: Over the past decades, English has become one of the major international languages widely used by many countries. Taiwan, being an international partner, has strived to improve its nationwide English proficiency to advance with international settings. This study investigates the correlation between eye movements of both 1) gazing time (fixation) and 2) frequency of re-reading (number of fixation) the vocabulary of familiar and unfamiliar professional English subjects, for those of both technical and vocational professionals of English as Foreign Language (EFL) participants, while reading professional English, to reading fluency. A newly invented eye chasing device has been used to monitor visual reading progress experiment. Fifteen technical high school students, who have completed Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET) in 2014, participated in the experiment. Their reading fluency are measured based on the results of eight questionnaires and answers (Q&A) after reading 8 professional English articles from computer engineering, mechanical, bio-medical, and business subject fields. SPSS 21 was used for descriptive and correlation statistics. Both hypotheses are accepted with results showing that readers from technical background spent more time fixing on reading familiar professional subjects, and mildly inverse relation on frequency of re-reading of professional English contexts. The combination use of multiple visual displays is recommended not only to improve English as foreign language (EFL) users’ training and practice but also to enhance quality on professional English readings.

Keywords: Vocabulary of familiar and unfamiliar subject, gazing time (fixation), frequency of reread (number of fixation), eye chasing device (ECD), professional English reading (PER), Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET)

1. Introduction

1.1 Purpose and Objective

Over the past decades, English has grown to become one of the major international languages widely used by many countries (Nunan, 2003). Taiwan, Republic of China (Tw, R.O.C.) being an international partner of the global village, has constantly been striving to improve its nationwide English proficiency to advance alignment with international settings (Lin, 2011). While short of literature studies on expert English reading and eye configuration, this study intends to investigate the correlation between eye movements of both 1) gazing time (fixation) and 2) frequency of re-reading (number of fixation) on the vocabularies of familiar and unfamiliar subjects, when situation occurs on re-reading professional English texts, to reading fluency. A newly invented ECD has been used to monitor this visual reading observation experiment. 15 recently completed their TVE JCEET have been invited to participate in this experiment.

This research aims at finding possible association on reading fluency of professional English subject contents, to human eyes reading pattern of technical and vocational based English as Foreign Language (EFL) participants, particularly on fixation of vocabularies, and on frequency of re-reading
the words. This research also attempts to serve as a reference to help bridge future researchers of possible advancement for EFL reading with help of visualization device. To contribute to the development of enhancement, this research has come up with following objectives:

1. To explore the differences between eye reading gaze time and reading fluency among technological and vocational students.
2. To detect the relationship between eyes rereading the words and reading fluency among technological and vocational students.

2. Literature Review

2.1 Background and Reading Fluency

In the past, with lack of proper tools, scholars were unable to fully identify the eye reading pattern of EFL readers when they read professional English materials, especially on those of familiar and unfamiliar fields to build the links with reading fluency. In recent studies, there have been a growing number of researches conducted on ECDs’ applicability, and putting them to test on general education, biological, and psychological studies (Clark & Clark, 2010; Orquin & Mueller Loose, 2013; Rayner, 2009). With the construct of eye chasing device by the National Taiwan Normal University (NTNU), the authors are able to explore the relationships of eye movements to professional English reading.

Literacy is important for human development and interaction. Therefore, educators have attempted various approaches and methods to advance learners’ literacy and knowledge, while the knowledge and literacy acquired are transferable and appropriate to expand on learning scopes and applicable for broad range of skills utility (Koo, Becker, & Kim, 2014; Kuhn, Schwanenflugel, & Meisinger, 2010; Lin, 2011; Perego & Boyle, 2000). Vision is an important function of learning literacy by means of visually reading for knowledge absorption (Clark & Clark, 2010; Lin, 2011; Orquin & Mueller Loose, 2013). To increase the speed and fluency of learning and the ability to demonstrate the generalized responses across fields, theory of Instructional Hierarchy (IH) by Haring and Eaton (1978) is further explained by Ardoin and Daly (2007) stated that knowledge and information are stimulus. Hence repeated practice and enhanced accuracy of response and perception to stimuli have greater control over behavior and recognition. Learners are more likely to be able to generalize from their existing knowledge and apply their wisdom and skills to new circumstances. However, numerous exemplars of targeted stimuli in multiple situations need to be implied by variety for generalization of application in order to link with practical situation (Kuhn et al., 2010; Stokes & Baer, 1977). Consequently, with more exemplars and stimuli from previous training and language learning, people of technical backgrounds may exercise a better set score of reading fluency through generalization, despite of reading unfamiliar professional English.

Reading fluency, regardless of various definitions, focuses on the consensus of accuracy, automaticity, and prosody as central components (Hudson, Pullen, Lane, & Torgesen, 2008; Kuhn et al., 2010; Rasinski, Reutzel, Chard, & Linan-Thomas, 2011). Reading fluency is then defined in terms of rate and accuracy, simultaneously decoding and comprehending, recognition and understanding of what has been visualized and read (Hudson et al., 2008). To syndicate the former studies, and extend on the research, the authors have added reading and fluency with visualization and PER. In the process of finding the relationships on gazing time (fixation), frequency of re-reading (number of fixation) the vocabularies of familiar and unfamiliar subjects and topics from various PER, the authors have adopted a newly invented low cost but high quality ECD to monitor the eye movements.

2.2 Eye Chasing Device References and English as Foreign Language (EFL)

Former studies have used eye chasing device for different studies (Cole, Gwizdka, Liu, Belkin, & Zhang, 2013; Mayer, 2010). The studies have shown that participants who spent more duration on ECD required the greater amount of attention on emphasis and access (de Koning, Tabbers, Rikers, & Paas, 2010; Ho, Tsai, Wang, & Tsai, 2014). English learners, of both native and foreigner, differ from
one another, as the classrooms and programs that serve them. Despite of the diversity among second language readers, one common factor, as an equation of the process of reading English is essentially similar among the readers of native or non-native English speakers (Ardoin & Daly III, 2007; Fitzgerald, 1995; Goodman & Goodman, 1978). The process contains decoding of characters to linguistic they represent to thrash out at meaning. What disseminates between EFL and native English readers are the cognitive linguistic and experiential resources of reading, particularly the reading fluency (Fitzgerald, 1995; Goodman & Goodman, 1978; Peregoy & Boyle, 2000). As further noted, the direct correlation to reading fluency in English comprises “(a) English language proficiency, (b) background knowledge related to the text, and (c) literacy abilities and experiences, if any, in the first language” (Peregoy & Boyle, 2000).

2.3 Technological and Vocational Education Joint College Entrance Examination of Taiwan

The Technological and Vocational Education (TVE) system is important to nurture human resources in Taiwan. Under the commission of Taiwan Ministry of Education (MOE), English is one of the mandatory tests. Therefore, the test is a well-respected and legitimate exam. The results and associated backgrounds consequently provide the valid and consistent records for this research perseverance.

2.4 Research Questions

To accomplish the purpose of this study, the following two questions were proposed.
1. What is the relationship between eye movements on fixation, for people of English as foreign language (EFL), with technical background (TB), to professional English reading fluency (PERF)?
2. What is the relationship between eye movements on number of fixation, for people of English as foreign language (EFL), with technical background (TB), to professional English reading fluency (PERF)?

2.5 Hypothesis

Base on the questions proposed and the literatures reviewed, this research intends to test the following hypotheses (Figure 1):
1. There is an inverse correlation between participants of technical background and the time spent on reading unfamiliar professional English. In another words, even though they may be reading unfamiliar subject, with technical background, participants may spend normal or lesser time gazing.
2. There is an inverse correlation between the frequencies of rereading the vocabularies of unfamiliar subject for participants of technical background on contents of professional English. In other words, even though they may be reading unfamiliar subject, with technical background, participants may spend normal or lesser number of times on fixation of words.

3. Methodology

3.1 Research Framework and Process

![Figure 1. Observation of eye movement through eye chasing device.](image_url)
3.2 Material

To conduct this experiment, 4 same sets of ECDs, head stabilizers, laptop computers, 8 (predesigned and preloaded into laptop computers) PER articles (with 2 from Mechanic, 2 on Computer Engineering, 2 from Bio-Medic, and 2 on Business), 8 (predesigned and preloaded into laptop computers) questionnaires, of one for each of reading article were used for this experiment, to promptly went through the experiment. To identify the unfamiliar words read, 15 participants were asked to circle out the words of unfamiliarity on physical printouts prepared by authors, after completion of reading the same 8 PER articles and responding to the 8 (Q&A)s electronically. All data were collected and analyzed.

3.3 Participant

Due to availability, the participants (n=15) are from Neihu Vocational High School who are majoring in Computer and Engineering majored students. They completed their TVE JCEET in 2014. This is to ensure that they have sufficient level of English knowledge and technical background for this experiment. This research has excluded the components of gender, age, social and economic status of participants. The sample population were volunteered to take part in the pilot test.

3.4 Design, process, and Procedure

Invitations for this experiment have been sent out to a number of local vocational and technical high schools. There were only 15 volunteers who would like to participate in the pilot test. To identify the focal possible PER outcomes from those with technical and vocational backgrounds, this research has invited the students who just completed their TVE JCEET for observations. On the date of experiment, one NTNU Professor and five research assistants went to Neihu Vocational High School to conduct the investigation. Participants were each equipped with one ECD, positioned individually against each one of the four head stabilizers, and sat in front of the four laptop. Participants were told to read a set of 8 pre-loaded professional English articles (2 from computer engineering base, 2 on mechanical base, 2 on bio medical field, and 2 from business related). Participants did not make known to the reading materials. After reading each article, the participants were required to answer 8 comprehension questions by selecting their answers. Participants were not assigned the time frame to complete the readings and comprehension questionnaires; however, they were accounted for by the proctors for analysis later. Four participants started the test at the same time, but performed the PER and answering the questions separately. Upon completion, participants were then asked to circle out the unfamiliar vocabulary words, of the same 8 professional English articles read electronically, on physical copies. Data were collected and analyzed afterward.

3.5 Instrument

Four recently produced EyeNTNU-180 eye chasers were used for monitoring and recording eye movements of 15 participants while reading professional English articles and responding to 8 Q&As. Each of EyeNTNU-180 set includes a laptop computer; a camera in front to record eye movements. The laptop is responsible for presenting 8 aforementioned professional English articles and questionnaire. In this experiment, a sampling rate is 180Hz (sampling 180 times per second). To avoid errors in eye chasing measurement caused by shaking of head and inconsistency of eye movement, a head stabilizer rack was used to fix head position. The distance between the screen and participants were set to 60cm straight apart. The normal time duration of a fixation of this experiment was set to 80 milliseconds.

3.6 Tools and Data Collection
EyeNTNU-180 was employed to collect eye movements, and calculates average time of visualization and coordination. Through these two parameters and ROI (Region of Interest), the Total Contact Time (TCT) and Number of Saccade (NOS) are able to be generated to provide verification of fixation and number of fixation of the words read. Four laptops were used separately on each one of the 4 separate experimental stations. The screen height was adjusted to individual’s visual level, where participants were able to face straight on the screen. To avoid major or sudden physical lurching, which may affect eye positioning; participants were each placed on a head stabilizer comfortably on chin cushions throughout the experiment. Fixation Calculator, software designed from open source was used to examine the data of inspected components. One major focal indicators of the Range of Interests (ROI) were categorized by ROI-splitter software and eye movement analyzer to evaluate eye movement data to generate scan paths, gazing time, frequency of rereading the words, average and total contacts.

<table>
<thead>
<tr>
<th></th>
<th>Average time of unfamiliar word fixation (ms/word)</th>
<th>Average time of unfamiliar word fixation standard deviation (ms/word)</th>
<th>Average time of familiar word fixation (ms/word)</th>
<th>Average time of familiar word fixation standard deviation (ms/word)</th>
<th>Average number of saccade (NOS)</th>
<th>Average number of normal direction scanning and reading (ANNDSR)</th>
<th>Percentage of saccade (NOS / (Total Average NOS + ANNDSR))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanic</td>
<td>359.41</td>
<td>79.934</td>
<td>102.81</td>
<td>16.271</td>
<td>791</td>
<td>8217.5</td>
<td>8.78%</td>
</tr>
<tr>
<td>Computer engineering</td>
<td>332.61</td>
<td>65.568</td>
<td>102.24</td>
<td>13.588</td>
<td>915</td>
<td>8213</td>
<td>10.02%</td>
</tr>
<tr>
<td>Bio-Medic</td>
<td>236.11</td>
<td>50.570</td>
<td>98.81</td>
<td>11.746</td>
<td>645</td>
<td>6406.5</td>
<td>9.15%</td>
</tr>
<tr>
<td>Business</td>
<td>201.54</td>
<td>46.319</td>
<td>97.11</td>
<td>12.027</td>
<td>670.5</td>
<td>6092.5</td>
<td>9.91%</td>
</tr>
</tbody>
</table>

Figure 2. Descriptive Statistic for Vocabulary of Familiar and Unfamiliar Subjects: Gazing Time (Fixation), Frequency of Reread (Number of Fixation), and Standard Deviations.

SPSS 21 software was used for descriptive statistics and Pearson correlation. The average time spent on gazing at unfamiliar vocabularies for Business subject is (201.54 millisecond/ms /word, standard deviation 46.319), Bio-Medic subject is (236.11 millisecond/per word, standard deviation 50.570), Computer engineering is (332.61 millisecond/per word, standard deviation 65.568), and Mechanic is (359.41 millisecond/word, standard deviation of 79.934); while the average time spent on fixation of familiar words for Business subject is (97.11 ms/word, standard deviation 12.027), Bio-Medic of (98.81 ms/word, standard deviation 11.746), Computer engineering being (102.24 ms/word, standard deviation 13.588), and Mechanic subject of (102.81 ms/word, standard deviation 16.271), as shown in Figure 2. The term saccade is defined in this research as re-reading of the words and visually tracing backward at vocabularies of normal reading sequence (contrary to normal sequence of logical reading). Figure 2 shows the average number of times of saccade for Business subject being (670.5), Bio-Medic being (645), Computer engineering of (915), and Mechanic subject being (791); while the average number of normal directional sequence of reading and scanning at the contexts of Business subject is (6092.5), Bio-Medic (6406.5), Computer engineering (8213), and Mechanic of (8217.5). To take NOS and divides it by the denominator of Total Average NOS plus ANNDSR, the authors are able to measure the percentage of frequency on saccade, for each one of the professional English reading subjects, as shown in Figure 2. Figure 3 is a sample diagram of the 4 PER articles’ eye maps; the lines are the visual scanning paths traveled, where the different coloring indicates the time of fixation, with no coloring means skipping of the words, and darker colors indicate longer fixation and repetitive saccades accumulated.
4. Results and Discussions

It has been observed, from Figure 2 that participants on average spent more time gazing at unfamiliar vocabulary words of Mechanic subject, and their identical background in technical field of Computer Engineering. However, the average time spent on reading the unfamiliar words of Bio Medic and Business fields are about 100 ms per word lesser than the former two. Mechanic and Computer Engineering, subjects wise though independent, are closer in academic study, therefore they are often grouped together under Engineering school, but Bio-Medic and Business professional subjects. The reason for longer fixation time may be explained by the similar causes provided by the former studies stated in literature review section that readers tend to devote more time and efforts browsing at recognizable contents. It is also possible because people are more willing to spend extra time reading at the contexts they are able to associate with, and are able to understand fluently than the unfamiliar subjects, i.e. in this experiment of Bio-Medic and Business professional English readings. Figure 2, indicates that the average time spent on fixing at familiar words fall around 100 milliseconds (ms) per word and the time spent is consistent throughout all the 4 professional subjects, regardless of the differences among the 4 professional English reading subjects experimented for this research.

To calculate individual professional reading field’s Percentage of Saccade, the authors took the Number of Saccade (NOS) as nominator and divide it by (Total Average Number of Saccade plus Average Number of Normal Direction Scanning and Reading) as denominator. The resulting percentages fall in between 8.78% ~ 10.02% (8.78% for Mechanic, 9.15% for Bio-Medic, 9.91% for Business, and 10.02% for Computer Engineering). Figure 2 indicates that Percentage of Saccade is steady throughout all four different PERs. In Total Average Number of Saccade, this technical background participants’ saccade frequency reduced noticeably when reading unfamiliar subjects. It could be explained that the behavior changes because of human rejection and un-anticipation of reading at unfamiliar subjects. These behavioral reflections can be identified through scan path. From the eye map scan path in Figure 3, the participant spent more time and intensity reading identical technical
background of Computer Engineering and related Mechanic than Bio-Medic and Business professional English reading.

<table>
<thead>
<tr>
<th></th>
<th>Mechanic UNFV</th>
<th>Mechanic FV</th>
<th>Computer Engineering UNFV</th>
<th>Computer Engineering FV</th>
<th>Bio Medic UNFV</th>
<th>Bio Medic FV</th>
<th>Business UNFV</th>
<th>Business FV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanic UNFV</td>
<td>1</td>
<td>0.498</td>
<td>.915**</td>
<td>0.473</td>
<td>0.635</td>
<td>0.298</td>
<td>.668**</td>
<td>0.415</td>
</tr>
<tr>
<td>Mechanic FV</td>
<td>0.498</td>
<td>1</td>
<td>0.326</td>
<td>.886**</td>
<td>0.199</td>
<td>0.689</td>
<td>0.282</td>
<td>.434**</td>
</tr>
<tr>
<td>Computer Engineering UNFV</td>
<td>.915**</td>
<td>0.326</td>
<td>1</td>
<td>0.301</td>
<td>.755**</td>
<td>0.106</td>
<td>0.777</td>
<td>0.288</td>
</tr>
<tr>
<td>Computer Engineering FV</td>
<td>0.473</td>
<td>.886**</td>
<td>0.301</td>
<td>1</td>
<td>0.355</td>
<td>.628**</td>
<td>0.353</td>
<td>0.404</td>
</tr>
<tr>
<td>Bio Medic UNFV</td>
<td>.635*</td>
<td>0.199</td>
<td>.755**</td>
<td>0.355</td>
<td>1*</td>
<td>0.091</td>
<td>.908**</td>
<td>0.034</td>
</tr>
<tr>
<td>Bio Medic FV</td>
<td>0.298</td>
<td>.689**</td>
<td>0.106</td>
<td>.628*</td>
<td>0.091</td>
<td>1**</td>
<td>-0.044</td>
<td>.576*</td>
</tr>
<tr>
<td>Business UNFV</td>
<td>.668**</td>
<td>0.282</td>
<td>.777**</td>
<td>0.353</td>
<td>.908**</td>
<td>-0.044</td>
<td>1**</td>
<td>0.087</td>
</tr>
<tr>
<td>Business FV</td>
<td>0.415</td>
<td>0.434</td>
<td>0.288</td>
<td>0.404</td>
<td>0.034</td>
<td>0.576</td>
<td>0.087</td>
<td>1</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level.

Figure 4. Pearson correlation (2-tailed) table showing the relationships between the familiar and unfamiliar vocabularies of 4 PERs from Mechanic, Computer Engineering, Bio-Medic, and Business subject fields, with N = 15. Familiar vocabulary = FV, Unfamiliar vocabulary = UNFV.

Figure 4 shows the gazing times Pearson’s correlation between the familiar and unfamiliar vocabulary of 4 professional English readings performed by Mechanic, Computer Engineering, Bio-Medic, and Business students. It is recognized that regardless of professional reading subjects, when readers come across to unfamiliar vocabularies, there is a uniformity of positive significance on the time speed on reading. For Engineering participants, the time spent on fixation and re-reading the words correlations are much stronger among the Computer Engineering and Mechanic participants, but not for Bio-medic and Business PERs. It is also observed that all significant relationships are positive in trend.

5. Conclusion

There are a growing number of researches conducted on eye chasing devices; however, after reviewing various literatures, the authors noted that professional English reading and eye movement together from English as foreign language has not been explored. Therefore, this lack of research has prompted the authors’ intention to explore the correlation between eye configurations of English as foreign language users / learners with technical background, and their PERs of eye fixation and frequency of re-reading the vocabulary. With English being one of the major international languages widely used throughout most settings, the authors also intend to contribute this study to improve the EFL language usage in Taiwan.

Reading is an important part of learning, as reading focuses on the consensus of accuracy, automaticity, and prosody combined in reading fluency. Theories based on Instructional Hierarchy (IH) believe that instructed and repeated practice and reinforcement improve accuracy and may further develop perceptions through stimulations. Therefore repeated eye fixation and gazing may improve reading fluency through vocabularies and minds association. These associations can be processed through prior knowledge as stated in literature reviews and in this research experiment. With the help of ECD, the authors are able to carefully examine the correlation, with participants’ eye movements, among the variables. As the result of research experiment and the literatures studied, the two hypotheses
are accepted by the authors. The eye movement and visualization serve as important functions of learning, the authors would suggest EFL to combine multiple visual equipment and tools to enhance English as foreign language users’ training and practice. It may dramatically enhance the quality of professional English reading.

Acknowledgements

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Assisting Tools for Selecting Proper Semantic Meaning by Disambiguation of the Interference of the First Language

Nattapol KRITSUTHIKUL\textsuperscript{a,c,d,*}, Shinobu HASEGAWA\textsuperscript{b}, Cholwich NATTEE\textsuperscript{a}, & Thepchai SUPNITHI\textsuperscript{d}

\textsuperscript{a}Information, Computer, and Communication Technology (ICT), SIIT, TU, Thailand
\textsuperscript{b}Center for Graduate Education Initiative (CGEI), JAIST, Japan
\textsuperscript{c}School of Information Science (IS), JAIST, Japan
\textsuperscript{d}National Electronic and Computer Technology Center (NECTEC), Thailand

*nantapol.kritsuthikul@gmail.com

Abstract: In this work, we proposed an assisting tool to EFL Thai students to find the incorrect concept word usage in writing. To prevent selecting incorrect term effect by translation from native language, a list of commonly confusing words along with a method to score words in co-occurrence are exploited. The proposed method can indicate the miss-using word in terms of semantic and suggest the possibly correct one with detail and reason.

Keywords: English as Foreign Language (EFL), Writing Skill, Natural Language Processing (NLP), Semantic, Meaning, n-gram, search engine

1. Introduction

Most of EFL students are influenced of translating their native language to English language when they try to communicate in English. However, semantic of words in languages is apparently not equal in terms of scope, sense, usage, etc. (Speaks, 2014), and translation often applies incorrectly due to the lack of a clear understanding of the word meanings. While selecting the word in translation, students often select the word with a board meaning or the frequently seen word confused by its polysemic as they assume the word has a sense of explanation in the same form.

The issues of the translated words from native language to English are greatly noticeable in the work of writing. EFL students use incorrect word to express their content because they do not know the word that represents their concept. The incorrect issues can be categorized into four types: (1) using word with border meaning (hypernym), (2) using word with excessive specific meaning (hyponym), (3) using frequently seen word with similar but incorrect meaning or usage (disjoint similar concept) and (4) using direct word-to-word translation in the proverb or grammatical pattern (ignoring correlated concept). These issues are originated with the interference of their native language because of translation and the original language not containing the concepts.

From observation, case (1), using the word with boarder or too general sense, has been found the most. Unfortunately, common students clearly know the concept that they want to mention, but they do not know the equivalent translated word in English thus they select the words with general concept which are in their knowledge. Moreover, the other cases can be happened in their writing from time to time based on students’ limitation of English knowledge. For example, the concept “sandal” is wanted to be expressed. For case (1), students who do not know the word may select the word “shoe” because the word is the only concept they have for footwear. Some students may use the word “slipper” as case (3) because they do not know the difference among those concepts, which are the indoor and outdoor usage purpose, since the
detail may be missing from a bilingual dictionary. Furthermore, there is a case that the concept “sandal” is expressed as a compound word in their native language, such as Thai for ‘รองเท้า’ (rongtao - shoe - [noun]) - แตะ (tae - sound made by flip-flop shoe - [noun but it is polysemy to common word for verb as ‘to touch’] ), hence they may invent new words, for instance “*touch shoe” or “*tae shoe”, to represent the concept because they lack the English word for the concept or they believe there is no such concept in English.

These issues become more commonly found in EFL writing works because for them, these concepts are very confusing in terms of conceptual ambiguity from the divergence of their native language. Moreover, the translation method in expressing English for EFL students cannot be prevented since English language is greatly different from their native, and it interrupts and limits the way of their recognition. Hence, reducing the interference of the native language (L1 or the first language, henceforth) is the key to improve their English expressing. There are the words that often found as confusing words in translation provided by published dictionaries and guideline for translation by veteran translators. This information is a good hint to assist on disambiguation for those words.

In this work, we aim to develop an assisting tool to help EFL students in Thailand on selecting a proper English word. Since the case of using the hypernym is the most common and foremost issue, we aim to handle this issue first. By comparing the English written output from students with widely-published data, the likeness of pattern and wording in the written work is matched. This will result as if consulting student individual writing sentence with the large corpus to check the co-occurrence of the given words to evaluate the selection of accompanying words. By employing a list of confusable words in translation from Thai to English and WordNet, the tool is designed to reduce the interference of Thai native language on selecting the English words with commonly found cases, using hypernym and hyponym. We expect that this tool will improve their English writing skill and help them to gain more understanding of semantic concepts of English words.

2. System Architecture and Prototype System

The system is designed to find the inappropriate English words in terms of semantic meaning in the writing work of EFL student in Thailand, and to suggest a list of the better words for manual selection. The system architecture is illustrated in Figure 1.
2.1 Sentence handling module

This module gets an input as a digital English sentence made by EFL Thai students. To find an incorrectly semantically used English word among sentence, words are chunked with the $n$-gram model. The system divides the sentence into a group of consequent fragments.

For example, an input sentence from a student is “I write a picture”. It will be assigned in $n$-gram model as given in Figure 2.

![Figure 2. An $n$-gram model of the sentence “I write a picture”](image)

2.2 Frequency of composited words measurement module

To acknowledge with the words with an inappropriate semantic meaning within the sentence, Hits rate (Number of search result) from search engine (e.g. Bing (Microsoft Bing, 2009), Google (Google, 1998), and so on) is employed as a concordance for measurement. Since we believe that the less frequency the words are used in co-occurrence, the more chance they are incorrectly composed with the wrong semantic meaning together. The rate is assigned to every roll. As a result from Figure 2, the hits rates of their responding consequent fragments are exemplified in Figure 3.

![Figure 3. Hits rates of each gram by using Bing and Google](image)

From Figure 3, according to extremely low hits rate from both Bing and Google for $n$-gram where $n = 4$, it is assumed that $n$-gram where $n = 4$ is incorrect. Moreover, $n$-gram where $n = 3$ starting from ‘write’ (3 #2 roll) also gets a remarkably low once comparing to other hit rates.

2.3 Confusing word matching module
Once the consequent fragments are found with low Hits rate, each fragment is examined through the Confusing Wordlist provided from published dictionaries and a guideline from veteran translators. Within the Confusing Wordlist, words ambiguous to each other are given together in a list format with their POS. An example of Confusing Wordlist is shown in Figure 4.

| 1. PEOPLE@N | CITIZEN@N | POPULATION@N | NATIVE@N | INHABITANT@N |
| 2. ABOVE@PREP | OVER @PREP | HIGHER@ADJ | |
| 3. WRITE@V | DRAW@V | |
| 4. PREVENT@V | PROTECT@V | |
| 5. ADVICE@V | INTRODUCE@V | SUGGEST@V | GUIDE@V |
| 6. SANDAL@N | SLIPPERS@N | FLIPFLOP@N | FLIP-FLOP@N | THONGS@N |
| 7. TALK@V | SPEAK@V | SAY@V | TELL@V | CONVERSE@V |

Figure 4. An example of Confusing Wordlist

With words given in Confusing Wordlist, an example from Figure 3 is found with the word in given in line#3 from Figure 4 therefore the system attempts to replace the found word with the given alternative words in the list and re-do the Frequency of composited words measurement module With replacing word ‘write’ with word ‘draw’, we gain the result demonstrated in Figure 5.

<table>
<thead>
<tr>
<th>n-gram</th>
<th>consequent fragments</th>
<th>Hits rate from Bing</th>
<th>Hits rate from Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>I draw a picture</td>
<td>156,000</td>
<td>2,080,000</td>
</tr>
<tr>
<td>3 #1</td>
<td>I draw a</td>
<td>1,110,000</td>
<td>34,100,000</td>
</tr>
<tr>
<td>3 #2</td>
<td>draw a picture</td>
<td>5,190,000</td>
<td>39,900,000</td>
</tr>
<tr>
<td>2 #1</td>
<td>I draw picture</td>
<td>4,870,000</td>
<td>3,190,000</td>
</tr>
<tr>
<td>2 #2</td>
<td>draw a picture</td>
<td>32,200,000</td>
<td>8,900,000</td>
</tr>
<tr>
<td>2 #3</td>
<td>draw a picture</td>
<td>53,400,000</td>
<td>48,400,000</td>
</tr>
</tbody>
</table>

Figure 5. Hits rates of each gram after replacing the confusing word ‘write’ with word ‘draw’

From comparing Figure 3 and 5, we found that the Hits rate of roll 3 #2 from Google is boosted about 135 times while the whole sentence “I draw a picture” obtains much higher hits rate ratio than the sentence “I write a picture”.

2.4 Hint generation module

To give a suggestion with reason, WordNet (Princeton University, 2010) is exploited to this work to show a relation between written word and correct word. There are three cases.

- If the written word is a hypernym by WordNet of the word returning better Hits rate, the template which mentions the word in use is “too general term” will be shown.
- If the written word is a hyponym by WordNet of the word returning better Hits rate, the template which mentions the word in use is “too specific term” will be shown.
- If both words are not related within WordNet, only the suggested words are given as a possible better word based on Confusing Wordlist.
Moreover, the suggested word will be given which Thai definition and Thai translation provided by digital Thai-English bilingual dictionary, LEXiTRON (NECTEC LEXiTRON, 1995) to give more details for learners.

3. Experiment

The objective of this experiment was to evaluate the usability of the prototype. Research subject is fifteen volunteered Thai students studying in Grade 8 from a provincial boarding school in Chonburi, Thailand. Each student was assigned to compose ten sentences in both Thai and English. Specific words from Confusing Wordlist shown in Figure 6 must once be used in the each of written English sentences. The total of those 150 sentences were given to the system and returned results given in Figure 7.

<table>
<thead>
<tr>
<th>able</th>
<th>above</th>
<th>accept</th>
<th>accord</th>
<th>accordance</th>
<th>according to</th>
<th>advice</th>
<th>affect</th>
<th>agree</th>
<th>bring</th>
</tr>
</thead>
<tbody>
<tr>
<td>capable</td>
<td>citizen</td>
<td>come</td>
<td>converse</td>
<td>draw</td>
<td>effect</td>
<td>enable</td>
<td>equal</td>
<td>equivalence</td>
<td>espadrille</td>
</tr>
<tr>
<td>exact</td>
<td>except</td>
<td>flip-flop</td>
<td>flipflop</td>
<td>go</td>
<td>going to</td>
<td>gonna</td>
<td>good</td>
<td>guide</td>
<td>higher</td>
</tr>
<tr>
<td>in accordance</td>
<td>accurate</td>
<td>inhabitant</td>
<td>introduce</td>
<td>lay</td>
<td>lie</td>
<td>mule</td>
<td>native</td>
<td>over</td>
<td>people</td>
</tr>
<tr>
<td>population</td>
<td>prevent</td>
<td>protect</td>
<td>raise</td>
<td>rise</td>
<td>said</td>
<td>same same</td>
<td>sandal</td>
<td>say</td>
<td>slippers</td>
</tr>
<tr>
<td>speak</td>
<td>suggest</td>
<td>take</td>
<td>talk</td>
<td>tell</td>
<td>thongs</td>
<td>well</td>
<td>write</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Specific words from Confusing Wordlist assigned to students

36 Incorrect found by system

39 Incorrect found by human

5

2

2

Suggest correct word

Suggest incorrect word

Figure 7. Results of System comparing with human

4. Discussion

From results given in Figure 7, the system returned 36 found incorrect words from 150 sentences. From those 36 found words, there were two words that are apparently correct but the system marked as incorrect. These findings were caused by the lower Hits rate of the correct one. In details, the found one is “I speak English well”. Since the n-gram chunked the sentence into gram based fragments, the immediate word ‘I speak’ was focused while the word ‘speak’
is in the Confusing Wordlist along with ‘say, talk, etc.’ as shown in Figure 4 line 7. Hench, the system decided to try ‘I say’ which gives much higher Hits ratio. This issue was generated from considering low gram number. The less n-gram word is searched for Hits, the more Hits ratio will be returned. Therefore, bi-gram word should be avoided and high number of n-gram should take higher priority.

Moreover, there are five incorrect cases that the system cannot find. This issue comes from the insufficiency of the words in the Confusing wordlist. Since the Confusing wordlist was only gathered with publicly provided data, there are other possible confusing words. It is best to gather more and more words to cover the list. Furthermore, type of confusing should be categorized to increase the scope and detail of the confusion.

Last, there are two of the suggested hints led to incorrect word selection. Since the system provides the list of possible words, students, who lack knowledge of the words though there are additional details given by bilingual dictionary, cannot select the proper word among them. It is possible that the details given by the bilingual dictionary are insufficient for low-proficiency student to understand. Thus, to facilitate more details, another detail related to the word in Thai should be added. Furthermore, an image of the word will be greatly helpful to exemplify the visual instance of the word mentioning an entity while video of motion is an explicit example of acting semantic.

5. Conclusion and Future work

This paper presents an assisting tool to help EFL Thai learners to select proper words by their semantic that they intend to. This work applies the Hits ratio from search engine to consider the words in use as statistical concordance. The low Hits result is used to find an inappropriate words using in co-occurrence. By employing confusing wordlist, the found incorrect words in consequence are given with the reason why the words are incorrect. The result of the system is to find the incorrect word among writing work with the suggest words and reason of the confusion. From testing with 150 written sentences by Grade 8 Thai students, 34 from 39 incorrect words were found while 32 from 34 found results were suggested accurately with words containing appropriate concepts to the context.

To improve the system, we plan on adding more confusing words based on Thai to English translation to increase coverage. Types of confusing will be categorized to scope and give better reason for word incorrectly used in writing. Additional information such as an image of entity and a short video of motion will be attached to suggested hint for learner to clearly understand the implicit concept of word.

Acknowledgements

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Effects of Students Using Smartphones to Receive Different Amount of L1 Support for Listening Comprehension and Vocabulary Recall

Gwo-Jen HWANG\textsuperscript{a}, Yi-Hsuan HSIEH\textsuperscript{a}, Ching-Kun HSU\textsuperscript{b*}
\textsuperscript{a} Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
\textsuperscript{b} Department of Technology Application and Human Resource Development, National Taiwan Normal University, Taiwan
*ckhsu@ntnu.edu.tw

Abstract: The study aims to explore whether different amount of the first language (Chinese) information will lead to different effectiveness on high school students’ listening comprehension and vocabulary recall. Furthermore, the study also discusses the relationship between different difficult degrees of videos with two kinds given amount of subtitles/captions and students’ learning performance in English listening comprehension and vocabulary recall. One class was given the full first language subtitled movie with no foreign language captions while the other class was given the partial first language subtitled movie with full foreign language captions. The findings indicated that although the students received only the assistant of the partial first language subtitles, learners’ understanding of the listening comprehension will not be affected and their performance in the vocabulary recall test statistically better than those who use the full first language.

Keywords: subtitle, caption, listening comprehension, vocabulary recall

1. Research Background and Purposes

English seems to be the most important communication tool for the global world. Many linguists would actually call it a universal language or a lingua franca. From the year 2005, Ministry of Education in Taiwan stipulates that every elementary school should start English education from the third grade. Yet English education is not confined to schools only, as living in a world surrounded by technology and multimedia nowadays, people have far more accesses to learn a foreign language (FL) than before. It is likely to use technology and multimedia to assist language learning. While there has long been interested in the relationship between multimedia and language learning, those studies have extensively investigated in the field of reading (Lysenko & Abrami, 2014) and vocabulary acquisition (Emine & Gülcan, 2012). However, the use of multimedia or mobile devices for listening comprehension is relatively unexplored; in particular how the effects of the interference of different amount of the first language (L1) information on the listening comprehension and vocabulary recall.

It goes without saying that if people want to be able to communicate with others, they should somehow comprehend what other people are talking about instantly. It can’t deny that listening is an essential skill in understanding a language (Chung, 1999; Liu, Chen, & Chang, 2009). From the year 2013, every high school graduate has to participate in the TELC which is referred to as Test of English Listening Comprehension. Therefore, it is urgent to provide high school students with more opportunities of foreign language listening practice. Besides TELC, the TOEIC, Test of English for International Communication, also includes 100 questions for the listening comprehension part.
However, in their own country, there is rare opportunity for the students to touch foreign languages after English class. Fortunately, with the advance of technology, there are abundant methods and materials available to support students in learning a foreign language. In daily life, many convenient computer-assisted or online learning systems are also handy for training English listening proficiency (Chapelle, 2009; Liu, Liu, & Hwang, 2011).

Of all the rich learning resources, videos are the most common and popular way to promote English listening comprehension. As a result, many researches regarding EFL learning often choose videos as learning materials instead of audios or texts (Chapple & Curtis, 2000; Vanderplank, 2010). The reason for the popularity of choosing videos as learning materials is partly because there are subtitles or captions on the videos. Chun and Plass (1997) have proposed that videos with captions are useful in learning second language reading. Recently, Hsu, Hwang, Chang and Chang (2013) also indicated that veiling the easy foreign vocabulary and showing only the difficult words in the captions can promote elementary school students’ listening comprehension.

Before proceeding with the following exploration on listening comprehension or vocabulary recall, the study needs to define two important concepts, “subtitles” and “captions”. According to Longman dictionary of contemporary English, “subtitles” means words printed over a film in a foreign language to translate what is being said, such as an English film with Chinese subtitles. It is contrasted with the concept “captions”, which deals with “words printed above or below a TV program, film, etc., to say what it is about or to give further information to help viewers who are deaf or hard of hearing to follow the dialogue, and it’s usually provided in the same language.” The above mentioned was as defined in related studies (Hsu, Hwang, Chang, & Chang, 2013; Danan, 2004) as well.

The study aims to explore whether different amount of L1 (Chinese) information will lead to different effectiveness on high school students’ listening comprehension and vocabulary recall. This study hypothesize that less L1 (Chinese) given information will not affect the understanding toward students’ listening comprehension. In the meantime, it is expected that less L1 (Chinese) interference can even be beneficial to students’ vocabulary recall. L1 interference or so-called “cross-linguistic and language transfer” refers to the influence of native language structures on students’ performance and development in the target language (Hashim, 1999). Furthermore, this study also discusses the relationship between different difficult degrees of videos with two kinds given amount of subtitles/captions and students’ learning performance in English listening comprehension and vocabulary recall. To evaluate the proposed hypotheses, an experiment has been conducted to investigate the following research questions:

1. Whether less L1 (Chinese) given information will affect the understanding of the listening comprehension?
2. Can less L1 (Chinese) interference be beneficial to students’ vocabulary recall?
3. Will different difficult degrees of videos with two kinds of subtitles/captions bring about diverse learning performance in English listening comprehension and vocabulary recall?

2. Method

2.1. Participants

The participants included two classes of 11th graders of a private high school in Taipei city. There were a total of 86 students who volunteered to take part in the experiment. The average age of the subjects was 16. It’s worth mentioning that the school is an all girls’ school, so there will not be gender difference in the case. All the participants learned
English as a foreign language and were all taught by the same instructor who had taught the English course for over 7 years.

2.2. Research Design

In this study, a quasi-experiment was conducted in a high school regular English course. The participants included two classes of 11th graders and there were a total of 86 students. Each student was equipped with one smartphone and a pair of earphone. One class was assigned to be the experimental group and the other was the control group. The experimental group, including 44 students, used the smartphones and earphones to watch the filtered L1 (Chinese) subtitle video with its corresponding captions (English) individually, while the control group with 42 students used the smartphones and earphones to watch the video with full L1 (Chinese) subtitles and with no (English) captions.

The videos for the two groups are the same content with different amount of the first language subtitles and foreign language captions. Figure 1 shows the different amount of the first language subtitles and foreign language captions for the control group (right) and the experimental group (left). In addition, there are two kinds of different difficult filtering degrees of the videos being used in the experimental group. Video one (V1) displays all English words (foreign language) and partial Chinese (the first language) translations which hidden the translation of 220 words, while video 2 (V2) presents all English words (foreign language) and partial Chinese translations (the first language) which hidden the translation of the highest frequently used 1000 words. In the control group, both two videos will have full first language (Chinese) subtitles and with no (English) captions.

![Figure 1. Students use the smartphones to watch the videos individually. The one to the left is the experimental group (partial L1 subtitles with full captions) and the one to the right is the control group (full L1 subtitles with no captions).](image)

All the videos are 15-minutes long. The students in either group can operate the function of the player in the smartphone to “play”, “pause” or “replay” the video according to their own watching requirements at will in the given time (20 minutes). After watching each video for 20 minutes, both groups of students took a listening comprehension test and a vocabulary recall test to assess their understanding in listening comprehension and the remembrance of the vocabulary. The experiment was conducted for a month, as shown in Figure 2.
2.3. Research tools
The instruments utilized in the present study were the listening comprehension and the vocabulary recall test. The listening comprehension test and the vocabulary recall test are developed by two experts in the English teaching field. One is an experienced professor in a university and the other is an English oral training instructor who is also a native speaker. The listening comprehension test consists of 5 multiple choice questions, each account for 20 points, with a perfect score of 100. The vocabulary recall test consists of two parts. The first part is the dictation test, it consists of 5 questions, and each accounts for 8 points. The second part is the vocabulary cloze test, it consists of 6 questions, and each accounts for 10 points. The two parts add up to be a perfect score of 100.

3. Research Results

3.1. Analysis of listening comprehension test

One of the objectives of the study was to examine whether to reduce the amount of the L1 (Chinese) information will affect students’ understanding of the listening comprehension.

By employing Independent t-Test on the listening comprehension test scores of the two groups, the results of this study showed that the mean values and standard deviations of the listening comprehension test scores were 39.05 and 16.20 for the control group, and 39.09 and 13.09 for the experimental group, as shown in Table1. The result showed that there was no significant difference between the two groups in the listening comprehension.
test \((t=0.01; \ p>.05)\). As a result, it indicated that reducing the amount of the L1 (Chinese) information will not affect students’ understanding toward the listening comprehension.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>44</td>
<td>39.09</td>
<td>13.09</td>
<td>0.01</td>
</tr>
<tr>
<td>Control group</td>
<td>42</td>
<td>39.05</td>
<td>16.20</td>
<td></td>
</tr>
</tbody>
</table>

\*\(p<.05\)

3.2. Analysis of vocabulary recall test

One of the objectives of the study was to examine whether to reduce the amount of the L1 (Chinese) information will affect students’ recall of vocabulary. Table 2 showed the Independent t-Test result of the vocabulary recall test of the two groups. The means and the standard deviations of the control group were 31.17 and 13.87, while they were 39.20 and 14.04 for the experimental group. According to the results \((t= 2.67, \ p< .05)\), it is found that there was a significant difference between the two groups; that is to say, less L1 (Chinese) interference and full foreign language caption will be beneficial to students’ vocabulary recall. Students who watched the video with less amounts of L1 (Chinese) subtitles but full foreign language caption exhibited better learning performance in vocabulary recall.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>44</td>
<td>39.20</td>
<td>14.04</td>
<td>2.67*</td>
</tr>
<tr>
<td>Control group</td>
<td>42</td>
<td>31.17</td>
<td>13.87</td>
<td></td>
</tr>
</tbody>
</table>

\*\(p<.05\)

3.3. The variation between difficult degrees of videos

Another objective of this study was to examine the relationship between different difficult degrees of videos with two kinds of subtitles/ captions and students’ learning performance in English listening comprehension and vocabulary recall. The study employs two different difficult degrees of videos in the experiment. The degrees of the videos were assessed by two experienced university professors in the language learning field. Video 1 (V1) is considered the harder one, and video 2 (V2) is thought to be the easier one to the subjects in this study.

From the research results, it was found that students in the experimental group which were provided with filtered L1 (Chinese) subtitles along with corresponding FL (English) captions performed better in V1’s vocabulary recall test compared with the control group, as shown in Table 3. However, the results also showed that speaking of the V1’s listening comprehension test, the control group statistically performed better than the experimental group. The results inferred that because the difficult piece (V1) has left more L1 (Chinese) subtitles with FL (English) captions words in the video which led students of the experimental group to divert attention from only listening to seeing the vocabulary provided. Therefore, those L1 subtitles and FL captions provided in the V1 improved the performance of the experimental group in V1’s vocabulary recall test while because those experimental group students’ attention was distracted by the vocabulary provided in the video, the test scores in V1’s listening comprehension part was consequently lower than
the control group’s test result.

Table 3. ANOVA analysis of vocabulary recall of different difficult degrees of videos.

<table>
<thead>
<tr>
<th>Group Treatment</th>
<th>Video Category</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>Pair Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (E)</td>
<td>Hidden the translations of</td>
<td>44</td>
<td>43.14</td>
<td>19.28</td>
<td>5.99*</td>
<td>EV1 &gt; CV1*</td>
</tr>
<tr>
<td></td>
<td>220 sight words (V1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hidden the translations of</td>
<td>44</td>
<td>35.27</td>
<td>15.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000 HFU words (V2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (C)</td>
<td>All L1 (V1)</td>
<td>42</td>
<td>27.29</td>
<td>16.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All L1 (V2)</td>
<td>42</td>
<td>35.05</td>
<td>18.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<.05

The research results was just in line with the theory of the split-attention effect in multimedia learning (Mayer, 1998). Many previous studies have also proved this so-called redundancy effect that integration of the redundant information with essential information imposes a cognitive load interfering the learning process. Under this circumstance, the redundant sources of information is beneficial for learning. (Bobis, Sweller and Cooper, 1993; Chandler and Sweller, 1991; Kalyuga, Chandler and Sweller, 1998; Sweller and Chandler, 1994).

The reason why there were no significance appeared between V1’s and V2’s vocabulary recall in the experimental group was somehow because no matter in V1 or V2, there were FL (English) captions embedded in both videos, and thus there were no significant difference between V1 and V2’s vocabulary recall experiment results. Conversely, because the study provided less L1 information with less FL captions in the video (V2), the experimental group students could put full attention to the listening and thus the students in the experimental group performed better in V2’s listening comprehension test. Accordingly, it is inferred that fewer captions may be better for students to practice listening proficiency.

On the other hand, it was because students in the control group who were provided with full L1 (Chinese) subtitles that they hold a higher level of understanding to the plots in V1’s listening comprehension test, although V1 was viewed as a harder one in two videos. However, since the study provide only L1 (Chinese) subtitles with no FL (English) information to subjects of the control group, it was hard for them to do the vocabulary recall, and hence the scores in the V1’s vocabulary recall test was lower than those in the V2’s.

Table 4. ANOVA analysis of listening comprehension of different difficult degrees of videos.

<table>
<thead>
<tr>
<th>Group Treatment</th>
<th>Video Category</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>Pair Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (E)</td>
<td>Hidden the translations of</td>
<td>44</td>
<td>28.18</td>
<td>20.83</td>
<td>26.08*</td>
<td>EV2 &gt; EV1*</td>
</tr>
<tr>
<td></td>
<td>220 sight words (V1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hidden the translations of</td>
<td>44</td>
<td>50.00</td>
<td>18.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000 HFU words (V2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (C)</td>
<td>All L1 (V1)</td>
<td>42</td>
<td>54.76</td>
<td>19.78</td>
<td></td>
<td>CV1 &gt; CV2*</td>
</tr>
<tr>
<td></td>
<td>All L1 (V2)</td>
<td>42</td>
<td>23.33</td>
<td>21.15</td>
<td></td>
<td>CV1 &gt; EV1*</td>
</tr>
</tbody>
</table>

*p<.05
4. Conclusions
This study examined two groups of students with different given amount of L1 (Chinese) subtitles and FL (English) captions. The control group was given full L1 subtitled movie with no FL captions while the experimental group was given filtered L1 subtitled movie with the corresponding FL captions. The findings indicated that although the experimental group received only partial L1 subtitles will not affect learners’ understanding of the listening comprehension. Moreover, the findings further showed that with only filtered L1 subtitles, the experimental group students’ performed statistically better than those in the control group with full L1 subtitles in the vocabulary recall test. While most of the multimedia assisted learning studies laid huge stress on using as much multimedia tools as one can during the teaching process, one of the major contribution of this study was that the results showed although it was partly useful with the help of the multimedia such as L1 subtitles, yet it could also be a distraction toward students’ learning process. Therefore, this study recommended that to avoid distraction from the multimedia distraction, there should be only the needed amount of the multimedia provided. It was not that as much multimedia assisted as better in teaching. For example, when it comes to course design, the instructors should choose appropriate and not excessive amount of multimedia according to the curriculum objectives. Moreover, with a view to achieving the teaching goals properly, the technology-assisted multimedia or tools should take students’ learning level into consideration.

This study found that if students need immediate aid to understand the content, they do not need to be provided with full L1 language. That is to say, the videos or movie series now available on TV showing L1 subtitle may provide opportunities for students to touch foreign language conditions and practice listening, but can actually offer limited training opportunities for learners to recognize vocabulary. To sum up the conclusions in this study and previous studies (Hwang, Chang, & Chang, 2013; Hsu, 2014; Hsu, Hwang, & Chang, 2014), if students want to train their listening proficiency and they have better prior proficiency of that target language, they can use no captions as well as subtitles, or only use the caption as well as subtitle of harder words. If students want to train their listening proficiency but they have poor prior proficiency of the target language, they can use caption which providing full or partial foreign language words and partial subtitles which are the translation of the harder words. If the students also want to recognize or memorize vocabulary during using the video to learn foreign language, they can use captions with full foreign language words and leaving only essential L1 information while only providing L1 subtitle without foreign language captions will not affect the vocabulary recall very well, but just support the immediate understanding to the content.

Accordingly, one of the major contributions of this study is to propose that the importance of foreign language (FL) captions is much higher than the significance of L1 language subtitles. However, previous studies have found that videos with whole foreign language but without any L1’s help will bring a risk of cognitive failure understanding. Still, this study found that full L1 (Chinese) subtitles without any FL(English) captions neither do any good to language learner’s vocabulary recall, but mainly instant comprehension of content. As to how much amount of the L1 information should be left to assist the learners, in fact, this study suggests future research combine with instant or online dictionary at hand or to provide scaffolding based on individual differences.

Still, it might be difficult to claim that the findings in this paper are significant since the number of subjects is not large and the experimental period is relatively short. For that reason, it was worth conducting extended studies with a large number of participants and a longer period of time in the future. Also, it is worth mentioning that the English listening and vocabulary proficiency can’t be achieved or promoted overnight. Still, it is believed that this study could provide a descriptive basis for the following and additional research.
as long as there is a continuing need for and adequate theoretical basis for the practical application of language teaching and learning.

Acknowledgements
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References


Virtual English village: A task-based English learning platform in Second Life

Yu-Ju LANa*, Hsiao-Hsuan WEIb & Ya-Li CHIUb

aNational Taiwan Normal University, Taiwan
bWanfu Elementary School, Taipei, Taiwan

*yujulan@gmail.com

Abstract: The purposes of the current study are to develop a virtual English learning village for elementary EFL learners in Taiwan to allow them to learn English beyond the regular school schedule. Four learning contexts were developed and used by 117 EFL learners from an elementary school in Taipei City for around 5 months. Learners’ motivation of learning English via executing language tasks in this virtual village were evaluated through questionnaire administration. The results reveal learners’ positive perception of the English learning mode as proposed in this study. Thus, a task-based English platform in virtual worlds can be a potential solution to the problems of the lack of authentic contexts nowadays in the traditional EFL settings, and consequently is able to provide elementary-school EFL learners with an immersive environment for building authentic experiences.

Keywords: Virtual worlds, task-based learning, English as a foreign language (EFL), English village

1. Introduction

In the digital era, English is regarded as an international language to which IT is widely applied in various fields around the world. In non-English-speaking countries, such as Taiwan, English proficiency is highly valued as a requisite feature of participating competitively in the international community (Lan, Sung, & Chang, December 2009). Traditionally, Taiwanese students often learn and practice English in static and old classroom activities, instead of learning from genuine or real world simulations of daily life. More and more teachers or scholars believe that a scenario environment is a pivotal component necessary for the acquisition of language (Lan, 2014). A meaningful language must be learned in conjunction with society, culture and personally relevant life experiences (Hedberg & Alexander, 1994; Krashen, 1981).

From this ideological frame of references, 12 elementary schools in Taipei City are selected and supported by the Taipei City Government to establish active and kinesthetic learning environment which is called English Village, hoping that children can begin to dream of a life with a broader and more global perspective. The 12 chosen schools designed the English Villages based on the consideration following specific pedagogical purposes of their own schools. However, similar topics such as airport, local culture, restaurant, post office, hospital, etc. could be found in different Villages owned by different elementary schools. Typically, each English Village is not only used by the students of the elementary school with that Village, but it is also visited by the students from all the elementary schools located nearby in the same educational district due to the limited amount of government budget to support every school to own its own English Village. One obvious problem has been encountered since the Village is established: the lack of opportunity for students to preview the skills needed in experiencing the Village before visiting the setting or reviewing what they have learned or experienced in the setting.

The purposes of this study were to develop and evaluate an authentic learning environment in virtual worlds (Second Life, SL) which aim at providing all the students from the participating or other elementary schools with an immersive environment to pre- and review the materials embedded in
the Village they visit in the real world. The methods are briefly described below, followed by the results and the conclusion.

2. Methods

2.1 Participants

117 students from an elementary school having an English Village (Wanfu English Sky Castle, WESC) in Taipei City, with three learning classrooms (the airport, the world style setting, and the setting with the local culture theme), participated in this study. They came to computer lab, logged in the virtual Village to preview or review what they would or had learned in WESC both before and after they visited the setting.

2.2 Research Design

A qualitative research design was adopted in the study. Students’ perception of English learning in SL was administered and analysed to determine what the participating elementary school learners thought about learning English in such a virtual village.

2.3 Instruments

2.3.1 Usability Questionnaire

The questionnaire used in this study was revised from what was developed by Lan (2014). 22 items of 4-point Likert Scale belonging to 4 dimensions (pragmatic, ease to use, and ease to learn, and satisfaction) are included in the questionnaire to determine the participants’ perceptions of English learning in the virtual village.

2.3.2 Virtual English Village in SL

Four learning contexts aimed at providing students with learning scenarios identical to what they experienced in the real English Village (WESC) were developed in Second Life. The contexts include (1) an international airport for learning check-in and passport control, (2) a ring toss game for learning to play the game in a traditional night market in Taiwan, (3) a food court in a night market for learning the names of foods and sentences used for ordering foods in a night market, and (4) a restaurant for learning to order food in a restaurant. Figures 1 and 2 show the real and virtual contexts in WESC and SL used in this study, respectively.
Figure 1. The Real Contexts in WESC Used in this Study: (1) Airport, (2) Ring Toss, (3) Food Court in the Night Market, and (4) Restaurant.

Figure 2. The Virtual Contexts in SL Used in this Study: (1) Airport, (2) Ring Toss, (3) Food Court in the Night Market, and (4) Restaurant.

2.3 Procedure

The study lasted for around 5 months. Each topic was learned for one month, plus another month for trainings on SL operation and questionnaire administration. At the beginning, all the students received the training on using SL, such as moving their avatars, clicking virtual objects, and answering questions in SL. Then all the participating students went to the computer lab once a week to learn the vocabulary words and sentences needed in experiencing the real English Village in their school. Three-stage activities were designed for guiding students to learn the target materials: firstly, learning vocabulary words by clicking the objects in SL; secondly, learning sentences by listening to the demonstration given by the non-player character (NPC); and thirdly, learning to communicate with the NPC via choosing correct responses. All the learning activities in each stage are self-directed. Besides, students will receive feedback from the system while practicing the conversation. They will be also given rewards from the system for having completed the learning targets. After all the learning stage is completed, a usability questionnaire was administered to all the participants for understanding their perception of the learning mode in SL.
3. Results

Table 1 lists the descriptive results of the usability questionnaire. Based on the data listed in Table 1, it is found that all the dimensions of the questionnaire got pretty high scores from students’ responses (above 3 out of 4) and very low standard deviation (less than .01).

Table 1: The descriptive results of the usability questionnaire.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Scores (N=117)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Pragmatic</td>
<td>3.31</td>
</tr>
<tr>
<td>Ease to use</td>
<td>3.39</td>
</tr>
<tr>
<td>Ease to learn</td>
<td>3.35</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>3.35</td>
</tr>
<tr>
<td>Total</td>
<td>3.32</td>
</tr>
</tbody>
</table>

In addition to the Mean and SD obtained from all the respondents as listed in Table 1, it is also found that for each item of the questionnaire, near 90 percent of the participants expressed that they extremely agree or agree with it that learning English in the virtual contexts in SL benefited their English learning.

4. Discussion and Conclusion

The primary mission of the English Villages is *environmental stewardship, curriculum integration, and a sampling of global cultures*. Using varied subject matters and pedagogies, the English Village aims to develop a variety of lesson formats that can be adapted to the needs of diverse learning styles of elementary school children in keeping with contemporary theories of multiple types of intelligence. By incorporating virtual contexts in virtual worlds into the physical English Village, learning is enhanced by the self-directed and task-based learning platform without special or temporal limitations.

The results of this study are in line with many of the previous TBA researches in SL contexts (e.g., Ellis, 2003; Deutschmann et al., 2009; Grant, 2008; Jee, 2011; Lan, 2014; Nunan, 2004). SL combines network connectivity and virtual reality, providing users with a virtual yet “real” environment in which they can interact socially with others via resident avatars (James, 2005). According to Burdea (1993), a virtual environment consists of three essential features: immersion, imagination, and interaction. Cooke-Plagwitz (2008) suggested that an environment such as SL can inspire language learners to reach learning goals without losing interest or motivation.

Based on the positive results obtained from the current study, it is suggested that virtual learning contexts should be included in regular EFL syllabus for providing elementary school EFL learners with an authentic and immersive English learning which has higher flexibility, lower costs and fewer limitations.

Acknowledgements

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References


Abstract: Good language skills bridge the gaps in global communication. Even though English is being considered the world language, advancing the English proficiency is the primary task in the countries where it is not the mother tongue. The learners’ language proficiency has been found to be correlated with their use of language learning strategies (LLS) (Hsiao & Oxford, 2002; Benson, 2011). That is why measuring the learners’ use of LLS is considered one of the most widely-spread methods of estimating the efficiency of language studies. The skills and habits of strategy use are very individual and usually develop over many years. However, as shown in several studies (e.g. Brunstein & Glaser, 2011; Kondo et al., 2012; Nash-Ditzel, 2010) it is possible to support learners’ language studies leading them to use more effective learning strategies. The aim of the current study was to conduct a literature review on different interventions that have been used to support using effective learning strategies in the context of technology-enhanced learning and drawing on the results of this review to design a model and concrete assignments to support learners’ effective LLS use towards greater language proficiency and self-regulation. The most promising interventions supported both cognitive and metacognitive activities and often utilized the form of prompts. Based on these principles a model was designed for scaffolding language learning assignments in a blended learning environment. Support for learners is provided with prompts that aim to guide learners to more efficient and conscious use of LLSs.

Keywords: language learning strategies, language proficiency, self-regulation, intervention

1. Introduction

The widespread use of learning technologies in different educational settings has generated the growing need for students to self-regulate their learning activities (Bannert & Reimann, 2012), assuring independence and learner autonomy when directing their studies. When in traditional classroom students may stay passive knowledge receivers, learning in technology-enhanced environments presumes learner autonomy, abilities to self-analyze and self-regulate their learning activities. Many studies have identified a significant positive correlation between academic achievement and self-regulated learning ability (Dabbagh & Kitsantas, 2005; Schunk & Zimmerman, 1994) which indicates that good learners typically have good self-regulating learning abilities. However, students rarely demonstrate adequate skills of self-regulation which in turn hinders to achieve satisfactory academic outcomes (Lee et al., 2010; Kiewra, 2002). Similar deficit of self-regulated learning skills has been reported in the studies of language learning (Benson, 2011). The learner’s use of language learning strategies is considered one way of assessing the efficiency of his language studies (Hsiao & Oxford, 2002) as strategy use is connected with language proficiency and have much potential for enhancing learning, learner autonomy, independence and self-regulation (Wong, 2011).

Self-regulated learning skills are of crucial importance to be academically successful, at the same time they seem to be complicated learning skills to acquire. Therefore, the most efficient ways to support learners’ cognitive and metacognitive learning strategies have to be found and instructed. As there is no single understanding of an efficient way of scaffolding self-regulation, the focus of the current study is (1) to find out the most effective supports and conditions for scaffolding self-
regulation reported in empirical studies, and (2) on the basis of them to develop a model with specific assignments to assist self-regulated language learning mechanisms in a blended English language course (English for Specific Purposes). When developing the model we drew on the theoretical frameworks of LLSs by R. Oxford (1990) and self-regulation by P. Pintrich (2000). Subsequently, the theoretical frameworks we proceeded from, will be introduced.

2. Models of learning and learning strategies

Many constructivist learning theories and models emphasize the role that self-regulation plays in the learning process. The theory of strategic learning (Weinstein, 1994) is focused on students as active, self-determined individuals who process information and construct knowledge. The model has placed the learner at its core, and surrounds him with three interactive components that explain successful learning: skill, will, and self-regulation. Skill refers to the actions or thinking processes which are related to recognition of key concepts and processes, and how meanings are constructed. Will indicates individual learning attitudes, acceptance of new information, will to concentrate and make efforts, and anxiety toward his own learning performance. Self-regulation describes the learner’s ability to manage his personal learning process, especially how to plan, monitor, focus on and evaluate his own learning. Categorized by the above three components, the learning strategies refer to any thoughts, behaviours, beliefs or emotions that facilitate the acquisition, understanding or later transfer of new knowledge and skills (Tsai, 2009). This general framework coincides with the approach to contemporary language learning supporting the principles of communicative language learning and metacognition. In the following subsection, an overview of the most dominating classification of LLSs is given.

2.1 Language learning strategies

Different classifications of language learning strategies have been produced by many researchers (Rubin, 1975; Stern, 1975; O’Malley & Chamot, 1990) that gave their input to the six-strategy taxonomy of Rebecca Oxford, designed in 1990. Strategies are the learner’s toolkit for active, conscious, purposeful and attentive learning, and they pave the way towards greater proficiency, learner autonomy and self-regulation (Hsiao & Oxford 2002). According to Oxford, LLSs have the features of contributing to the main goal, allowing learners to become more self-directed, being problem-oriented, including specific actions taken by the learner, involving many aspects of the learner, not just cognitive, supporting learning both directly and indirectly, being not always observable, being conscious, possible to be taught, flexible, and influenced by a variety of factors (1989). The system of LLSs developed by Rebecca Oxford is believed to be more comprehensive and detailed than earlier classification models by her predecessors (Jones, 1998). Oxford divided the LLS into two main categories: direct and indirect ones (Table 1). Direct strategies including memory, cognitive and compensation subgroups, directly involve the target language, such as reviewing and practising. Indirect strategies - metacognitive, affective and social ones, provide indirect support for language learning, such as planning, cooperating and seeking opportunities.

<table>
<thead>
<tr>
<th>Direct strategies: directly involve the target language, such as reviewing and practising</th>
<th>Memory strategies: aid in entering information into long-term memory and retrieving information when needed for communication</th>
<th>* Creating mental images</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>* Applying images and sounds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Reviewing well</td>
</tr>
<tr>
<td>Cognitive strategies: used for forming and revising internal mental modes and receiving</td>
<td>* Practising</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Receiving and sending messages</td>
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</table>
Oxford considered both cognitive and metacognitive strategies necessary for efficient language learning and so they are both comprised in her framework (1990). In the context of language learning, the role of metacognition is frequently emphasized but it is not defined clearly enough. To be able to assess the learners’ use of metacognitive strategies and self-regulation in general, it is important to understand the construct, its components and their interaction.

2.2 Self-regulated learning

There are several theories of self-regulated learning and numerous definitions which are important to understand the issues in this context. One of the initial, fundamental definitions comes from Bandura (1986), who incorporating it into his social cognitive theory of human behaviour, viewed self-regulation as the process of influencing the external environment by engaging in the functions of self-observation, self-judgment, and self-reaction. Drawing on his works, Zimmerman (1986) defined self-regulated learning as the process where students activate and sustain cognitions and behaviours systematically oriented toward the attainment of their learning goals. Winne (1996) accents the metacognitive perspective defining self-regulated learning as a metacognitively-governed behaviour where learners regulate their use of cognitive tactics and strategies. Another distinction between models of self-regulation is the postulated influence of the situation on self-regulation behaviour. Boekaerts (1997) defines self-regulated learning as a complex interaction between (meta)cognitive and motivational regulation. In her model that consisted of six components she differentiated both regulation systems in relation to three levels (goals, knowledge, and cognitive strategies).

The theories agree that self-regulated learning is an active and constructive process whereby students regulate different cognitive, metacognitive, motivational, volitional and behavioural processes during their learning (Winters et al, 2008). The numerous models of SRL that propose different constructs and conceptualizations share some general assumptions and features. Subsequently, Pintrich’s framework based on Zimmerman’s cyclical three-phase model and four assumptions will be explained.

| and producing messages in the target language | Analysing and reasoning |
| **Compensation** strategies: needed to overcome any gaps in knowledge of the language | * Guessing intelligently |
| **Indirect strategies**: provide indirect support for language learning, such as planning, cooperating and seeking opportunities | * Overcoming limitations in speaking and writing |
| **Metacognitive** strategies: help learners exercise executive control in planning, arranging, focusing, and evaluating their own learning process | * Centring your learning |
| **Affective** strategies: enable learners to control feelings, motivation and attitudes related to language learning | * Arranging and planning your learning |
| **Social** strategies: facilitate interaction with others, often in a discourse situation | * Evaluating your learning |
| * Lowering your anxiety | * Taking your emotional temperature |
| * Encouraging yourself | * Asking questions |
| * Taking your emotional temperature | * Cooperating with others |
| * Centring your learning | * Empathizing with others |
2.2.1 Pintrich’s conceptual framework for self-regulated learning

Pintrich’s general framework for theory and research is based on four assumptions: active, constructive assumption; potential for control assumption; goal, criterion or standard assumption; and finally, mediators between personal and contextual characteristics and actual achievement or performance (2000). Drawing from these assumptions he defined SRL as an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment (Pintrich, 2000). His framework is a complete and comprehensive model that enables to describe a very complex concept of self-regulated learning. In his model Pintrich described the regulation of a learning process in four areas: cognition, motivation and affect, behaviour and context. In these areas he distinguished four phases: forethought and planning, monitoring, control and reflection. Regulation is the keyword which covers all phases and areas. Although Pintrich’s framework is very elaborate and describes the system of strategies in detail, his instrument (Motivated Strategies for Learning Questionnaire) for measuring learners’ strategy use which draws on his framework does not provide satisfactory factor structure or model fit indices (Davenport, 2003; Dunn et al., 2011; Hamilton & Akhter, 2009; Saks et al., 2014). That is why researchers are still looking for more reliable theories and designing more fit measuring instruments to assess learners’ self-regulation (see e.g. Toering et al., 2012).

3. Supporting learners’ self-regulated learning strategies

Acquiring sufficient self-regulated skills and this way reassuring better academic achievements (Dabbagh & Kitsantas, 2005; Schunk & Zimmerman, 1994) cannot be considered self-evident. These skills have to be instructed and supported throughout the whole learning process. This is a challenge for instructional designers and teachers to develop and apply effective strategies and encourage learners to develop their self-regulated learning skills in the learning process. The aim of the current study was to find out the most effective supports and conditions for scaffolding self-regulation reported in previous empirical studies. The following is an overview of the studies describing the most efficient interventions.

There are several effective ways to support learners self-regulation, starting with designing SRL assisted mechanisms in personalised e-learning systems (Chen, 2009) to persuasive mobile textings (Goh et al., 2012) and elaborated training programs (Bannert & Reimann, 2012). Based on researches attempting to support self-regulated learning Bannert identified three principles for effective intervention: first, instruction on self-regulated learning must be integrated with the domain-specific instruction being embedded in the subject matter; second, the application conditions and the usefulness of taught self-regulated learning strategies must be explained to students. Otherwise, students may feel disturbed and interrupted, and will not use them. To avoid this it is recommended to model and explain how these conditions support their learning. And third, it is important that sufficient training time is provided in order to internalize and automatize the self-regulated learning strategies and skills. (Bannert & Reimann, 2012). SRL can be supported following different principles. Hannafin distinguishes four types of scaffolds: conceptual scaffolding consists of aids that guide students’ understanding of content. It guides learners regarding what to consider (Hannafin et al., 1999). Metacognitive scaffolding supports the underlying processes associated with individual learning management. It guides students’ ways of thinking and reflecting on their task (e.g., training and prompts for self-monitoring and reflection). Procedural scaffolding shows how to utilize available resources and tools orienting to system features and functions. Strategic scaffolding involves alternative approaches to learning activity supporting analyzing, planning, strategy and tactical decisions (Hannafin et al., 1999).

Earlier researches have provided evidence that the most efficient support for learner’s self-regulation is combined metacognitive scaffolding. Berthold (2007) used the combination of prompting and writing learning protocols for self-evaluation and feedback. Based on the results of several content
and self-report tests and content analysis of learning protocols he reported that using prompts stimulated the elicitation of cognitive and metacognitive learning strategies. Also, academic results were better in the groups who received cognitive or the combination of cognitive and metacognitive prompts. The author concluded that cognitive and metacognitive strategies are not independent of each other but complementary. Metacognitive strategies control and regulate cognitive ones (Berthold et al., 2007). These findings are supported by Brunstein and Glaser (2011) who also prompted using cognitive (writing) strategies with self-regulated ones. Assessing the learners’ writing skills (story quality, plan, text revisions, writing knowledge) and self-efficacy they concluded that an intervention that combined the instruction of writing strategies with self-regulation skills exerted a strong, coherent, and sustainable influence on procedural (planning and revising), declarative (knowledge), and self-related (self-efficacy) aspects of writing promoting novice writers’ compositional achievements. Lee and his colleagues presented a study which examined the effects of two scaffolding strategies on learners’ comprehension and self-regulation (2010). They combined generative learning strategy prompts and metacognitive feedback. Based on the results of knowledge and self-report SRL questionnaire (MSQL) they summarised that generative learning strategy prompts with metacognitive feedback improved learners’ self-regulation and use of generative strategies and, accordingly, their learning performance. In contrast, generative learning strategy prompts without metacognitive feedback improved only learners’ use of generative strategies (Lee et al., 2010). Similar effective metacognitive scaffolds have also been reported by Kramarski and Michalsky (2009; 2010) and Kramarski and Gutman (2006) who used IMPROVE self-questioning model.

Metacognitive scaffolding enables to foster several self-reported aspects of SRL, including self-monitoring, strategy use and interest (Winters et al., 2008) whereas the best results are achieved in the combination of cognitive and metacognitive support. With this knowledge we start designing our model for supporting learners’ self-regulated learning skills.

4. Model development and an example of supporting cognitive and metacognitive strategies in an ESP course

Taking the theoretical frameworks of LLSs by Oxford (1990) and self-regulated learning by Pintrich (2000) as a basis, we developed a model for supporting learners’ cognitive and metacognitive learning strategies for the blended English for Specific Purposes (ESP) course. Pintrich has distinguished four areas for SRL (cognition, motivation and affect, behaviour, and context) (Pintrich, 2000). In this study we will focus on the area of cognition and behaviour throughout all four phases. Cognitive and metacognitive strategies were supported concurrently as the evidence has shown that combined scaffolding of the two gives the best results in the support of self-regulation as well as content knowledge (Berthold et al., 2007; Brunstein & Glaser, 2011; Lee et al., 2010).

For this course, four specific language learning assignments were created to support the development of students’ metacognitive and cognitive LLSs (Table 3). The assignments were specially designed to take maximum advantage of the affordances of the digital learning environment (Moodle). Special attention was paid to students’ active use of language when solving problems connected with real-life situations in the tourism industry (Tasks 3 and 4). The four assignments were accompanied by other tasks which are carried out in the class in the course of regular studies: reading and analysing texts, summarizing, comparing and contrasting etc. Students’ interaction and communication are encouraged throughout the whole learning process, as well as in preparatory and follow-up phases. All learning activities are reflected orally in the classroom as well as in written form in students’ learning diaries.

The first assignment designed for the intervention is compiling a learning plan. It starts with oral discussion in the class where students are prompted to think on the goals they could have when starting the course, also their needs considering their level of language skills, the cognitive strategies they are used to employing when learning a language, the ways of assessing and giving feedback that could be most beneficial for them. If this is a new activity for students it is important to encourage them to open up and express their doubts and expectations. It is also important to explain why it is necessary to set goals and plan their activities beforehand. As a follow-up activity, the students, following the prompts, write their answers to the digital learning plan which will be the first
submission of their learning journals. Learning plan is not a finished document. Students are encouraged to return to it any time they feel that they could change or complete it. It is important to explain to the students that learning plan is an open document and their entries can be modified according to their needs, interests and level of development. The digital learning journal serves as a diary where students record their thoughts and impressions of the learning process. The journal, which is visible only for the learner himself and the teacher, gives information about the student’s progress, problems he may face as well as his self-monitoring skills. This is also the place where the teacher can give feedback to students’ progress and answer his questions.

The second assignment is writing an essay. The reason why this assignment was included in intervention was its focus on supporting reading, writing and compensation as cognitive strategies in addition to metacognitive ones. It starts with the class discussion again where the students are explained the assignment and interest towards the task is aroused. Subsequently, the prompts are used to activate students’ prior content knowledge and metacognitive knowledge. This is followed by setting goals, making plans for writing and time planning. The strategy use which is prompted in the class activities is basically metacognitive. The cognitive strategies students need for writing are prompted in the digital learning environment in the form of questions and study-tips. These are accompanied by metacognitive prompting for monitoring and self-evaluating. Figure 1 illustrates a sample of metacognitive prompts on planning.

As a follow-up activity in the class, the discussion on the whole writing process will be encouraged. Students are asked to share the problems they faced when writing, regulation processes they took up to overcome the problems and they are also asked to self-evaluate their activity throughout the whole process.

The third and fourth assignments are both pairworks and follow the same structure – collecting information about a destination or certain tourism enterprises, compiling the summary and making a presentation on the results. The main value of this task is its possibility to connect the real-life situation with language learning. The tasks are set this way that learners have to solve authentic problems using authentic materials and be able to justify their decisions. Similarly to the previous task, they also start with the class discussion to arouse interest and activate prior content and metacognitive knowledge. Since these tasks are pairworks and students set goals, plan their activities and time schedule, and divide the tasks together, it is important to apply social and active language use
strategies. Also, the independent work in the digital learning environment which follows the preparatory work in the class, demands from students employing various cognitive and metacognitive strategies which are prompted throughout the tasks. The oral presentations in the class are followed by reflection of the whole process. Students are encouraged to share their impressions and self-evaluate their activity as an individual and as a pair.

When developing the model special attention was paid to providing the assignments with appropriate prompting, cognitive as well as metacognitive. Earlier studies have proven that the frequency of use of certain self-regulatory processes are consistently associated with learning gains, (Winters et al, 2008), therefore similar structure and similar logic of prompting has been used throughout the course. The model and the efficiency of the developed scaffolding will be tested within further researches.
<table>
<thead>
<tr>
<th>TASK 1</th>
<th>TASK 2</th>
<th>TASK 3</th>
<th>TASK 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Plan</strong></td>
<td><strong>Essay</strong></td>
<td><strong>Evaluating Destination</strong></td>
<td><strong>Comparing Three Tourism Enterprises</strong></td>
</tr>
<tr>
<td>Goals for the course, setting priorities for the activity, planning the resource materials, working on essay</td>
<td>Setting goals for the task, planning the activities, working with resource materials, making a plan</td>
<td>Setting goals for the task, dividing tasks, planning the activities, working with resource materials, making a presentation</td>
<td>Setting goals for the task, dividing tasks, planning the activities, working with resource materials, making a presentation</td>
</tr>
<tr>
<td>Oral expression, discussing, justifying opinion</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
</tr>
<tr>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
</tr>
</tbody>
</table>

**Level 1 - Independent Work in the Classroom**

**Level 2 - Independent Work in the Web-based Environment**

**Strategies Supported with Prompts**

<table>
<thead>
<tr>
<th>TASK 1</th>
<th>TASK 2</th>
<th>TASK 3</th>
<th>TASK 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Plan</td>
<td>Essay</td>
<td>Evaluating Destination</td>
<td>Comparing Three Tourism Enterprises</td>
</tr>
<tr>
<td>Work on the materials, working on essay</td>
<td>Making a presentation</td>
<td>Making a presentation</td>
<td>Making a presentation</td>
</tr>
<tr>
<td>Oral expression, discussing, justifying opinion</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
<td>Oral expression, discussing, justifying opinion, making a presentation</td>
</tr>
<tr>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
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<td>Reading and writing strategies, critical thinking, self-monitoring</td>
<td>Reading and writing strategies, critical thinking, self-monitoring</td>
</tr>
</tbody>
</table>

**Table 3: Model for supporting cognitive and metacognitive strategies in a blended ESP course.**
Conclusion

The evidence has shown that for supporting students’ language studies and proficiency and for enhancing their self-regulated learning skills, the use of their cognitive and metacognitive learning strategies has to be scaffolded (Brunstein & Glaser, 2011; Kondo et al., 2012; Nash-Ditzel, 2010; Wong, 2011). Based on earlier studies (Berthold et al., 2007; Brunstein & Glaser, 2011; Lee et al., 2010; Kramarski & Michalsky, 2009, 2010) we may confirm that learner’s self-regulation can be supported, and the best results are provided by metacognitive scaffolds which are also the most frequently used type of scaffolding. Former studies have also proved that self-regulation is most efficiently enhanced by the combination of different strategy scaffolding, basically cognitive and metacognitive. The main utilized form of strategy support is prompting.

On the basis of the results of the analysis, a model and concrete assignments were developed to support learners’ cognitive and metacognitive strategies. For intervention four specific language learning assignments were designed and accompanied with prompts. Prompting scaffolds strategy instruction in the classroom as well as in the digital learning environment. While designing the model it was considered necessary to provide various phases of the tasks with prompts of cognitive as well as metacognitive strategies. Students are supported to monitor and self-evaluate their learning activities and self-efficacy with constant discussions in the class. The model and the efficiency of the developed scaffolding will be tested within further researches.

References


The Impacts of Using Interactive E-book on the Learning Effectiveness of English blank-filling cloze

Gwo-Jen HWANG\textsuperscript{a}, Yi-Hsuan HSIEH\textsuperscript{a}, Ching-Jung HSUEH\textsuperscript{a}, Ching-Kun HSU\textsuperscript{b}\textsuperscript{*}
\textsuperscript{a}Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan
\textsuperscript{b}Department of Technology Application and Human Resource Development, National Taiwan Normal University, Taiwan
\textsuperscript{*}ckhsu@ntnu.edu.tw

Abstract: This study used interactive e-book in English instruction and explored its benefits as well as negatives of 9\textsuperscript{th} grader students' learning achievements in the English blank-filling cloze test. A questionnaire is used to investigate students' "perceived usefulness" and "perceived ease of use" toward using the interactive e-book in learning English. To find out the effects of using interactive E-book on English blank-filling cloze test, a four-lesson experiment was conducted in the English course in a junior high school. The experimental results show that although the students using interactive e-book did not outperform the ones receiving conventional instruction in learning English, the statistical feedbacks in terms of "perceived usefulness" and "perceived ease of use" on the questionnaire showed that the students highly appreciated and accepted the interactive e-book learning activity.

Keywords: e-book, blank-filling cloze test, learning achievement, perceived usefulness, perceived ease of use

1. Background and objectives

1.1 Introduction

In the exam-oriented society, English is crucial for Taiwanese students. It is not only the first foreign language they learned in elementary school but also the fundamental key to successfully entering their ideal schools. What your English skill level is seems to be a significant qualification that everyone has to concern for studying or job-applying. With the state-of-the-art technology development, learners’ learning habits change. The prosperity of the Internet and the trend of online application alter the traditional way people acquire the information thoroughly. Moreover, the new-generated knowledge revolution in reading and publishing shows that reading is not just reading, and books are not just books. Thus, the paper-texted books have been transformed into digital materials. To cater readers’ multiple tastes, digitalizing the reading materials has been taken for granted.
People born from the mid-1990s to 2000s are called “Z generation,” or “the Internet Generation.” Most of them grow up in a technology-surrounded environment and they have plenty of chances to obtain abundant multimedia information. Among them, electronic picture books, a kind of literature in digital format edited for children to read, are included. (De Jong & Bus, 2002; Korat, 2009) Some scholars pointed out using educational electronic book as a tool can support children’s literacy. Learning from a familiar electronic book makes students close to their own learning styles.

However, the e-books not only have digital characteristics to make students more attentive, but also have various interactive ways to promote readers’ reading effectiveness (De Jong & Bus, 2003, 2004). On the other hand, some scholars pointed out that we should encourage teachers in the language field use computer technology combining teaching strategies to improve the negative reading effectiveness (Adam & Wild, 1997).

1.2 Purpose of this study

As for the academic subject, English, the level for senior high is much higher than it for junior, especially in the numbers of recognized words. The learning gaps make freshmen who just attend senior high frustrated. In addition, lots of students claim that they can hardly find the key points to answer the English blank-filling close test.

The researchers for this project are both high school English teachers. According to the curriculum plan by The Ministry of Education in Taiwan, junior high school students need to know 1200 basic words and 2000 advanced words. Furthermore, 7000 recognized words for senior high school students. Thus, we decided to teach students the words formation rules. In other words, we show them the concept for distinguishing prefixes, roots words and suffixes. We are looking forward to helping students memorize new words by decomposing English words and lightening their learning burdens.

The teaching material adopted from the senior high English textbook, New Fareast version by Professor Chen Chunyin. In accordance with the schedule, we focus on Book 1 Lesson 7 (Into Aesop’s World). Meanwhile, we make some extension to teach students the general rules to distinguish the morphological features and make introductions about some common slang about animals. Within the teaching process, we make use of the interactive characteristic of E-books to promote students’ learning motivation and intensify their learning effect. What we do makes students pay less effort but achieve more. Most important of all, it can lower the cognitive loads and mental efforts.

The English blank-filling cloze test is considered tougher than any other part in the English test. To get high score, students have to recognize the words, the morphological features and idioms. The coherence between semantics and syntax is important as well. Consequently, in this study, an experiment has been conducted on the “the impact of using
interactive e-book on English blank-filling close test.” To evaluate the effectiveness of the proposed approach, the following research questions are investigated.
(1) Does the interactive e-book learning have negative or positive impact on the learning achievements of the students?
(2) Do the students who learn with the interactive e-book highly perceived usefulness and perceived ease of use?

2. Literature review

2.1 e-books

By means of the specialty of the computer multimedia, e-books including learning materials like texts, pictures, voices, videos and animations give readers a whole new reading experience. The so called e-books don’t necessarily have the form of “books”, but using all types of screen devices to combine specific software reading the digital contexts. They are in place of the traditional paper reading in the past.

The main purpose of the e-book topic aims to make students utilize this e-book to review after school on their own. Moreover, researchers look forward to making all students understand the learning contents by themselves. Diminishing the uneven educational development like “twin-peak” phenomenon and shortening the urban-rural gaps of the students’ learning achievements are the researchers’ top priorities.

Basically, the e-books are divided into two categories. One is for Reading Only and the other is for Reading and Playing. The former one focus on pronunciation of the whole article, but lacks of interactive games. On the contrary, Reading and Playing provides interactive games, multimedia effects and all kinds of animations. By clicking the hyperlink, readers have lots of chances to practice reading skills. (De Jong & Bus, 2003) This study belongs to the category of Reading and Playing. Inclusive of animations and multimedia effects, the e-book combining learning materials and interesting games makes students impressed while learning and motivates their learning interests.

2.2 Interactive multimedia teaching

Based on the instructional quality of the interaction, Misanchuk and Schwier (1992) identified three levels of interaction, namely reactive, proactive, and mutual interactions. (1) A reactive interaction: It is a response to a given question. Using the repetitious practices help learners to construct basic concepts. (2) Proactive interaction: According to learners’ learning experiences, the system makes examples to help them interpret the concepts and present the learning materials in an understandable way. Learners can adopt the hierarchical structure as the most appropriate approach and enjoy the freedom to read the content wholly or partially. (3) Mutual interaction: In a mutual interaction environment,
the learner and system are mutually adaptive in reactions with each other. Based on the data that the learners imported, the system will classify the thinking patterns of the learners and arrange suitable learning environment for learners to choose from under different learning situations. Besides, the system will show the consequence of different options. Through these constructive advices, learners read in an appropriate environment.

This study is in the form of reactive interaction. Researchers use teaching games and multimedia effects within the e-book like familiar topics and pictures to help learners practice repeatedly and acquire the concept constructively.

In sum, the main purpose of this study is to help learners to learn through the e-book anywhere, anytime without the assistance of others. Not limited to school time or any learning field. As long as the learners want to learn, he can download the e-book that he needs immediately. In this way, students’ learning will be neither interrupted nor limited. Researchers hope that every student can study independently and be comprehensive about the learning materials through the e-book. Most important of all, improving the “twin-peak” phenomenon and shortening the urban-rural gaps of the students’ learning achievements can solve the uneven distribution of the teaching resources and human resources problem.

3. Experiment design

3.1 Participants

The subjects included two classes of 9th graders of a private high school in New Taipei City, Taiwan, R.O.C. A total of 109 students voluntarily participated in the study. One class was assigned to be the experimental group and the other was the control group. There are 54 students in the experimental group, who use interactive e-books to learn, while there are 55 students in the control group, who learn by the traditional way of the lecture and the worksheets. The average age of the subjects was 15. The experiment was conducted in the Advanced Placement English course. All of the students were taught by the same instructor who had taught the English course for over 10 years.

3.2. Instruments

The learning achievement test was developed by two experienced teachers. The questions in the test sheets were adapted from the teaching material in class. The pre-test scores were collected from the blank-filling cloze test in the weekly test student already took before the learning activity. The pre-test aimed to evaluate students’ prior knowledge toward the blank-filling cloze test. The study collected 6 times of the scores. Every test consisted of five multiple choice questions, and each question accounts for 1 point, with a total of 6 times of the scores of 30. The post-test was 30 questions, and each question
accounts for 1 point, with a total of the scores of 30. The post-test aimed to evaluate the students’ learning achievement in the learning activity.

The questionnaire used to evaluate students' “perceived usefulness” and “perceived ease of use” was adapted from Chu, H. C., Hwang, G. J., Tsai, C. C., & Tseng, Judy C. R. (2010) using a six-point Likert rating scheme. The questionnaire included 9 items, such as “I think it is helpful to use this kind of learning mode when learning something new.”; “I don’t need to spend too much time or energy during the learning process”

3.3. Experimental Procedures

Before the experiment, the two groups of the students took a pre-test, which was a regular part of the test every week. During the learning activity, the students in the experimental group learned with the interactive e-books, while the students in the control group learned with the conventional way of lecture and the worksheets. It was worth mentioning that the way with which the control group learned was just the way they used to do. That is, the students in the control group reflected the way students’ learned with conventional paper-based instruction before. The whole teaching procedure lasted for 4 periods of the class in a total of 200 minutes.

After the learning activity, students took the post-test and completed the questionnaire of the “perceived usefulness” and “perceived ease of use” to evaluate students’ learning achievement and their perceptions toward the “perceived usefulness” and “perceived ease of use”.

4. Research results

4.1. Analysis of learning achievements

The purpose of this study was to examine the impact of using interactive e-book on
English blank-filling cloze test. The pretest scores of the two classes are not significant ($t = 1.20; p>.05$). After the independent t-test on the post-test ($t = 0.87; p> .05$), the results still showed no significant differences in test scores between two groups. Consequently, this study implied that the junior high school students using e-book to instruct foreign language could not make sure to outperform those using paper-based instruction when learning the blank-filling cloze.

Table 1. t-test of the pretest and post-test

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pre-test Mean</th>
<th>Pre-test SD</th>
<th>Post-test Mean</th>
<th>Post-test SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental group</td>
<td>54</td>
<td>16.15</td>
<td>6.12</td>
<td>11.78</td>
<td>7.16</td>
<td>1.20</td>
</tr>
<tr>
<td>Control group</td>
<td>55</td>
<td>14.53</td>
<td>7.90</td>
<td>10.58</td>
<td>7.24</td>
<td>0.87</td>
</tr>
</tbody>
</table>

4.2. Analysis of “perceived usefulness” and “perceived ease of use”

In order to understand students’ “perceived usefulness” and “perceived ease of use” toward interactive e-books, the study utilized a questionnaire to evaluate. As shown in Table 2, the average perception of the “perceived usefulness” of the experimental group was 4.28 out of a Likert 6-point scale, it meant students hold a positive attitude towards the “perceived usefulness”; and the average “perceived ease of use” of the experimental group was as high as 4.21 out of a Likert 6-point scale, showing the students generally agreed that interactive e-book is easy to operate. To sum up, the study results suggest that students' hold a positive attitude toward learning with interactive e-books. Although the learning effectiveness of using e-books in practicing blank-filling cloze was not significantly better than the learning effectiveness of paper-based instruction, the students were willing to accept new technology in language learning. Therefore, future learning will not be limited in paper-based instruction.

Table 2. Descriptive data of “perceived usefulness” and “perceived ease of use”

<table>
<thead>
<tr>
<th>Category</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>perceived usefulness</td>
<td>54</td>
<td>4.28</td>
<td>0.74</td>
</tr>
<tr>
<td>perceived ease of use</td>
<td>54</td>
<td>4.21</td>
<td>0.85</td>
</tr>
</tbody>
</table>

5. Discussions and conclusions

This study integrates the interactive e-books into English teaching, hoping to assist students’ skills in answering questions in the English blank-filling cloze test. It expected that the effectiveness of learning English blank-filling cloze could be not decreased due to the interference of electronic media. The experimental results of this study found that the
learning achievement of e-book instruction was as good as paper-based instruction. There was no significant difference between the e-book instruction and paper-based instruction. Furthermore, the students’ feedback from the questionnaire shows that interactive e-book really enhance students' interest in learning English. The students in the experimental group highly perceived usefulness and ease-of-use on average. Through the operation of e-books and educational games, students look forward to each page of the e-books and anticipate the surprise the books bring to them. During the experimental process, the researchers find that students, even the low-achievers who were easily doze off in class, actively participate in classroom activities with the help of the e-books.

The pictures and games embedded in the e-books succeeded attracting the attention of students, allowing them to reveal a pleasant smile in the learning process, and hence the atmosphere in the classroom is happy and harmonious. Integrating technology into teaching create a win-win situation for both teacher and students. Although due to limited funds and manpower, students cannot hold and operate a Tablet PC individually to use e-books this time, yet this interactive e-books system truly presents the learner-centered, teacher-assisted blueprint. Students think jointly the content of e-books, discussing with each other, and giving immediate feedback. All these improve the learning outcomes and the classroom atmosphere. After school, students can also download e-books to do the review or preview from the cloud space.

Although the subjects were all from high school Advanced Placement classes, those students still have to prepare the Comprehensive Assessment Program for Junior High School Student. These subjects may therefore like candles burning at both ends; they cannot very well prepare the high school curriculum. Thus, the learning achievement research results are not significant. However, feedback from the questionnaire which shows that considering the “perceived usefulness” and “perceived ease of use”, the experimental group highly approved and accepted interactive e-books. Nevertheless, the main limitation of this study is the time limitation. Because graduation ceremony and educational examinations are around the corner, the experiment cannot last long. The study recommends that for the future study, the experiment time may require a month at least, the effectiveness will be more obvious.

Acknowledgements
This study is supported in part by the Ministry of Technology and Science in Taiwan under contract numbers: NSC 102-2511-S-003-055-MY2, MOST 103-2628-S-003-003-MY2, and NSC 102-2511-S-011-007-MY3.
6. References


Correlation of English Test Outcome From TVE Joint College Entrance Examination of Taiwan VS. Professional English Reading Speed and Comprehension

Hong-Fa HO\textsuperscript{a}, Yi-Yeh CHUNG\textsuperscript{a}, Chen-Ku LIN\textsuperscript{b}, Chen-Hsiung LIN\textsuperscript{c}, & SOH O-K\textsuperscript{d}

\textsuperscript{a}Department of Electrical Engineering, National Taiwan Normal University, Taiwan (R.O.C.)
\textsuperscript{b}Ph.D. Graduate Institute of Political Science, Taiwan Normal University (R.O.C.)
\textsuperscript{c}Department of Industrial Education, National Taiwan Normal University (R.O.C.)
\textsuperscript{d}School of Languages & Linguistics, University Kebangsaan Malaysia

\* 3rrr168@gmail.com

Abstract: Educators throughout history have tried to evaluate the different aspects of learning performances. Notice the importance of learning for understanding and time spend studying, this research explores the correlation based on performance outcome from English examination of the English as foreign language (EFL) participants to professional English reading performances on reading speed and reading comprehension, using eye chasing device for observation. 15 student volunteers with technical background participated with experiment. SPSS 21 was used for descriptive and Pearson correlation statistics, with both hypotheses accepted on positive correlation among the English testing outcomes of technical background participants, who have recently completed their Technological and Vocational Education Joint College Entrance Examination of Taiwan 2014, and professional English reading speed and comprehension. Realizing that prior knowledge helps with reading, the authors recommend the use of intensive reading practices of both contextual and graphical images while training the EFL learners. Once they build up solid foundation of broader knowledge, they will be able to read faster and comprehend better.

Keywords: English subject testing outcome (from Technological and Vocational Education Joint College Entrance Examination of Taiwan, TVE JCEET), reading speed (RS), reading comprehension (RC), eye chasing device (ECD), professional English reading (PER)

1. Introduction

1.1 Purpose and Objective

Educators throughout history have tried to evaluate the different aspects of learning performances (Alexander, 2000). Knowing the importance of learning for understanding and time spend studying, this research explores how testing outcome of the participants of English test of Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET), from vocational and technical high school, correlate with professional English reading performances on reading speed and reading comprehension, using the eye chasing device for observation. This research aims at finding possible answers on both technical and vocational students’ visual reading formation. The research also attempts to offer suggestion on the way to improve EFL students’ visual learning with education. To serve these purposes, the authors have come up with the following objectives:

1. To explore the differences of English subject testing outcome (from Technological and Vocational Education Joint College Entrance Examination of Taiwan) and professional English reading speed among technological and vocational students.
2. To detect the relationship between English subject testing outcome (from Technological and Vocational Education Joint College Entrance Examination of Taiwan) and reading comprehension among technological and vocational students.
2. Literature Review

2.1 Background on Reading Comprehension

A growing number of eye chasing tests have yielded a handful of findings relevant to reading experiences (Biedert, Buscher, & Dengel, 2010; Lowell & Morris, 2014; Mayer, 2010). Nevertheless, using eye chasing application to identify the implication between English testing outcome of TVE JCEET, and professional English contents’ reading speed and reading comprehension have not been examined. Hence, the authors attempt to fill the gap.

Paivio (1990)’s dual coding theory helps on explaining the reading comprehension through text-diagram representations. The theory describes that the text and diagram representations are deposited in various cognitive systems due to variety of physical formats (Clark & Clark, 2010; Ho, Tsai, Wang, & Tsai, 2014; Paivio, 1990). Therefore, a combination of scanning or reading diagram and text both could be intensely used to synthesize and enhance cognitive information processing for comprehension than using text or diagram alone (Clark & Clark, 2010). The combinations are important because the information are imperative knowledge for speed of processing and understanding and they can also be expanded for broad range of advanced learning, convert into skills for processing and application, and as outcomes of performance output (Lin, 2011; Orquin & Mueller Loose, 2013). It is stated that the longer the duration time was, based on former research experimental results, the greater the amount of attention that was allocated and accessed (de Koning, Tabbers, Rikers, & Paas, 2010; Ho et al., 2014).

The more the readers know about the subject, the easier the reading understandings the reader gains. The authors therefore perceive that familiarity with professional English subject contents may also reflects on the timing of reading and gazing at professional English articles. Efficient readers trigger their prior knowledge for reflecting on their schemata, predicting the layouts and outcomes, generalizing and actively reading for answers, as these characteristics enhance understanding and speed (Anderson, 1994; Fitzgerald, 1995; Goodman & Goodman, 1978; Peregoy & Boyle, 2000), even when they pursuit professional English reading. This quality is due associated with the factors that knowledge is able to be generalized, conceptualized, and theorized to encompass various scopes, transferred to multiple applicability, and enhanced for creativity (Lin, 2011). Base on previous findings, the authors have identified that with the longer duration of reading time, the greater the attention spent on professional English reading, while the reading speed may expand, the reading comprehension may intensely extend.

2.2 Eye Chasing Studies and Reading Speed

In 1993, Hegarty and Just conducted a research study by using reading with help of visual chasing framework. In this research, they have revealed that participants of technical background regardless of their high and low mechanical abilities in their reading behaviors tended to read some clauses or sentences before viewing diagram to construct relationship. Readers’ prior knowledge of subjects and strategies of reading cognitively and psychologically can help efficient readers to associate, inference, and form speed and recognition of professional reading contents and materials (Ehrlich & Johnson-Laird, 1982; Glenberg & Langston, 1992; Hegarty & Just, 1993; Just & Carpenter, 1987). Mayer (2003) on the other hand, described that “learners’ cognitive integration process involves selecting appropriate aspects of words or images, building coherent visual and verbal mental models from each representation, and finally incorporating both mental models based on learners’ prior knowledge to generate learning” (Mayer, 2003). As in conjunction to Myer’s study, the later experiments conducted also indicates that, as revealed by heat map of eye chasing device, visual distribution of participants tend to spend more time reading the textual than the graphical records. Participants of high prior knowledge (high PK) showed longer fixation durations than low prior knowledge (low PK) participants. The high PK participants revealed more inter-scanning transitions than low PK participants between words and pictures, but diagrams as well. Therefore, it has been learned that high PK participants are more capable of integrating text and graphic information (Ho et al., 2014). With certain subjects being more intensive and complex, i.e. specialty and expert contents, than
general readings, with the latter being more frequently studied, the authors thus focus on the lesser known of professional English reading. Syndicating and generalizing the findings from previous studies, the authors recognize that prior knowledge will help with reading comprehension and forming generalization of understanding to other lesser familiar professional readings, as aforementioned factors, including but not limited to prior knowledge concept may enhance understanding, could also be features influencing professional English reading speed and comprehension of this research’s participants.

2.3 Technological and Vocational Education Joint College Entrance Examination of Taiwan

The Technological and Vocational Education (TVE) system is important to nurture human resources in Taiwan. Under the commission of Taiwan Ministry of Education (MOE), the nationwide TVE Joint College Entrance Examination, of various professional fields, including English subject as one of the mandatory tests, has been used for technological and vocational colleges and universities throughout Taiwan (TCTVET, 2014). Therefore, this test is a well-respected and legitimate exam. The outcomes and associated references from TVE JCEET consequently provide the relevance for this research goal.

2.4 Research Questions

To accomplish the purpose of this study, the following two questions were proposed.
1. What is the relationship between English examination outcomes from TVE JCEET, for people of English as foreign language (EFL), with technical background (TB), to professional English reading speed?
2. What is the relationship between English examination outcomes from TVE JCEET, for people of English as foreign language (EFL), with technical background (TB), to professional English reading comprehension?

2.5 Hypothesis

Based on the questions proposed, this research intends to test the following hypotheses:
1. There is a positive correlation between the participants of technical background, earning a high English testing outcome from Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET), to be able to read professional English articles faster than those with a lower score. In words, despite of reading familiar or unfamiliar professional English subject, participants with technical background, those who have received high scores on the English examination of TVE JCEET are able to read fast, those with lower score are reading slowly.
2. There is a positive correlation between the participants of technical background, earning a high English testing outcome from Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET), to have positive professional English reading comprehension. In other words, despite of reading familiar or unfamiliar professional English subject, participants with both technical and vocational background, are able to achieve positive outcome because they have done well in English of TVE JCEET.
3. Methodology

3.1 Research Framework and Process

Figure 1. Eye Chasing Device Was Used for Professional English Reading Eye Movement.

3.2 Material

To conduct this research experiment: the authors have come up with 8 professional English reading articles similar to Taiwan college entry level of English proficiency, with 2 from computer engineering subject, 2 from mechanics subject, 2 from bio-medic subject, and 2 from business fields, along with 8 multiple choice questionnaires, one for each of the 8 articles, preinstalled them into laptop, for participants to read on screen display and respond through mouse clicks, to test participants’ reading comprehension and speed, without participants’ knowledge of contents in advance. To observe eye movements while reading, eye chasing device, head stabilizer, laptop computer were used. All participants read and answered all 8 assigned professional English readings and questionnaires, both.

3.3 Participant

To examine the English reading proficiency of those technical background participants, 15 students from the Na Fu Vocational and Technical High School of Taiwan, who completed their Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET) in 2014, was invited to the pilot test. It is with the help of eye chasing device that the eye movements, such as, region of interest (ROI) and total contact time (TCT) by participants, are made available for analysis.

3.4 Design and Procedure

Participants are told to read 8 English professional articles and answer 8 questions after finish reading each one of the 8 articles. Participants were then put to test at this experiment. One National Taiwan Normal University (NTNU) Professor and 5 National Taiwan Normal University (NTNU) research assistants proctored the experiment at Na Hu High School. 4 sets of same eye chasing devices were mounted, for prompt testing, to observe the eye movement of participants when they read and answered the questions.

3.6 Instruments

Four recently made of same EyeNTNU-180 eye chasers created by National Taiwan Normal University Electronic Department team, and sponsored by the Taiwan’ Ministry of Education and the Ministry of Science and Technology, were used to monitor and record eye movements of 15 participants while reading professional English articles and responding to questionnaires and answers Q&A. Each of EyeNTNU-180 set includes a laptop computer in front of a camera to record eye movements. The laptop presented professional English articles and questionnaires. In this experiment, a sampling rate is 180Hz. To avoid errors in eye chasing measurement caused by shaking of head and
inconsistency of eye movement, a head stabilizer was used to fix head position. The distance between the screen and participants were set to 60cm straight apart. The normal time duration of a fixation of this experiment was set to 80 milliseconds.

3.7 Data Collection

The recently produced EyeNTNU-180 eye chasing device was adopted to monitor eye movements, to assess time of professional English reading, and to site coordination. By identifying the parameters and ROI (Region of Interest), the authors were able to determine the reading speed and possible comprehension, when measured against the testing outcomes from TVE JCEET English subject and the 8 Questionnaires and Answers after reading the arranged professional English articles. The authors had designed a computer program to examine the data of inspected components. The ROIs were categorized by ROI-splitter software and eye movement analyzer to evaluate eye movement data to generate scan paths, total gazing time, and eye contacts. Data are presented as following:

<table>
<thead>
<tr>
<th>Participant</th>
<th>TVE JCEET of English test outcome</th>
<th>RC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>78</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>72</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>68</td>
<td>4</td>
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<tr>
<td>5</td>
<td>56</td>
<td>4</td>
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<tr>
<td>6</td>
<td>52</td>
<td>4</td>
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<tr>
<td>7</td>
<td>48</td>
<td>3</td>
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<tr>
<td>8</td>
<td>48</td>
<td>3</td>
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<td>9</td>
<td>48</td>
<td>3</td>
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<td>10</td>
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<td>3</td>
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<tr>
<td>11</td>
<td>44</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>44</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>42</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>42</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>42</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 1. The outcome of English subject TVE JCEET scores, for each one of the 15 participants, and the amount of Q&A answered correctly out of 8 English professional readings, identified as reading comprehension (RC).

<table>
<thead>
<tr>
<th>Professional English Reading Subject</th>
<th>Average Words per Minute (WPM)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>3777.5214</td>
<td>10741.04128</td>
</tr>
<tr>
<td>Electrical engineering</td>
<td>1635.2505</td>
<td>1624.66644</td>
</tr>
<tr>
<td>Bio-Medic</td>
<td>2368.9379</td>
<td>3272.17114</td>
</tr>
<tr>
<td>Business</td>
<td>1143.5126</td>
<td>753.10136</td>
</tr>
</tbody>
</table>

Figure 2. Descriptive statistic of average words per minute (WPM), and Standard deviation, read by all 15 participants together for each one of the 4 professional English subjects, by combining the outcomes of 2 questions per subject together into four aforementioned professional subjects. Based on the experiment, it is noticed that technical background participants tend to read Mechanical field at 3777.5214 WPM, more than Business subject of 1143.5126. To account for the individual participant’s WPM, the authors took total number of words in the article / (tct/(1000x60)), tct stands for total.
Eye gazing time used.

<table>
<thead>
<tr>
<th></th>
<th>TVE JCEET</th>
<th>Professional English Reading Comprehension</th>
<th>Mechanical Engineering</th>
<th>Electrical Engineering</th>
<th>Bio-Medic</th>
<th>Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson correlation</td>
<td>1</td>
<td>.865**</td>
<td>.377</td>
<td>-.105</td>
<td>-.340</td>
<td>-.372</td>
</tr>
</tbody>
</table>

Explain: ** p<0.001 ; * p<0.01 , N=15

Figure 3. Two tails Pearson correlation between the 4 professional English readings and TVE JCEET English testing outcome.

4. Results and Discussions

4.1 TVE JCEET English and Professional English Reading tests’ outcomes, Statistic Report

Figure 1 shows the outcome of English subject TVE JCEET scores, for each one of the 15 participants, and the number of Q&As answered correctly out of the 8 English professional readings from this correlation experiment, identified as reading comprehension RC. The authors hypothesized that participants of technical background who has received higher TVE JCEET English scores would tend to comprehend better when they attend to professional English reading, taking their exam outcomes as indicators. This hypothesis is reflected in Figure 1 with higher TVE JCEET earners getting higher RC scores. Figure 2 is the descriptive statistic, (by combining the results of two questions per subjects together and blending them into 4 professional English categories) which shows the average words per minute (WPM), and the standard deviations, read by all 15 participants together for each one of the 4 subjects examined. Participants of technical background on average tend to read more WPM on Mechanical, followed by Bio-Medic, then Computer Engineering, and finally Business professional subjects. To account for the individual participant’s WPM, the authors took total number of words in the article / (tct/(1000x60)), tct stands for total eye gazing time used.

Figure 3, indicates that the two tails Pearson correlation table shows significant relationship between TVE JCEET English testing outcome and RC, number of questions answered correctly after reading the 8 professional English articles, but specific subjects. The examination outcomes strengthen the explanation that testing outcome and comprehension have positive correlation as stated in hypothesis 2, regardless of professional subjects read. The descriptive statistics on standard deviation and average TVE JCEET English test outcomes, and professional English reading Q&As answered correctly by the 15 pilot test participants are listed in Figure. 4. From this experiment, the authors have identified that TVE JCEET English testing outcome has positive relationships on reading speed, and professional English reading comprehension.

<table>
<thead>
<tr>
<th>Professional English reading subject</th>
<th>Average</th>
<th>Standard Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVE JCEET English test outcome</td>
<td>53.33</td>
<td>12.414</td>
<td>15</td>
</tr>
<tr>
<td>Professional English reading comprehension</td>
<td>3.07</td>
<td>1.335</td>
<td>15</td>
</tr>
</tbody>
</table>

Figure 4. Descriptive Statistic of standard deviation and average TVE JCEET English test outcomes and professional English reading Q&As answered correctly.

5. Conclusion

Performance is an important output for educational results that educators have strived to assess and invent different features of learning practices. Knowing the importance of learning for comprehension and the amount of time spend studying, this research intends to explore how testing
outputs of the participants of English subject of Technological and Vocational Education Joint College Entrance Examination of Taiwan (TVE JCEET), from vocational and technical high school, link with professional English reading performances on reading speed and reading comprehension, using eye chasing device for surveillance. With Paivio (1990) dual coding theory and its supporters advocate on the benefits of reading comprehension, through both text-diagram representations, the authors combined literature review and this research experiment corresponded that reading of textual or graphical images alone would not be as effective in terms of speed and comprehension as scanning through both together. While knowledge and information processing are able to be transferred, synthesized, and created to encompass broader scopes of outputs (Ho, 2014; Lin, 2011), and with the results of this experiment, the authors therefore accept the two hypotheses proposed, because they have showed positive correlations on English subject testing outcome of TVE JCEET to professional English reading speed and comprehension.

The more and in-depth of the existing knowledge and training, the faster the one is able to read for comprehension, as the same applies for professional English subjects of familiar and unfamiliar field for those of English as foreign language practitioners. The authors would recommend of intensive reading practices of contextual and graphical images while training the EFL learners. Once they build up the solid foundation of broader knowledge, they will be able to read faster and know better.

Acknowledgements

This research is partially supported by the “Aim for the Top University Project” and “Center of Learning Technology for Chinese” of National Taiwan Normal University (NTNU), sponsored by the Ministry of Education, Taiwan, R.O.C. and the “International Research-Intensive Center of Excellence Program” of NTNU and Ministry of Science and Technology, Taiwan, R.O.C. under Grant no. NSC 103-2911-I-003-301. We would also like to thank Hao-Yuan Lin who has prepared and revised previous versions of this document.

References


A Tablet-based Chinese Composition Assessment System

Kat LEUNG\textsuperscript{a}, Barley MAK\textsuperscript{b} & Howard LEUNG\textsuperscript{c}*
\textsuperscript{a}Caritas Institute of Higher Education, Hong Kong
\textsuperscript{b}The Chinese University of Hong Kong, Hong Kong
\textsuperscript{c}City University of Hong Kong, Hong Kong
*howard@cityu.edu.hk

Abstract: Chinese composition is an important aspect for students to learn the Chinese language. In this paper, we present our tablet-based Chinese composition assessment system. We have implemented a system to be run on a pen-based tablet device to help teachers assess student’s composition. Our system is able to display student’s composition work on the tablet device, allowing teachers to markup on the student’s work to provide written comments and record his/her voice to provide oral comments. The recorded assessment session can be played back such that the written comments can be shown which are synchronized with the oral comments. Our system facilitates teachers to provide both written and oral comments easily which can be stored and played back. Our system can also be used by researchers to analyze teachers’ assessment process by studying their feedback.

Keywords: Chinese composition, tablet, assessment, written and oral feedback

1. Introduction

Various new technologies have been proposed to help students learn different aspects of the Chinese language. Novel technology has been developed for mobile device to help teachers implement reading strategy instruction and support students’ individual and co-operative reading activities in Chinese language classes (Chang, Lan, Chang, & Sung, 2010). A measure has been proposed to assess the ability of Chinese character recognition made by foreigner Chinese learners and a two-phase learning strategy has been presented for these learners to learn Chinese characters (Ho & Lin, 2010). A mobile-assisted game was adopted to let students learn the formation of Chinese characters and the social interactions have been examined to analyze how student grouping can affect the learning outcome (Wong, Hsu, Sun, & Boticki, 2013).

In terms of teaching Chinese composition, Li (2005) proposed two new methods for teaching Chinese composition and described some example lesson plans with games that aimed to enhance the students’ skill in Chinese composition. Blogging was adopted in a Chinese composition class in a high school in Taiwan (Lou, Wu, & Smith, 2010). They concluded that students’ writing skills were enhanced in a positive way. In the study by (Ying, Leung, Lee, & Chow, 2014), the authors focused on identifying the role of teachers in Chinese composition marking as well as determining the difference between traditional paper-based marking and tablet-based marking. Two teachers reported the usual time taken to mark a composition in the traditional paper-based marking which was found to be similar to the time required for them to mark a composition using our proposed tablet-based composition marking system.

In terms of teaching Chinese composition, Li (2005) proposed two new methods for teaching Chinese composition and described some example lesson plans with games that aimed to increase students’ interest in doing composition in class. They had shown significant increase in writing speed for junior secondary students over 13 weeks after applying their proposed method. Sim (2005) described the teaching of Chinese composition in Singapore by comparing the past and the present. So (2005) believed that information technology can bring new opportunities in teaching Chinese
composition. In particular, So (2005) gave a visionary example that “the students can also watch their essays being marked from their computer terminals at any time”.

Shum (2005) compared four different methods in evaluating Chinese compositions of senior secondary school students in Hong Kong: 1) teacher provided detailed feedback to the students; 2) teacher used symbolic codes to mark the mistakes; 3) the evaluation was based on peer assessment according to a checklist; and 4) the evaluation was self-conducted according to a checklist. The survey results showed that the first group, i.e., the detailed teacher evaluation, was a much more popular method perceived by the students than the second group, i.e., the teacher evaluation with symbolic codes. This indicated that students prefer detailed feedback and our system provides an easy way for teachers to give written as well as oral feedback. Lo (2006) stated that two methods are commonly used to provide formative assessment in school: 1) individual, face-to-face, oral feedback in class; and 2) assessment paper review with follow-up remedial work or activities. Lo (2006) also mentioned that one of the challenges in employing the first method is the heavy workload of the teachers for preparing the oral feedback. The sound recording feature in our system allows teachers to record their voice feedback while they assess the student’s composition so that it will take less time for the teachers for preparing the oral feedback.

In this paper, we present our tablet-based Chinese composition assessment system. We have implemented a system to be run on a pen-based tablet device to help teachers assess student’s composition. Our system is able to display student’s composition work on the tablet device, allowing teachers to markup on the student’s work to provide written comments and record his/her voice to provide oral comments. The recorded assessment session can be played back such that the written comments can be shown which are synchronized with the oral comments. Our system facilitates teachers to provide both written and oral comments easily which can be stored and played back. Our system can also be used by researchers to analyze teachers’ assessment process by studying their feedback.

2. Chinese Composition Assessment System

2.1 System Overview

Our system design is illustrated in Figure 1. The student first composes a Chinese passage as instructed by the teacher. The student then submits the composition to the teacher. The teacher can use our system to open the composition and provide oral and written feedback in this assessment stage. After the teacher finishes the assessment, the marked result is sent back to the student. The student can use our system to playback the teacher’s assessment to receive the oral and written feedback in this playback stage.

Figure 1. System Design.
The assessment stage and the playback stage will be explained in more details in the following sections.

2.2 Assessment Stage

In the Assessment Stage, the teacher opens the student’s composition and reads it using our system. The teacher can markup directly on the student’s work to provide written comments. The teacher can also record his/her voice to provide oral comments.

2.2.1 Opening Student’s Composition Work

The student forms his/her composition on normal grid paper in the traditional way. The finished composition is scanned and stored in the commonly used JPEG format. Sometimes the composition work may consist of several pages and they will be stored with the same prefix and numbered in sequence. The teacher can run our system on a tablet and open the student’s composition. The scanned composition will be displayed using our interface. Besides, since the grid paper may be in landscape or in portrait, our system can also be run in the landscape mode or in the portrait mode in the tablet to accommodate both options, and the composition work will be displayed with the correct aspect ratio, as illustrated in Figure 2 and Figure 3. We also provide a list box in our interface which can show a list of possible teachers’ names and a particular teacher can choose his/her name there to identify who performs the assessment in case the students’ composition get distributed among different teachers or the same student’s composition is marked by more than one teacher. The assessment date is also shown and will be saved together with the teacher’s feedback.

![Figure 2. Display of Student’s Composition Work in Landscape.](image)
Some people may argue why we do not let the students form their composition directly in the tablet to save the trouble of paper writing and scanning. Our existing approach for scanning the paper-based composition has the benefit that existing work by the students can be scanned and ready to be used by our system for the assessment. Besides, some students may find it easier to compose their
work with pen and paper in the traditional way. Nevertheless, we agree that allowing students to provide input directly to form their composition in the tablet can be a good option and we may add this feature in our future work.

2.2.2 Navigating to Different Pages

A student’s composition work may span several pages. As mentioned in the previous sub-section, each page will be scanned with the same prefix in the file name which is numbered in sequence. Our system will detect automatically the total number of pages exist in the student’s work after the teacher opens it with our system. In our interface, we have provided several buttons to facilitate the easy navigation of the pages. In particular, there are 4 buttons that allow the teacher to navigate to the previous page, the next page, the first page and the last page.

2.2.3 Providing Written Comments

Once the composition is displayed in our interface, the teacher can markup on the tablet using a stylus. The teacher’s markup will be shown in red. With this function, the teacher can circle the characters that are written wrongly or underline some sentences whose structure is not well organized. The teacher can also write down explicit comments for the students to improve their work. This function simulates the actual scenario in which a teacher marks a student’s composition work on paper with a red pen such that the teacher does not need much extra time to learn to use our system for the assessment.

Figure 4 and Figure 5 illustrate two example pages of student’s composition with the teacher’s markup made using our system.

2.2.4 Providing Oral Comments

In addition to written comments, our system is able to allow the teacher to record his/her voice during the assessment such that the teacher can provide oral comments. This function can be complement to the written comments. For example, the teacher can circle a character while saying which part of the character is written wrongly. The teacher can underline some sentences and voice out how they can be revised to improve the flow. The teacher can also provide general comments to the student to provide advice about how to improve the composition skill in the future. This feature can also save the teacher’s time such that the teacher does not write down too much details in the written comments as the feedback can be included in the oral comments.

This voice recording feature can also be used by researchers to study the way teachers mark students’ composition. Researchers can ask the teacher to voice out what they are thinking while they are assessing the composition. Under this “Think Aloud” approach, the teacher’s oral comments can be saved and analyzed by the researchers together with the written comments.

2.3 Playback Stage

The assessed composition can be played back by the student. First the student can open the marked result using our system to view the markup by the teacher. The student can navigate to the previous page, next page, first page and last page using similar buttons as introduced in the previous section for the assessment stage. The student can also playback the assessment session such that the student can see when the teacher writes down the comments with the exact timing and listen to the teacher’s oral feedback which is synchronized with the written comments. Our interface provides control buttons to let the student to play, pause and stop the playback session.

This feature can also help researchers to playback the teacher’s oral comments and the written comments to study the assessment process made by the teacher. As mentioned previously, the researchers may ask teachers to voice out their thoughts in a “Think Aloud” approach which are stored
as oral comments. The researchers may analyze different assessment strategies adopted by the teachers and try to devise novel ways for students to improve their composition skills.

Figure 4. Example 1 of Student’s Composition with Teacher’s Markup.
3. Conclusions and Future Work

Chinese composition is an important aspect for students to learn the Chinese language. In this paper, we propose a tablet-based Chinese composition assessment system which can help teachers to provide written and oral feedback. We present our implementation of the system and introduce the features. The recorded assessment session can be played back for student to receive the feedback. Our proposed technology enhances students’ Chinese composition skill as detailed feedback can be made available with the teacher’s written comments synchronized with the oral comments. Researchers can also extract different patterns from the teachers’ assessment to devise strategies to help students improve their Chinese composition skill.
As future work, there are many potential additional features that can be incorporated into our system. For example, we can implement the input function that allows students to write or type their composition directly into our system such that there is no need to scan paper work. In addition to applying our tablet-based assessment for helping teachers to provide feedback of Chinese composition, we will look into the issues of developing more advanced technologies to support peer assessment such that students can work together on their Chinese composition in a more collaborative manner. As included in the study of Shum (2005), the adoption of peer-assessment by classmates was shown to motivate students to revise their Chinese composition. We can explore some pattern recognition techniques that can be used to categorize the teachers’ comments in a more automated fashion and provide some quantitative analysis.

References


Abstract: This study aims to examine negotiated interaction amongst English-as-a-foreign-language undergraduates in a real time text-based environment. It looks at the interactional patterns of negotiation on Facebook between dyads of learners and native speakers of English. Overall, all dyads tended to negotiate meaning rather than form, as numerous errors (e.g., morphosyntactic errors) were not repaired during the tasks. The learners were found to employ a number of interactional strategies for communication breakdowns, e.g., clarification request and comprehension check. In addition, the results derived from the interview data reveal that all learners had a positive perception of working with others on Facebook, e.g., increasing motivation and engagement.

Keywords: Language Related Episodes, Computer-Mediated Communication, Synchronous Text-Based CMC

Introduction

Over the past two decades, the use of online chat or instant messaging in synchronous computer-mediated communication (CMC) has become a popular means to enhance second language learning (Sauro, 2012). Due to its capacity to store data files, CMC has potentially provided opportunities for researchers to examine interaction (Peterson, 2009). In light of this, much of the existing research, such as Lee (2001), Peterson (2009), and Sotillo (2005), has explored negotiated interaction in CMC environments.

The underpinning sociocultural theory highlights that social interaction between conversational interlocutors helps scaffolding to take place in cognitive development (Vygotsky, 1978). In second or foreign language (L2/FL) learning, learners interact with more competent individuals to negotiate new words or expressions in the language during a conversation, and the negotiated interaction may be able to provide the learners with linguistic input (Long, 1996). For instance, in collaborative negotiation, a series of ongoing interactional processes take place in order for learners to comprehend the unknown items or to convey intended messages, e.g., asking assistance from their interlocutor and clarifying the meaning of a word. In this way, the learners will be able produce their output relevant to the unknown linguistic items.

Results of negotiation research reveal that unknown words are more likely to be a trigger of negotiated routines than any other forms of linguistic aspects, such as grammar. Fernández-García and Martínez-Arbelaitz (2002) found that when their participants encountered unfamiliar lexical words, they tended to engage in negotiation for meaning. Such results are in line with Tudini’s (2003) study, which revealed that lexical and structural difficulties were found to trigger modified negotiation. In terms of communication strategy use, Jepson (2005) claimed that his participants employed a
greater number of clarification requests in both text and voice chat. Nevertheless, such results in terms of types of strategy use differ from study to study, as Lee (2001) reported that her participants employed clarification checks, requests and self-corrections more frequently than other strategies, e.g., word invention.

Another strand of research has investigated attitudes or perceptions of learning in CMC, whether learners perceive CMC learning positively, or whether use of CMC can foster learners’ engagement or participation and motivation in the target language. For instance, Peterson (2010) revealed that learners working collaboratively with others in a virtual world demonstrated high levels of motivation and interest and low levels of stress when communicating with others in the virtual world.

This study builds upon previous research in traditional face-to-face (F2F) and CMC settings regarding how second or foreign language (L2/FL) learners employ communication strategies to overcome what they lack linguistically in the target language when conversing with their conversational interlocutors, e.g., Nakahama, Tyler, and van Lier (2001). Specifically, the current study aims to explore the synchronous text-based interaction taking place on Facebook between the learners and the native speakers of English and the learners’ perceptions of collaborative learning in the CMC environment. There are two research questions: What are the interactional strategies used by the participants during the task in the real time text-based CMC? What is the perception of collaborative learning in the CMC environment?

Method

Participants

This pilot study involved ten participants, that is, five native speakers of English and five EFL learners, whose ages ranged between 21 and 25 years old and whose first language was Taiwanese or Mandarin Chinese. They had been learning English for more than ten years. The sample of the learners included three female and two male students who were sophomores and had majored in Tourism. Each dyad consisted of a native speaker and a learner, resulting in five dyads in total.

Instruments

Tasks

Three types of communication tasks were made available on Facebook, namely, the information gap and the decision-making activities, and a reading article; the first two tasks were designed based on the task-based approach (Willis & Willis, 2007), and the last one, drawn from the learners’ textbook, was modified in this study. For example, the reading task was an attempt to generate negotiated interaction, as there were several words or expressions that were new to the learners.

Retrospective interviews

The interviews were held a few days after the paired participants had completed the given task in terms of the perception of collaborative learning in the text-based environment, such as, ‘Can you describe the learning experience with your partner on Facebook?’ and ‘What is the most challenging part when learning collaboratively on Facebook?’ The learners were interviewed individually in the chatroom on Facebook.
Data analysis

Existing taxonomies of interactional strategy use were adopted to analyze the text-based CMC discourse of the participants, such as Bower and Kawaguchi (2010), Lyster (1998), and Varonis and Gass (1985). According to the modified interaction, the interactional strategies may include confirmation and comprehension checks, clarification requests, and asking for assistance. One excerpt taken from Varonis and Gass (1985:78) is given below to illustrate that learners check each other’s comprehension, in this instance, when the learners encountered the unfamiliar lexical item ‘ingless.’

a. 140J: I was born in Nagasaki.
   → Do you know Nagasaki?
b. 120S: I’m from Venezuela.
   UL J: Venezuela
   →120S: Do you know?
c. 140S: declares her ingress
   140J: Ingless
   140S: Yes, if for example, if you. When you work you had an ingress.
   → you know?
d. 140S: and your family have some ingress
   140J: yes ah, OK OK
   →140S: more or less OK?

In the above discourse, each arrow indicates a trigger showing that the hearer does not understand part of an utterance, e.g., ‘Do you know Nagasaki?’ Following the trigger, Lines a. – d. indicate a series of negotiated episodes, where Line a. represents a trigger, Line b. was the indicator, Line c. was the response, and Line d. was the reaction to the response.

Procedure of data collection

All the participants took part voluntarily in the real time text-based communication. Afterwards, they were asked individually to work with their interlocutors on Facebook at the same time by using text chat in the chatroom. Each pair of participants notified the first researcher of this study regarding the time of the online discussion, and then the researcher invited each pair into the same chatroom to undertake the tasks. Each pair completed one set of tasks each time, which took them one hour approximately. This resulted in 15 hours of data, that is, 15 dyads of NS-NNS, and it took around six weeks to complete the tasks. One week after the five pairs of participants had completed the three types of tasks, the online retrospective interviews were held on Facebook, where individual learners were interviewed by using a text chat. Each interview lasted nearly 30 minutes, giving 150 minutes of interviews in total.

Results

This section discusses how the results of the pilot study answer the two research questions. Prior to this, the negotiated interaction that was found in the traditional face-to-face environments took place in the text-based CMC environment, such as this current study and some other studies (e.g., Fernández-García and Martínez-Arbelaitz, 2002). First, errors
that occurred in the learners’ output were categorized as grammatical errors, errors of lexis, or misspellings. It was found that the learners made the most errors in grammar (76%), which was followed by lexical items (29%), and the fewest errors were those of misspelling (5%). Examples of the grammatical errors included morphosyntactic errors (e.g., subject-verb agreement) and prepositions.

In the first research question, the negotiation discourse during the tasks tended to focus on meaning rather than on form. Hence, many grammatical errors were not corrected by the learners’ interlocutors. During negotiation for meaning, a number of interactional strategies were identified, including confirmation and comprehension checks, clarification requests, asking for assistance, and others. In Table 1, the learners employed the most frequent strategy of asking for assistance (35.8%), whilst the strategy least frequently used was the confirmation check (9.4%). It should be noted that apart from one dyad of NS-NNS (Barry-Mei), the rest of the dyads tended to negotiate meaning rather than form.

Table 1: Summary of Interactional Strategy Use by the dyads

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Counts</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation check</td>
<td>5</td>
<td>9.4</td>
</tr>
<tr>
<td>Comprehension check</td>
<td>10</td>
<td>18.9</td>
</tr>
<tr>
<td>Clarification request</td>
<td>12</td>
<td>22.6</td>
</tr>
<tr>
<td>Asking for assistance</td>
<td>19</td>
<td>35.8</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
<td>13.2</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>100</td>
</tr>
</tbody>
</table>

Noticeably, negotiated interaction took place when the learners came across new words, whereupon they asked for help from their interlocutors to provide the meaning of the unknown words. In other words, negotiation was less likely to occur when learners made grammatical errors. In the current study, most learners were likely to ask their partners the meaning of new words in a reading task, e.g., ‘What does X mean?’

In the second research question, most learners (N=4) had a positive perception of working with others on Facebook, as they believed that they gained linguistic knowledge from their superior interlocutors. Three learners commented that the interaction in the environment enhanced their motivation and engagement in meaningful communication. Specifically, two main aspects emerged from the interview data in relation to the perception of learning in the synchronous text-based environment, namely, cognitive support and affective scaffolding. Regarding cognitive support, the results reveal that four out of the five NNS participants agreed that interaction with native speakers could help them improve their linguistic knowledge in English in terms of vocabulary and grammar. For example, one female learner, Mei, recounted that when she had grammatical errors in her answers, her partner, Barry, corrected them by comparing the differences in sentence structure between English and Chinese: ‘Barry is a native speaker of English speaking some Chinese... then he said the structure in English is more rigid than that in Chinese...’

Instances such as this were found in the interaction between Mei and Barry in the log files, where he both implicitly and explicitly explained grammar points to Mei, e.g., ‘... let’s [let’s] keep the sentence in the present tense. Ill [I’ll] give you a hint. Its [It’s] in the ending.’

Regarding affective scaffolding, when compared to their previous experience in face-to-face communication, all the learners stated that they felt much less pressure having a chat with native speakers in the text communication during the tasks. As another learner, Joan, stated ‘All our conversation is done on Facebook; that makes me feel less embarrassed if I make some grammar mistakes... but if I talk to a native speaker in person, when making stupid mistakes, I will feel nervous...’
Discussion and Conclusion

This pilot study was intended to examine the negotiated interaction taking place in a real time text-based environment by integrating the overarching socio-cultural theory applied in the L2/FL settings into the synchronous CMC. The preliminary results suggest that the learners made more grammatical errors than misspellings or errors of lexis. There were five types of interactional strategies used by the pairs of NS-NNS in this study: confirmation and comprehension checks, clarification requests, asking for assistance, and others (e.g., use of L1). The learners showed a greater preference for using the strategy of asking for assistance rather than any other strategies, such as clarification requests. It is important to note that there were various types of errors in the learners’ messages, but these were not corrected by their superior interlocutors though one pair of participants tended to contribute to form negotiation while the others were more likely to initiate negotiation for meaning. Such results discovered in this study corroborate those in previous research. Finally, the results of the retrospective interviews suggest two essential components in terms of cognitive support and affective scaffolding in relation to the perception of collaborative learning in the text-based environment, such as corrective feedback on grammatical errors provided by an interlocutor.

This study, like any other study, has its inherent limitations. One limitation is that the small size of the sample being adopted in this study cannot provide generalizability to the wider context. Another limitation of this study, which needs to be addressed in relation to the categories of errors occurring in the learners’ output, can also include other types of errors, such as word order. Likewise, the interactional strategies can be divided into further different categories, such as word coinage. In addition, one aspect of language use in the text-based communication may focus on the corrective feedback or recast provided by interlocutors and the responses of learners to the corrective feedback. However, those aspects require further investigations.

Acknowledgements

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References


Exploring the Effectiveness of a Flipped Classroom Based on Control-Value Theory: A Case Study

Jiu-Tong LUO, Meng SUN, Bian WU & Xiao-Qing GU*
Department of Educational Information Technology, East China Normal University, China
*xqgu@ses.ecnu.edu.cn

Abstract: Flipped classroom is a newly emerged video-lecture-supported teaching approach that aims to improve learning outcomes and teaching effects though students’ self-regulated learning after class, teachers’ assistance and interaction during class. In this paper, we explored the effectiveness of a flipped-classroom Java Programming course based on control-value theory in a university of China. The specific goal of this case study was to explore students’ achievement emotion in this flipped classroom setting and explore the correlation among the given factors. Adopting a mixed method, this study collected data on students’ Java self-efficacy (control), motivation (value), achievement emotion, self-regulated learning ability learning outcomes as well as open questions about attitudes and suggestions to flipped classroom. And students’ learning outcome was multi-dimension evaluated, including self-reports after each project, assignments, online activities participate and final exam. The findings showed that the control-value theory could explain the effectiveness of the flipped classroom well. In addition, implications were also concluded from this study.

Keywords: Flipped classroom, control-value theory, effectiveness, case study

1. Introduction

Over the past decades, the public were dissatisfied with teaching effects of traditional approaches. With the development of newly emerged information technology, video-lecture can help students learn by themselves. Flipped classroom is based on a student that arrives to class ready for the learning experience and prepared by watching the video-lectures provided by the teacher in advance (Bristol, 2014). Nowadays, more and more researchers are focusing on the different parts of flipped classroom to transform the traditional education system together with MOOC and micro-video. This study mainly explored the effectiveness of flipped classroom based on control-value theory put forward by Pekrun (2006) focusing on exploring students’ achievement emotion and its antecedents and effects.

2. Background

2.1 Flipped classroom

The conception of flipped classroom can be traced back to 2008, the chemistry teachers at Colorado’s Pike’s Peak, veteran Woodland Park High School came to the idea to provide video records of their lessons online for those absent students to see what they missed (Tucker, 2012). And it soon became very famous for its concept of having students to learn self-paced. Bishop and Verleger (2013) provided a comprehensive survey study of flipped classroom and concluded that a) most researches aimed to explore students’ perceptions and use single-group designs; b) students’ attitude generally positive overall, although they tent to in-person lessons to video lectures and c) little work investigating students learning outcomes objectively.
2.2 Control-Value theory

Control-Value theory was first put forward by Pekrun. It focused on achievement emotion and aimed to analyze the antecedents and effects of emotion experience in achievement and academic setting (Pekrun, 2006). Various factors were concluded in this comprehensive framework, such as expectancies, attributions, intrinsic/extrinsic value, achievement emotions, outcome emotions, self-regulation of learning and so on (Pekrun et al., 2007). By using control-value theory, we can improve the understanding of students’ motivation, learning, performance (Artino Jr, 2012) and engagement (Buff, 2014).

The control dimension for the students learning a course factor often refers to their expectancies, attributions and confidence, such as self-efficacy (Pekrun et al., 2007). Self-efficacy was defined as people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performance (Bandura, 1986; Askar and Davenport, 2009).

The value dimension of the course is both instinct and extrinsic (Pekrun et al., 2008). Motivation can explain the students’ judgments of the course value for their own. ARCS model was a comprehensive motivation model includes attention, relevance, confidence and satisfaction for teachers develop qualified material for students in online or blended learning environment (Keller, 2010). And another factor can influence the students perceiving the value of courses is their technology acceptance. TAM is a framework measuring users’ perceived and intention of using technology (Davis et al., 1989).

Achievement emotions are also intimately involved in virtually every aspect of the teaching and learning process and, therefore, an understanding of the nature of emotions within the school context is essential (Schutz and Lanehart, 2002). In the control-value theory, achievement emotion is defined as emotion tied directly to achievement activities or achievement outcomes, includes enjoyment, joy, relaxation, anger, frustration, boredom, shame, hope, pride, relief, anxiety, sadness, disappointment, hopeless and so on (Peruk, 2007).

Self-regulated learning is an important aspect of students’ academic success (Effeney et al., 2013; Zimmerman, 2002). According to Zimmerman (2002), self-regulated learning is actions directed at acquiring information or skill that involve agency, purpose, and instrumentality self-perceptions by a learner. And it was cited as the effects of achievement emotion (Peruk et al., 2007).

2.3 The research framework

According to the control-value theory, we put forward a framework for this study showed as following (see Figure 1). The aim of this study was mainly focused on exploring achievement emotion and testing the framework in a flipped classroom as a pre study for the further exploration of effectiveness of this newly emerged teaching approach in the coming semester. As mentioned above, the control and value dimension had several factors, and this study only considered students Java self-efficacy as the control factor, while course motivation as the value factor.

![Figure 1. The Research Framework Based on Control-Value Theory.](image)

3. Methodology

3.1 The study

The research reported here was taken in Shanghai, China that aimed to facilitate students’ learning and enhance teachers’ teaching by changing their roles during and after classes. There were totally 21 students (6 Male, 15 Female) including 9 sophomore and 12 junior students majoring Educational Technology in a normal university in Shanghai participated in this study.
3.2 The pedagogy

This research was taken in a flipped classroom setting. The students were asked to learn Java programming course by self-regulated learning out of class. Students were divided into several groups to fulfill three projects assigned to them, with each group containing 2-3 person. During this course, each student was asked to finish 3 projects with their teammates. 4 weeks were given to finish the first project which contains 3 sub-tasks, and 5 weeks for the next with 4 sub-tasks and 9 weeks for the last one with 8 sub-tasks.

The teacher provided learning materials in advance on the learning platform (Sakai). The videos were limited up to 8 minutes, known as micro-video podcast. It was reported that this kind of micro-video could contribute to the students’ learning interests and attention last longer in self-regulated learning environment. Besides, several other types of materials, such as pdf, doc as well as hyperlinks of Java API etc. were also provided for the students to facilitate their self-regulated learning. Students were encouraged to participate online activities such as posting, and discussing with each other. Students also needed to submit a self-report of performance after they finished each project.

The learning outcome of the participated students were multi-dimension evaluated, including self-reports after each project, assignments, online activities participation as well as final exam. The calculation of final learning outcome followed the given formula below:

\[
\text{Total Learning outcome} = 10\% \times 3 \text{ Projects} + 10\% \times (\text{online activities and self-report}) + 60\% \times \text{final exam score}.
\]

3.3 The methods

Adopting a mixed method, this research used instruments which contained 12 items measuring students’ Java self-efficacy adapted from Askar and Davenport (2009), 16 items measuring motivation adapted from TAM (Davis et al., 1989; Saadé and Bahli, 2005) and IMMS based on ACRS motivation model (Keller, 2010), 21 items measuring the achievement emotions adapted from the Achievement Emotions Questionnaire (AEQ) (Pekrun et al., 2011), 19 items measuring self-regulated learning ability adapted from Barnard et al. (2009) as well as open questions about attitudes and suggestions to flipped classroom. Collected data including the factors list above in this flipped classroom setting presented on a seven-point Likert scale, from strongly agree to strongly disagree, as well as demographic variables. All of the items in these questionnaires were adopted from existing scales in English, and then translated to Chinese for the participants, so the reliability of the questionnaires were guaranteed. Both quantitative and qualitative methods were adopted in this study. Descriptive and inferential statistics were used to analyze the structured questionnaires., while content analysis was used to coding the open questions.

4. Results

Only 19 students answered the Java self-efficacy and motivation scales effectively; 20 of them answered the achievement emotion and self-regulated learning scales effectively and 18 students answered all of the scales. The reliability of the questionnaires on students Java self-efficacy, motivation, achievement emotion, and self-regulated learning were good, Cornbash’s \( \alpha \) were 0.93, 0.93, 0.95, 0.74 respectively.

4.1 The result of self-efficacy

In this research, the Java self-efficacy (control dimension) scale was divided into three levels from basic understanding of Java Programming to confidently finishing a comprehensive Java project gradually, and each level contains 4 questions. The Min, Max, Mean and SD of each item were listed in the table 1 below. The total cornbash’s \( \alpha \) was 0.93, and 0.75, 0.70, 0.91 for level 1, 2, and 3 respectively.
Table 1: The result of self-efficacy scales (N=19).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>L1-01</td>
<td>3</td>
<td>6</td>
<td>4.21</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>L1-02</td>
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<td>7</td>
<td>4.63</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>L1-03</td>
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<td>6</td>
<td>4.74</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>L1-04</td>
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<td>6</td>
<td>4.84</td>
<td>0.96</td>
</tr>
<tr>
<td>Level 2</td>
<td>L2-01</td>
<td>2</td>
<td>6</td>
<td>4.11</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>L2-02</td>
<td>2</td>
<td>5</td>
<td>4.11</td>
<td>1.05</td>
</tr>
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</tr>
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<td>6</td>
<td>4.37</td>
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</tr>
<tr>
<td>Level 3</td>
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<td>3.74</td>
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<td>5.11</td>
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<td></td>
<td>L3-04</td>
<td>2</td>
<td>7</td>
<td>4.32</td>
<td>1.20</td>
</tr>
</tbody>
</table>

4.2 The result of motivation

The course motivation scale (value dimension) contained five parts, such as: perceived ease of use, perceived of useful, intention to use, attention and relevance. The Min, Max, Mean, and SD of each item were listed in the table 2 below. The total cornbash’s $\alpha$ was 0.93, and 0.87, 0.83, 0.74, 0.55, 0.84 for the five different parts mentioned above respectively.

Table 2: The result of motivation scales (N=19).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
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</thead>
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<td>Perceived Ease of Use</td>
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<td>3.74</td>
<td>1.10</td>
</tr>
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<td>PEU2</td>
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<td>6</td>
<td>4.58</td>
<td>1.35</td>
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<tr>
<td></td>
<td>PEU3</td>
<td>1</td>
<td>6</td>
<td>4.53</td>
<td>1.43</td>
</tr>
<tr>
<td>Perceived of Useful</td>
<td>PU1</td>
<td>2</td>
<td>6</td>
<td>4.32</td>
<td>1.29</td>
</tr>
<tr>
<td></td>
<td>PU2</td>
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<td>6</td>
<td>4.32</td>
<td>1.11</td>
</tr>
<tr>
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<td>PU3</td>
<td>2</td>
<td>6</td>
<td>4.16</td>
<td>1.17</td>
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<tr>
<td>Intention to Use</td>
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<td>7</td>
<td>5.00</td>
<td>1.41</td>
</tr>
<tr>
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<td>2</td>
<td>7</td>
<td>4.68</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>ATT1</td>
<td>3</td>
<td>7</td>
<td>4.84</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>ATT2</td>
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<td>7</td>
<td>5.74</td>
<td>0.94</td>
</tr>
<tr>
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<tr>
<td></td>
<td>ATT4*</td>
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</tr>
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<td>6</td>
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<td>1.39</td>
</tr>
<tr>
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<td>5.21</td>
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</tr>
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<td>5.47</td>
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</tr>
<tr>
<td></td>
<td>REL4</td>
<td>3</td>
<td>7</td>
<td>4.95</td>
<td>1.08</td>
</tr>
</tbody>
</table>

*The items were assessed conversely.

4.3 The result of achievement emotion

The total cornbash’s $\alpha$ of achievement emotion was 0.95, and 0.87, 0.34, 0.71, 0.84, 0.96, 0.85, 0.68 for enjoyment, hope, pride, hopeless, anxiety, boredom, and angry respectively. There were no cornbash’s $\alpha$ of shame and relief parts, because there was only one item for both of this two parts. The Min, Max, Mean, and SD of each item were listed in the table 3 below.

Table 3: The result of achievement emotion scales.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enjoyment</td>
<td>EM1</td>
<td>3</td>
<td>7</td>
<td>5.40</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>EM2</td>
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<td>7</td>
<td>4.75</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td>EM3</td>
<td>3</td>
<td>7</td>
<td>5.20</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>EM4</td>
<td>4</td>
<td>7</td>
<td>5.50</td>
<td>1.05</td>
</tr>
<tr>
<td>Hope</td>
<td>HP1</td>
<td>1</td>
<td>7</td>
<td>4.05</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>HP2</td>
<td>3</td>
<td>7</td>
<td>4.55</td>
<td>1.16</td>
</tr>
<tr>
<td>Pride</td>
<td>PD1</td>
<td>3</td>
<td>7</td>
<td>5.40</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>PD2</td>
<td>3</td>
<td>7</td>
<td>5.05</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>PD3</td>
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<td>6</td>
<td>4.55</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
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<td>7</td>
<td>5.05</td>
<td>1.54</td>
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<tr>
<td></td>
<td>ANX2</td>
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<td>7</td>
<td>5.20</td>
<td>1.40</td>
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<tr>
<td></td>
<td>SM1</td>
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<td>4</td>
<td>2.85</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
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<td>7</td>
<td>5.70</td>
<td>1.03</td>
</tr>
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<td>BD2</td>
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<td>5.50</td>
<td>1.28</td>
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<td>3</td>
<td>7</td>
<td>5.60</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td>AG1</td>
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<td>7</td>
<td>5.70</td>
<td>1.38</td>
</tr>
<tr>
<td></td>
<td>AG2</td>
<td>3</td>
<td>7</td>
<td>5.20</td>
<td>1.47</td>
</tr>
</tbody>
</table>
The result of self-regulated learning

The total Cronbach’s α of achievement emotion was 0.74, and 0.86, 0.73, 0.51, 0.58, 0.34, 0.63 for goal setting, environment structure, help seeking, time manage, task strategy, and self-evaluation respectively. The Min, Max, Mean, and SD of each item were listed in the table 4 below.

Table 4: The result of self-regulated learning scales.

| Construct         | Item | Min | Max | Mean | SD  | | Item | Min | Max | Mean | SD  |
|-------------------|------|-----|-----|------|-----| | Item | Min | Max | Mean | SD  |
| Goal Setting      | GS1  | 2   | 6   | 4.10 | 1.41| | TM1  | 3   | 7   | 4.95 | 1.19|
|                   | GS2  | 1   | 6   | 3.55 | 1.40| | TM2  | 2   | 5   | 3.60 | 1.05|
|                   | GS3  | 2   | 7   | 3.90 | 1.41| | TM3  | 2   | 6   | 3.40 | 1.23|
|                   | GS4  | 2   | 6   | 4.15 | 1.23| | TS1  | 1   | 6   | 3.50 | 1.43|
| Environment       | ES1  | 2   | 7   | 4.95 | 1.15| | TS2  | 3   | 6   | 4.45 | 0.76|
| structure         | ES2  | 4   | 7   | 5.15 | 0.99| | TS3  | 2   | 6   | 4.30 | 1.13|
|                   | ES3  | 1   | 7   | 4.75 | 1.45| | SE1  | 2   | 6   | 3.85 | 0.99|
|                   | ES4  | 3   | 7   | 5.20 | 1.24| | SE2  | 1   | 5   | 3.50 | 1.10|
| Help Seeking      | HS1  | 2   | 7   | 5.25 | 1.29| | SE3  | 1   | 5   | 4.20 | 1.11|
|                   | HS2  | 4   | 7   | 5.40 | 0.68| | N=20, Cronbach’s Alpha=0.74|

The result based on control-value theory

The correlation between students’ Java self-efficacy (control) with their achievement emotion in flipped classroom setting was 0.77 (N=19, p<0.01, one-tailed); the correlation between motivation and achievement was 0.69 (N=19, p<0.01, one-tailed); the correlation between achievement emotion and self-regulated learning was 0.41 (N=20, p<0.05, one-tailed); the correlation between self-regulated learning with students’ multi-dimension evaluated learning outcome is 0.39 (N=18, p<0.05, one-tailed) (see Figure 2).

Figure 2. The Results Based on Control-Value Theory.

5. Discussion and implications

As can be found in the data above, the students’ achievement emotion in this study tend to be positive, for the Mean of each item was above the average (except 1 item). The results of other scales were also good and the correlations based on the framework were significant. When the students were asked whether they satisfied with their performance in this course or not, most of them still answered not too bad or general. It implicated that students could do even better and have potential of improvement in the flipped classroom. This made us confident to continue using this strategy in the coming semester, and develop more scaffoldings to support their learning.

Although the total reliability of the scales were good, but the reliability of some sub-constructs were not as good as the total because of the limited participates in this study. Actually, there were over
50 students participated in this course at the beginning, but most of them dropped out for the course pressure, limited time et al. This also showed that the students still had some resistance to this innovative teaching approach.

6. Conclusion

This study explored the effectiveness of a flipped classroom based on control-value theory. The study found that students’ achievement emotion could be well explained using the framework of control-value theory and each the correlations between them were also significant.

The limitations of this study are listed as following, a) the sample size is small (only 21 participants); b) the alpha values of some scales were low, even though they were adopted from previous researches. Despite the limitations, this study severed as the pre study of the ongoing study of flipped classroom, and concluded many useful implications to the study will be take in the next semester to get a better knowledge of students’ development based on control-value theory by using this innovative teaching strategy.

References


Analysis on Students’ Acceptance of Digital Reading in Ubiquitous Cooperative Inquiry-based Learning Environment

Jing-Ya CHEN, Jing LEONG, Xiao-Juan XU & Xiao-Qing Gu*
East China Normal University, Shanghai, China

Abstract: Due to the advanced ubiquitous technology, learning can happen almost anywhere and at any time. Most students can learn by using mobile devices they want. Digital reading is an important part of students’ learning which can increase their learning interesting and support them learning. And ubiquitous cooperative inquiry-based learning demonstrates improvement of student engagements and expectations for personal success by learning and sharing experiences in small groups. More and more researchers become interested in examining the potential benefits of digital reading supported by ubiquitous technology. This paper tries to investigate students’ use of digital reading in a classroom context while they engage in collaborative inquiry-based learning. Studies were conducted to examine whether individuals’ reading motivation will affect they acceptance of digital reading and test scores of the subject. Results show that firstly, reading motivation correlates highly with students’ acceptance of digital reading; secondly, if students have higher degree of acceptance of digital reading, their digital reading behaviors show more active. Teachers need to pay more attention to students’ reading motivation to improve their digital reading performance and learning outcome.

Keywords: Digital reading, ubiquitous technology, user acceptance, reading motivation

1. Introduction

With the popularity of wireless communication and ubiquitous technologies, ubiquitous and mobile learning has become more and more important and helpful in education (Chu, Hwang, Tsai & Tseng, 2010). Ubiquitous learning is often regarded as “learning anywhere and at anytime” (Hwang & Tsai, 2011). Mobile devices (e.g. smart phones, laptops or iPad) are emerged to assist students to learn in a ubiquitous learning environment. Supported by these ubiquitous technologies, students can acquire and communicate knowledge in anywhere, and at anytime. Reading is a necessary part in every discipline. The paradigm of reading, in particular for young people, is increasingly using digital reading rather than paper (Mangen, Walgermo, & Brønnick, 2013). Digital reading provides students a lot of functions (e.g. highlight, hyperlinks, notes) to assist them to read. If students can use these digital reading tools effectively, it might improve their memory and learning outcome. Motivation can affect their performance in different learning areas, including reading (Wigfield & Guthrie, 1995). And the level of user acceptance of information technology will also affect their using behaviors (Davis, 1989). There exists a large body of researches on how to use these technologies to enhance teaching and learning in different disciplines, but few are focused on the impact factors of students’ acceptance of digital reading in ubiquitous cooperative inquiry-based learning environment.

Two studies were conducted in this paper. First, a study was conducted to investigate students’ usage of the network and social software usage (N=1327). Based on the first study, 102 students in Grade 7 were invited to participate in the second study, to further investigate their use of digital reading in a classroom context while they engage in collaborative inquiry-based learning. In this study, we designed a collaborative inquiry-based learning activity. PDF tool and MOODLE platform were used in this study to support students’ reading and learning. Students were encouraged to use reading tools (e.g. highlight, notes) in learning activities, for better memorizing and understanding. Analyses were conducted to examine whether individuals’ reading motivation will affect their acceptance of digital reading and test scores of the subject.
2. Literature review

2.1 Ubiquitous learning

Yahya et al. (2010) proposed that Ubiquitous learning (U-learning) is a learning paradigm which takes place in a ubiquitous computing environment that enables learning the right thing at the right place and time in the right way, to make it easier to understanding the concept of u-learning. Ubiquitous computing technology in u-learning constructs a ubiquitous learning environment to enable anyone to learn at anyplace at any time. In recent years, a variety of computing and communication technologies have been developed, such as wireless communication equipment, smart mobile phones, PDAs (Personal Digital Assistant), which are being used in our daily life (Sakamura et al., 2005; Friedewald et al., 2011; Yahya et al. 2010). For example, smartphones have been proved possible to serve as u-learning devices by researchers (Shin et al., 2011; Chen et al., 2009). A student equipped with a mobile device can connect to any other devices, and access the network by using wireless communication technologies (Uemukai et al., 2004). So creating an effective ubiquitous learning environment can increase students’ engagement in learning.

2.2 Reading motivation

It’s well known that children’s motivation can affect their performance in different learning areas like reading (Wigfield & Guthrie, 1995). Previous researches suggest that motivation is very important to reading engagements (Wigfield et al., 2004), which can indicate children’s behaviors, including choice of which activities to do, hold on at these activities, and their level of effort expended (Wigfield, 1997; Guthrie & Wigfield, 1999). Reading motivation represents students’ personal goals, values and beliefs with regard to the topic, processes, and outcomes of reading (Wigfield & Guthrie, 2000). It can influence children’s reading skills (Morgan & Fuchs, 2007). So reading motivation gives students powers to read and learn. Other studies use strategies to stimulate students’ motivation in order to improve their reading in different subjects, such as science (Guthrie & Wigfield, 1999). In a digital world, students’ learning behavior might be totally different when they are in traditional learning. Vogel, Kennedy, and Kwok (2009) suggested that students’ motivation plays a significant role in engaging and sustaining students to use mobile devices for learning purposes. So some features of digital reading devices might influence students’ reading motivation, and then affect their attitudes and behaviors of reading. But few studies focus on the relationship between reading motivation and digital reading behaviors. Therefore, this study attempt to find whether reading motivation related to degree of digital reading acceptance and reading behaviors in a digital reading environment.

2.3 User acceptance of digital reading

With the development of information technology and network, a lot of digital services support people reading and learning. Although almost all the children today are regard as "digital natives" and familiar with information technology, their acceptance and usage pattern of technology are different (Kennedy, 2010). Therefore, user acceptance of information technology might affect students’ learning in digital learning environment. Prior researches have done some study about user acceptance of information technology, mainly focusing on assessing the design and application of systems, such as on-line learning systems (Saadé & Bahli, 2005). According to literature review, many studies analyses user acceptance level and factors by using IS success, Task- technology fit and User Acceptance of Information Technology (TAM) model. TAM is the most widely used in the study about user acceptance by using different technologies, including perceived usefulness, perceived ease of use, attitude toward using, and actual usage behavior (Davis, 1993). Davis (1989) also suggested that both usefulness and ease of use had important correlation with usage behaviors, and usefulness had a significantly greater correlation with usage behavior than did ease of use. Bennett (2008) noted that some potential factors might affect user acceptance of information technology like Socio-economic status, sex and specialized disciplines etc. Jones and Healing (2010) claimed that students’ Initiative decided the students’ participation in technology. Davis (1992) once used motivation theory to understand user acceptance and usage of new technology. So this study put user acceptance into a
specific reading situation, and analyzes the correlation between reading motivation and user acceptance of digital reading.

2.4 Reading behavior

As to students’ reading behavior, previous studies have investigated how students read in traditional learning. Morrow, Rand, & Smith (1995) suggested that read aloud behaviors in upper elementary grades can improve story reading. With the change in the traditional learning environment, the usage of ubiquitous technology support students’ learning process, and change their learning behaviors. Past researches have focused on user behaviors in Web environments (Liu, 2005; Nicholas, et al., 2008). Liu (2005) claimed that digital readers are likely to develop the screen-based reading behavior which is characterized by more time spent on browsing and scanning, keyword spotting, one-time reading, non-linear reading, and reading more selectively. Until recently, little attention has been drawn to analyze reading behaviors when in a specific discipline situation. This study researches reading behaviors in the digital environment from a different perspective by observing students’ reading behaviors (e.g. highlight, make notes and using navigation) in digital reading process and analyzing the relationship between students’ acceptance of digital reading.

Recent researches have mentioned that motivation, user acceptance, behaviors and outcomes have some correlation, but not take it a specific learning situation into consideration. Therefore, this paper tries to examine whether individuals’ reading motivation will affect their acceptance of digital reading and test scores of the subject in a ubiquitous collaborative inquiry-based learning environment.

3. Research question

In this study, two main research questions were addressed regarding students’ use of digital reading in a classroom context while they engage in collaborative inquiry-based learning:

What are the relationships between students’ reading motivation, digital reading acceptance and test scores?

For students with high degree of acceptance of digital reading, do they also show more active digital reading behaviors?

4. Design and Method

4.1 Contexts

In these years, Shanghai has been focusing on the IT construction in basic education and supplying personalization and ubiquitous quality education to learners from the aspect of policy and practice. The experiment school we choose is one of the earliest experimental bases for Information technology education in Chang Ning district in Shanghai. Chinese, Mathematics, English, Geography and other disciplines are involved into ICT support teaching research projects.

The reason why this study chooses geography as the experimental subject is that, this subject has its own website and laboratory room to support students studying in a ubiquitous learning environment; furthermore, in geography class reading and remembering a lot of information in maps and pictures are required. It has a high demand for color and multiple media. Therefore, geography materials are more suitable for the student to carry on digital reading.

4.2 Participants

Two studies were conducted to investigate usage of network in middle school students and understand students’ acceptance of digital reading while they engage in collaborative inquiry-based learning. The participants in two studies are all from one middle school in Chang Ning district in Shanghai.

In the first study, there were 1327 student participants. A survey is designed to analyze the usage of network and social software (eg. Wechat). The second study tries to understand how digital reading can be integrated into a collaborative inquiry-based learning. In the second study, 102 students
in grade 7 were involved. They were between 14 and 15 years old (49.1% female, 50.9% male). The experiment was conducted during their geography study.

4.3 Instruments

In the first study, a questionnaire is designed to investigate students’ network usage. This questionnaire has 16 items which includes respondents’ basic information, usage of network and social software.

In the second study, we use the reading motivation scale based on the Motivations for Reading Questionnaire (MRQ) which designed by Wigfield (1996) to measure students' reading motivation. The MRQ contains 54 items and assesses 11 possible dimensions of reading motivations, including reading efficacy, reading challenge etc. It can be used with children in late elementary school and middle school.

On measuring students’ acceptance of digital reading, this study uses a model of technology acceptance to examine students’ feeling about using mobile devices to read and learn in a cooperative geography learning course. This questionnaire is adapted from the technology acceptance model (TAM) which has been widely used to study user acceptance of new computer technologies.

By observing the students’ digital reading behaviors in geography class, we designed a digital reading behaviors questionnaire (6 items) to analyze the correlation between degree of acceptance of digital reading and digital reading behaviors.

4.4 Design

This study integrated reading process into in a ubiquitous Jigsaw cooperative learning environment. During four weeks inquiry-based learning activities, whether there is a significant correlation between students’ reading motivation and digital reading acceptance and test scores are investigated.

Our study choose ‘1.4 Hu-Ning-Hang district’ of the seventh grade geography course as research content. The four-week inquiry theme was “the design and production of thematic maps in Hu-Ning-Hang district in Shanghai”. The detail of learning activity design as shown in Table1.

Table 1: Learning activity design of Hu-Ning-Hang district

<table>
<thead>
<tr>
<th>the stages of Inquiry Learning</th>
<th>Students’ activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1a: expert views on one aspect of background research</td>
<td>Students were separated into four expert groups which read different digital materials. During the reading phase, students should utilize the annotation services to make annotations (such as highlighting and underlining) on emphatic text and then answered the inquiry questions in MOODLE.</td>
</tr>
<tr>
<td>Stage 1b: Background research on all aspects of Hu-Ning-Hang district in Shanghai</td>
<td>Reorganized new teams which each team was made up by four different experts and every team discuss the questions in MOODLE and made a presentation.</td>
</tr>
<tr>
<td>Stage 2: Design proposal preparations</td>
<td>Read digital materials the teacher offered, each team chose what kind of thematic map they wanted to make. And find relevant information online, copy useful information and upload the final version to the MOODLE.</td>
</tr>
<tr>
<td>Stage 3: Peer review of design proposals for the thematic map in Hu-Ning-Hang district in Shanghai</td>
<td>Draw the thematic map on computer or ipad according to the design proposal, and then upload the final thematic map to MOODLE.</td>
</tr>
<tr>
<td>Stage 4: Summary and reflection</td>
<td>Discussed and evaluated other teams’ works in the</td>
</tr>
</tbody>
</table>
The following questions were posted by the researcher in four stages to support the online discourse in a ubiquitous environment:

Stage 1a: Expert views on one aspect of background research
Question: Imagine you are a geologist, how would you introduce related information to someone who wants to know the advantages and disadvantages about geographical location, natural conditions, economic production, tourism and cultural aspects in Hu-Ning-Hang district in shanghai? Give your opinion.

Stage 1b: Background research on all aspects of Hu-Ning-Hang district in shanghai
Imagine you are one member of the Group of Experts on of China Geography, and you have been asked by the superior to design a thematic map in Hu-Ning-Hang district in shanghai:
Question 1: After reading some case studies about thematic map, what processes or stages do you think would be involved in developing a thematic map? Make a decision about what kind of thematic map your group would design.
Question 2: What information do you need? How do you decide which information is needed? Why is the information important?

Stage 2: Design proposal preparations
The superior has listened to the presentations of the expert groups and he would like all design groups to answer a few further questions during the preparations of the design proposal.
Question 1: What kind of materials are you intending to put into your thematic map?
Question 2: How to use your thematic map and what are the advantages of it compared with general map?

Stage 3: Peer review: review the designed proposals for the thematic map in Hu-Ning-Hang district in shanghai.
Question: after reviewing other groups’ proposal, can you tell why do they design their thematic map like this? Based on the aspects of knowledge acquired in stage 1 and 2, would you elaborate factors that influence their design proposal?

Stage 4: Summary and reflection
Question: Now you have completed design of a thematic map in Hu-Ning-Hang district in shanghai. Based on your insights and knowledge gained over the four stages, can you discuss for some thematic map design theories specific to Shanghai for next year’s students?

4.5 Data resources and method

In the first study, 1327 questionnaires were collected from all the students in this experiment school. In the second study, the reading motivation scale was distributed before the experiment, degree of acceptance of digital reading questionnaire and digital reading behaviors questionnaire were distributed after the four- week courses. 102 questionnaires were collected, of which 91 are valid. A correlation analysis was used to investigate the correlation with students’ reading motivation, degree of acceptance of digital reading and digital reading behaviors. All analyses were conducted by using SPSS version 19.0.

5. Analysis and Results

5.1 Usage of network and ubiquitous technology

In order to know the students’ network and ubiquitous usage, a survey were conducted in this experiment school. The following section describes some important results.

In terms of the network usage, over half students (53.05%) prefer using smartphone to search information online. And only 95 out of 1327 students do not use internet. In the question of “Do you really like the Internet”, almost 72% students very like internet, and most of them (65.56%) have ability
of self-control, knowing when and how to use internet. In addition, when students meet difficulties in study, they (55.09%) first choose to search solutions online. Thus the data can imply that internet has become a large part of the students’ life and they were familiar to use these internet devices with their own preferences.

As to students’ attitudes about smartphones, 75.51% participants have a smartphone and the trend is still increasing. 91.18% participants think smartphone can be used as a learning tool. Smartphone can be regarded as a kind of ubiquitous technology tools which supports students to learning at anytime, anywhere. From the results, the participants’ attitudes about smartphone is positive and they (43.48%) think smartphone don’t affect their learning in a bad way.

In terms of the social software usage results, although over half of the participants (60.74%) still use phone or message to contact with family and friends, 39% prefers to use some social software such as QQ, Email, Wechat etc. And 945 participants (71.21%) have kept online in Wechat all day.

5.2 The relationship between reading motivation, learning outcome and students’ acceptance of digital reading

Seen from table 2, participants’ reading motivation and the reading scores of geography lesson were positively correlated, and reached statistical significance (r=. 269, P<0. 01) in a digital reading environment. These results supported the comment that reading motivation affects directly the reading scores (Wigfield &Guthrie, 1995). Therefore, when students study in a digital learning environment, the one who has stronger reading motivation will has a better reading score.

<table>
<thead>
<tr>
<th></th>
<th>reading motivation</th>
<th>Geography scores</th>
<th>Acceptance of digital reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>reading motivation</td>
<td>1</td>
<td>.269**</td>
<td>.285**</td>
</tr>
<tr>
<td>Geography scores</td>
<td>Pearson correlation</td>
<td>.269**</td>
<td>1</td>
</tr>
<tr>
<td>Acceptance of digital reading</td>
<td>.285**</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

The result also indicated positive correlations between participants’ reading motivation and degree of acceptance of digital reading reached statistical significance (r=. 285, P<0. 01). So when students’ demands for reading are higher, they show more positive attitudes for digital reading and more willingness to accept this new reading method. Among the sub-items of reading motivation (not shown), reading curiosity and reading efficiency are correlated with degree of acceptance of digital reading, but not very strong. Thus, if students have more desire and curiosity to read, they would prefer to try fresh reading methods. Therefore, it means that teachers should take students’ reading motivation into consideration while using ubiquitous technology, in order to increase students’ acceptance of digital environment. In these results, one thing should be considered is that although the co-relations are statistically significant, its effect sizes (r square) are not that high, which led to this result may be due to test questions in geography might not very relevant with digital reading contents. It will be improved in the further research.

5.3 The correlation between degree of acceptance of digital reading and digital reading behaviors

Students’ acceptance of digital reading show high correlation with participants’ reading behaviors which reached statistical significance (r=. 706, P<0. 01) as shown in table 3. In a cooperative
inquiry-based learning environment, if a student has a high degree of acceptance when he read digital materials, it means his digital reading behaviors will be more active. Results from table 4 indicated that all the sub-items of digital reading behaviors correlated highly with students’ degree of acceptance of digital reading. This study focuses on students’ digital reading behaviors including using navigation, highlight, clicking hyperlinks, taking notes, searching tools, and reread the notes or highlights they have made, which can support students reading and understanding. Thus, the higher degree of acceptance of digital reading students have, the better they can adapt to digital reading. They will use digital reading tools more actively.

Table 3: The correlation between degree of acceptance of digital reading and digital reading behavior (N=91)

<table>
<thead>
<tr>
<th>Acceptance of digital reading</th>
<th>Digital reading behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance of digital reading</td>
<td>Pearson Correlation</td>
</tr>
<tr>
<td>Correlation</td>
<td></td>
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<tr>
<td></td>
<td>.706**</td>
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</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4: The correlation between degree of acceptance of digital reading and subitems of digital reading behavior (N=91)

<table>
<thead>
<tr>
<th>Acceptance of digital reading</th>
<th>Using navigation</th>
<th>Highlighting</th>
<th>Clicking hyperlinks</th>
<th>Take notes</th>
<th>Search tool</th>
<th>Reread the highlights/tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>.564**</td>
<td>.557**</td>
<td>.588**</td>
<td>.577**</td>
<td>.604**</td>
<td>.506**</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

6. Conclusion

This paper mainly presents two studies. From the first study, the results indicate that almost all middle school students have passion on network learning and have ability to acquire knowledge by using ubiquitous technology (e.g., iPad, iPhone); furthermore, “digital natives” would like connect other people by using social software (e.g. QQ, Wechat), they have a high level of using mobile devices; thirdly, as to ubiquitous learning, 72% participants think mobile phone can be a learning tool, their attitudes are positive. Overall, if a good guide can be provided to students about how to use ubiquitous technologies to support learning, it might help them using network better.

In the second study, participants completed digital reading and cooperative inquiry-based learning activities in a geography course. This study focuses on investigating students’ reading motivation, acceptance of digital reading and reading behaviors in digital learning environment. Results show that there’s a high correlation among reading motivation, students’ acceptance of digital reading and learning outcome. And if students have higher degree of acceptance of digital reading, their digital reading behaviors show more active. So when teaching in a digital learning environment, teachers can use some strategies to increase students reading motivation and students’ acceptance of digital reading, which might affect their learning behaviors and improve their digital reading performance and learning outcome.

Certainly, this paper still has some limitations that need to be considered. In the second study, limitations stem from its scope, particularly the size and composition of the sample population. And in the data analyses process, a few of incomplete data were deleted, it might effect on the results of correlation analysis. But we try to remain the maximum data authenticity. This study has found that the relationship between reading motivation, students’ acceptance of digital reading and digital reading
behaviors, there is a need for future research about how mobile technologies can be used to enhance learners' motivation and learning outcome.

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References


Visualizing Ubiquitous Learning Logs Using Collocational Networks

Kousuke Mouri ¹, Hiroaki Ogata², Noriko Uosaki³, SongRan Liu⁴
¹,²Faculty of Arts and Science and the Graduate School of Information Science and Electrical Engineering, University of Kyushu, Japan
³Center for International Education and Exchange, Osaka University, Japan
⁴Advanced Technology and Science, University of Tokushima, Japan
*{mourikousuke, hiroaki.ogata, n.uosaki, lb90518}@gmail.com

Abstract: This paper describes a system that can be used to visualize some ubiquitous learning logs using collocational networks to discover several learning patterns. Visualization of the system is based on vast amount of learning data in ubiquitous learning environment. Ubiquitous Learning Log (ULL) is defined as a digital record of what learners have learned in the daily life using ubiquitous technologies. It allows learners to log their learning experiences with photos, audios, videos, location, RFID tag and sensor data, and to share and to reuse ULL with others. This paper will reveal about the relationship between the ubiquitous learning logs and learners by using network graph and collocational networks. Also, this paper will explicate the system through which learners can grasp their learning time, histories, knowledge and location.

Keywords: ubiquitous learning, network graph, time-map, information visualization, collocational networks

1. Introduction

Recently, researchers in the educational engineering area have been studying focusing on ubiquitous themes. For example, CSUL (Computer Supported Ubiquitous Learning) or context aware ubiquitous learning (u-Learning) have been constructed using computing technologies such as mobile devices, QR-code, RFID tag and wireless sensor networks (Hwang et al., 2008; Ogata & Yano, 2004). These learnings take place in a variety of learning space such as classroom, home and museum. Also, the cutting-edge technologies can provide the right information using the contextual data like location, surrounding objects and temperature.

Therefore, many researchers have been focusing on effective learning with ubiquitous technologies. We have developed ubiquitous learning system called SCROLL (System for Capturing and Reminding of Learning Log) (Ogata et al., 2011). The system will support international students to learn their target languages. Traditionally, international students take memos when they have learned something in their daily lives. However, if the notes have not been taken in detail, they can neither actively recall what they have learned, nor the location where they learned them. Therefore, we have proposed SCROLL which enables learners to recall their past learning experiences by saving them to the system with location, photo, or video as digital records.

Also, these learning dataset include spatiotemporal data. Spatiotemporal data usually contain the states of an object, an event or a position in space over a period of time. These datasets might be collected at different locations, various time points in different formats. It poses many challenges in representing, processing, analysis and mining of dataset due to complex structure of spatiotemporal objects and the relationships among them in both spatial and temporal dimensions (K.Venkateswara Rao et al., 2011, 2012).

Similarly, it poses many issues about relationship between the learners and the ubiquitous learning logs due to complex structure of the ubiquitous learning logs in SCROLL. In addition, it is important for learners to recognize what and how they have learned by analyzing and visualizing the past ULLs, so that they can improve what and how to learn in future (Ogata et al., 2011). To tackle these issues, it is necessary to reveal relationships between the learners and the ubiquitous learning logs.
Therefore, this paper proposes a method to visualize relationships between the learners and the ubiquitous learning logs using Time-map, network graph and collocational networks. The objective of this study will reveal what and how the learners learned language in their daily lives. Therefore, this paper is aimed to recommend appropriate learning patterns and trends for the learners, using collocational networks.

2. Related Works

2.1 Learning Analytics and Knowledge

In recent years, Learning Analytics and Knowledge (LAK) has been drawing an attention from researchers of such fields as educational engineering, information science and network science. To date, Course Management System (CMS) and Learning Management System (LMS) enabled us to record learners’ access logs onto server. The Learning Analytics (LA) aims for practical use based on learning mechanisms revealed by visualizing, mining and analyzing vast amount of learning data (Ferguson 2012). This paper focuses on the Social Learning Analytics (SLA), a subset of the LAK (Buckingham 2012). The SLA puts forward presenting appropriate information to learners at the appropriate timing through the Dashboard in real time. As a new challenge, this paper aims to reveal about relationships between learners and learning logs on spatiotemporal fields.

Therefore, this paper is expected to contribute to educational improvement and strategies below.

- This study facilitates the analysis of learners by visualizing all data on spatiotemporal.
- This study enables future prediction about learners and learning environment from visualized learning logs.

2.2 Time-map

Time-map is a library of javascript, which collaborated with Google map and SIMILE (Semantic Interoperability of Metadata and Information in unLike Environments) TimeLine (SIMILE project). SIMILE focuses on developing robust, open source tools that empower users to access, manage, visualize and reuse digital assets. The time-map function means that the user can scroll the timeline and then the Google map will display the learning logs recorded during learners’ selected period. It is designed to help learners to reflect what they have learned. For example, if a learner clicks his learning logs on timeline, Google map will display their positions as shown in Figure 1. After visualizing log information, Time-map will facilitate learners to reflect on their logs with spatio and temporal information. They are able to grasp their learning context and time zone. Also, it is a possibility that the geographic information is a clue of recalling what they have learned.

![Figure 1: Time-map](image-url)
3. Design of the system

3.1 SCROLL

With the evolution of the mobile device, people prefer to record learning contents using mobile devices instead of taking memos on paper. Most of the language learners have their own learning notes. In this paper, learning log is defined as a recorded form of knowledge or learning experiences acquired in our daily lives.

One of the objectives of SCROLL is to support international students in Japan to learn Japanese language from what they have learned in formal and informal setting. It adopts an approach of sharing user created contents among users and is constructed based on a LORE (Log-Organize-Recall-Evaluate) model which is shown in Figure 2 (Ogata et al., 2011).

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones shown in Figure 3. The server side runs on Ubuntu 12.04.2 and it is programing using Java, Spring MVC and Mybatis. The developed software for Google phone is a native java application based on Android SDK (Li et al., 2012).

3.2 Collecting a ubiquitous learning log on SCROLL

The learners can record some learning language such as English, Japanese and Chinese with a photo using android device and SCROLL as shown in Figure 4. Figure 5 shows a learning log on android device.
The learning log includes meta-data such as author, language, created time, location (latitude and longitude) and tag. The learners will record or review a learning log using these functions on android device. Such iterative learning is supported by our quiz function on SCROLL. There are three types of quizzes generated automatically by the system, which are yes/no quiz, text multiple-choice quiz and image multiple-choice quiz. Figure 6 shows an image multiple-choice quiz interface generated automatically based on the meta-data of ULLs.

3.3 Structure based on network graph in SCROLL

To reveal several relationships between the learners and knowledge or knowledge and location, we have uniquely defined them as three-layers structures as shown in Figure 7.

The upper layer contains each author in order to confirm position of own or other learners. The intermediate layer contains the knowledge that learners learned. Also, some fields of learning tasks can be included in this layer. For example, some task-based learning in ubiquitous learning
environment can be carried out using knowledge and event (Mouri et al., 2013; Sharon 2013). The scalability of the layers can be enhanced and the field of visualization can be widened by linking one’s own learning logs to the knowledge learned by doing tasks.

The lowest layer contains data such as location and time. In order to realize spatiotemporal visualization of our learning logs, nodes on the intermediate layer are linked to the nodes on the lowest layer.

Analysis by categorizing three-layers has following advantages:

- Places with a large number of links to the related knowledge are the places where they can learn a lot of knowledge. For example, if a certain supermarket or convenience are related with a lot of knowledge such as natto, green soy beans, tofu, miso soup, and cup noodle, by analyzing relationships between the knowledge and the location the System can provide learners with a valuable learning information.

- Knowledge which is related to many places is the knowledge which we can learn in various places. For example, if a learner experience tea ceremony of a traditional Japanese culture at the university in Japan, a set of tea ceremony related knowledge (eg. tea, sit: to sit in the correct manner on a Japanese tatami mat) can be learned in other various places. The tea can be learned by purchasing at the supermarket and the seiza can be learned at the martial art gym.

3.4 Collocational networks in SCROLL

Collocational networks are two-dimensional networks which contain interlinked collocation, i.e. word which occur together in a text. The concept of collocational networks originates in an article by Williams (Williams 1998). In his study, Williams uses the network as a corpus linguistic tool in order to create specialized dictionaries. Also, Magnusson describes an important to visualize most central concept in the text. There are some collocational networks on the SCROLL. For example, if a learner A learned natto (a traditional Japanese food made from fermented soybeans) at the supermarket, he/she might learn other food at the same time. Therefore, the collocational network can show relationships between the knowledge and time. Similarly, it can show collocational relationships between knowledge and place and place and time.

In this paper, we propose a method using collocational networks in order to predict their learning patterns and trends in the future and to expand their field of view. Using recorded collocational data on SCROLL, this study have constructed the collocational networks.

Firstly, the collocational relationships between knowledge on the intermediate layer will link in time-series order what they have learned. For example, if the learner A learned a tofu in the next learning after studying natto, the natto and tofu on the intermediate layer will be connected. Also, if the learner B learned a green soy beans after studying a natto, the natto and the green soy beans on the intermediate layer will be connected in the same way. By linking their knowledge and knowledge in the next learning, SCROLL can be predicted knowledge that they might be able to learn in the next learning.
However, their notable knowledge is a possibility which is connected many edges. For example, after
the learner A and B learned the natto, there are two learning path as described above. That is, there are
two paths of "they learn the tofu after learning the natto" and "they learn the green soy beans after
learning the natto" as shown in figure 8 (left network image). Figure 8 is one of an example of some
learning patterns, and there are many learning patterns in actually in the ubiquitous learning
environment.

Secondly, in this paper, we attempt to categorize the names, such as hospital, university and
restaurant of nearest place where they have learned, using Google place api from the latitude and
longitude of past ubiquitous learning logs. Also, some buildings acquired from its place include a lot
of attributes. Hence, it is necessary to construct collocational network including the place and the
attributes.

For example, if a learner A learned the word such as "electronic engineering" and "computer
science" at the kyushu university in japan after studying some word such as "ecology" and "biology"
at the tokushima university in japan, it is created edge to connect "tokushima university" to "kyushu
university" on the lowest layer. On the other hand, a learner B learned another word at the tokushima
station near the university after studying some words such as "ecology" and "biology" at the
tokushima university in japan, it is created edge to connect "tokushima university" to "tokushima
station" on the lowest layer. In addition, prediction of the next learning place is determined by the
number of the attributes of the place. For example, the collocational network shown in Figure 8 (right
network image) is connected from the tokushima university to tokushima station, marunaka
(Supermarkets' name in japan) and kyushu university. The attributes of the tokushima university
include "university" and "school". Similarly, the tokushima station includes "station", and the
marunaka includes "supermarket", "shop" and "food", and the kyushu university includes "university" and
"school". By comparing to attributes of three types, it is evident that the attributes of the
tokushima university and kyushu university are same.

Therefore, there are a possibility that two learning place are high relationship. However, there is a
possibility that the distances between two places are a far. That is, it is necessary to calculate the
distances between current position of the learner and target learning place. Also, as described above,
to expand a field of their view regarding the place is effectiveness in order to understand learning
situation and context.

4. Implementation

This section describes ways of the implementation of the system for visualizing the three-layer
structure using network graph using collocational networks and Time-map.

4.1 System for visualizing network graph in SCROLL

4.1.1 How to create node or connect edge on three-layers

Firstly, system for visualizing network graph will create authors' node on the upper layer. To date, the
number of learners in SCROLL is approximately three thousand people.

Secondly, the system will create knowledge node on the intermediate layer. Then, the system will
connect authors' node related to knowledge node that learners have learned. For example, if learner A
learned a learning log like “natto”, “tofu (bean curd)” and “sushi”, the system will connect "learner A"
of node on the upper layer to "natto", "tofu" and "sushi" on the intermediate layer.

Thirdly, the system will create location node on the lowest layer. Then, the system connect
knowledge node on the intermediate layer to node of the location on the lowest layer. For example, if
the learner A have learned knowledge of "natto" at the supermarket in Japan, the system will connect
"natto "on the intermediate layer to the latitude and longitude of "supermarket" on the lowest layer.

4.1.2 Color of visualized nodes

The learners might get confused when they recognize past learning logs because there might be too
many of visualized nodes. Therefore, it is definitely necessary to establish some criteria for distinction
of each node. To effectively distinguish kind of each node, we defined as Table 1 below using node color.

### Table 1: Color to distinguish the kinds of nodes

<table>
<thead>
<tr>
<th>Node</th>
<th>Layer</th>
<th>Node color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner’s own name</td>
<td>Upper layer</td>
<td>Pink</td>
</tr>
<tr>
<td>Names of other learners</td>
<td>Upper layer</td>
<td>Blue</td>
</tr>
<tr>
<td>Representative learners</td>
<td>Upper layer</td>
<td>Green</td>
</tr>
<tr>
<td>Knowledge of learners</td>
<td>Intermediate layer</td>
<td>Yellow</td>
</tr>
<tr>
<td>Location of learners</td>
<td>Lowest layer</td>
<td>Red</td>
</tr>
</tbody>
</table>

- Pink color node shows the learner’s own name on the upper layer. If connecting the pink node to yellow node on the intermediate layer, edge color will be decided as pink so that they can be easily recognized as the learner’s own logs.
- Blue color nodes show the names of other learners on the upper layer. If connecting the blue node to yellow color node on the intermediate layer, edge color is decided blue color.
- Green color node shows the names of famous or representative learner on the upper layer. If connecting the yellow node to the green node on the intermediate layer, edge color will be decided as green color.
- Yellow nodes represent both the learner own knowledge and the knowledge of other learners. For example, the learner can recognize his own knowledge because edge between the learner own name on the upper layer and the knowledge on the intermediate layer is pink color. In addition, the learner might discover knowledge of other learners related to own knowledge.
- Red color node shows the location of learners on the lowest layer. The node includes latitude, longitude and created time.

#### 4.2 Combining network graph and Time-map

The interface of network graph for visualizing relationships between the learners and ubiquitous learning logs is shown in Figure 9. The learners can recognize relationships between own/others author and knowledge by using the network graph interface. Figure 9 shows an example of interface on collocational network based on knowledge. The network layout consists of using two basic layouts and an original layout.

The first layout consists of using Yifan Hu multilevel layout (Y.F Hu, 2001, 2005). It is a very fast algorithm with a good quality on large graphs. It combines a force-directed model with a multilevel algorithm to reduce the complexity. The repulsive forces on one node from a cluster of distant nodes are approximated by a Barnes-Hut calculation (Barnes and P. Hut., 1986), which treats them as one super-node.

The second layout consists of using the random network. It is simple algorithm generating them randomly on the graph after filtering some nodes, and then the system will connect relationships related between node and node.

The third layout consists of using original layout we have developed. As shown in Figure 9, the layout regards x axis as time axis. In this figure 9 case, the knowledge that they might be studying in the next learning after studying the natto will be generated to right side in constant interval (Next knowledge are tofu, coffee, router and kimchi).

Recommendation objects in Figure 9 are shown rankings in the learning trends in order to expand a field of their view from visualized ubiquitous learning logs on the network graph. By arranging the in-degree centrality in the high order from the ubiquitous learning logs that they might study in the next learning, the learners are able to recognize famous or representative learners and important knowledge.

Time-map function in Figure 9 consists of the timeline and Google map. It represents the shift of learning history in accordance with lapse of time. The learners might forget the learning logs when and where they have learned before. Therefore, the system can remind the learners of them by
combining timeline with map. The system will remind them of their learning logs recorded during the specified period of time by showing them on the timeline (default: two month before and after the setting time). Besides, the system will lead them to be aware of knowledge recorded right before or after the knowledge of their interest which was recorded by other learners. Therefore, it will give them a clue on what to learn in the next learning.

5. Conclusion and Future work

This paper described the system for visualizing relationships between the learners and the learning logs, using collocational networks. International students can add their knowledge as the learning log in SCROLL, and then SCROLL can provide learning contents to recall what they learned based on their learning contexts. By using the system that we proposed, the international students can discover the knowledge related to others learners and the interesting knowledge.

In the future, we will develop a new function so that the system can analyze various situations focusing learning analytics such as network analysis (Freeman 1978; Shane 2014), decision tree (Bitner 2000) and association rule (Florian 2005).

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SIMILE project: http://www.simile-widgets.org/timeline/


The Research of China’s Policies and Practices of Life-long Learning in U-learning Environment

Bingqian JIANG\textsuperscript{a}, Jun XIAO\textsuperscript{b}, Jing LENG\textsuperscript{a}, Xiaoqing GU\textsuperscript{a}

\textsuperscript{a}Department of Education Information Technology, East China Normal University, China
\textsuperscript{b}Shanghai Engineering Research Centre of Open Distance Education, Shanghai Open University, China

\textsuperscript{a}51130104045@student.ecnu.edu.cn

Abstract: Recently, life-long learning and u-learning are significant concepts in the area of technology-enhanced learning that have changed learning. This paper begins with an overview of u-learning and life-long learning. And then, it focuses on the review of China’s national policies of life-long learning. By using Keller’s Attention, Relevance, Confidence, Satisfaction (ARCS) model, it finally analyzes Shanghai Life-long Learning Network as the practice case.

Keywords: life-long learning; u-learning; national policies; learning platform

1. Introduction

The 21\textsuperscript{st} century is an era of knowledge economy and one reform after another has been happening in the education and learning area. Nowadays, the idea of life-long learning has won more and more popularity among people from all walks of life. Building a life-long learning system is no longer just an idea or concept, but evolves into an actual practice of education reform and social activities from which the system is enriched and becomes mature. With the rapid development of computer technology and network communication technology, a new learning mode based on ubiquitous computing technology-ubiquitous learning, emerges as the times require. Ubiquitous learning is very flexible and practical as anyone who wants to learn could receive education in any form and at any time. This learning concept offers a brand-new life-long learning mode and provides new opportunity for the development of life-long learning, which greatly promotes the building of life-long learning system.

This paper first explores life-long learning theory and ubiquitous learning theory and then makes an interpretation of the future development of current life-long learning from the perspective of China’s policy planning. Using Shanghai-an economic center city as the research setting and combining ubiquitous leaning mode, the author investigates the current status of Shanghai’s life-long learning system which has adopted ubiquitous learning mode. Then we analyze the design of public service platform open to life-long learners as the case of the infrastructure construction of national policies.

2. Literature Review
2.1 Ubiquitous Learning Overview

As technology becomes more powerful, ubiquitous learning (u-learning) has been a mainstream way of learning in recent years. There are different views in defining and characterizing u-learning, but most researchers believed that u-learning derived from the concept of ubiquitous computing. The term “ubiquitous computing” was coined by Mark Weiser, described as “the calm technology, which recedes into the background of our lives”. His vision allows people and the environment with the combination of various computational technologies to exchange information and services at anytime and anywhere (Weiser, 1991). Then, “ubiquitous” was used into the field of education, promoting the generation of “u-learning”. Birgit Bomsdorf pointed out, that “ubiquitous computing leads to ubiquitous learning allowing to embed individual learning activities in everyday life.” (Bomsdorf, 2005)

To some extent, u-learning combines the strength of e-learning and m-learning. Dey Casey (2005) formulated the view of “u-learning = e-learning + m-learning”. Although there are various views of u-learning, a broader definition of it is “anywhere and anytime learning”. U-learning is intended to build a learner-centered intelligent environment, supporting learners use all kinds of terminals to access learning content regardless of time and place. In u-learning environment, learning will be more likely to happen, learning support services also will be more humanization, and learners' interaction with the environment will be further strengthened. U-learning truly reflects the “people-oriented” learning conception and brings innovation of learning styles.

2.2 U-learning and Life-long Learning

2.2.1 The related concepts of life-long learning

“Life-long learning” and “life-long education” are inseparably two concepts. Both of them are proposed and evolved in the basis of human social change, under the background of human society transformation from industrial economy to knowledge economy. Life-long education thought that education should be throughout the beginning and end of life. In other words, people can also accept education via kinds of ways after the completion of compulsory education or basic education. It breaks through the framework of formal school education, regards education as a continuous process in personal life, and implements a uniform from preschool to old age throughout the educational process.

Compared with “life-long education”, “life-long learning” emphasizes learner-centered, focuses on the diverse needs of learners. From the perspective of individual learners, learning is not only the need of earning a living, but also is the personal development need. It has become an essential part of one’s life. 1st Global Conference of Life-long Learning proposed that life-long learning is the 21st survival concept (Longworth & Davies, 1994). People obtain knowledge, change behavior, and develop ability by continuous learning. Promoting life-long learning is an important means to deal with the world of social development needs.

U-learning refers to education is no longer limited by time and space, realizing “anywhere and anytime learning” from a technical point of view. Life-long learning emphasizes a type of learning concept, and the u-learning focuses on the learning support from technology. But they have consistency in concept hierarchy – the meaning of continuous learning. U-learning is more flexible and practical that learners can accord their characteristics and needs to choose the most suitable learning for their own, and the learning time, place, content and ways are all personal. In some sense, u-learning makes it possible to access learning network and get learning service anytime and anywhere. It provided a new
learning model for life-long learning, adapted to the needs of life-long learning, is also expected to be a strong support for the built of the learning society.

The concept of the “learning society” emerged with two authors in the 1960s and 1970s. It is closely related to life-long learning and life-long education. After much debate, UNESCO (2005:60) offered the following as a view of the learning society:

Thus, learning, as a phenomenon may generalize at all levels of our societies and offer a model for organizing the time, work and lives of our institutions. Such an evolution illustrates a paradigm shift. On the one hand, education and learning can no longer be confined to a set and settled space-time, but may develop over a lifetime. On the other hand, the human actor must be put at the heart of the continuing process of knowledge acquisition and communication.

Therefore, building a learning society and cultivating life-long learning ability are necessary conditions for implementing life-long education.

2.2.2 National policies of life-long learning

Life-long learning theory has brought profound changes in the field of education; u-learning has given new idea for it. In order to put forward life-long learning and the construction of a learning society, government has been drawn up many polices.

Currently, China is using IT to propel modernization and industrialization, promoting life-long education actively, thereby constructing the life-long learning system. In 2002, the 16th National Congress of the Communist Party of China clearly put forward that constructing a learning society would be an important goal of building well-off society in an all-around way in the first 20 years of this century. Subsequently, the national Ministry of Education had further made explicit strategic plan of "the education information construction projects": promoting community education actively, constructing life-long learning system rapidly, and facilitating learning society in the paper of "2003-2007 Year Education Promotion Motion Plan". In 2010, the Outline of China's National Medium-and Long-Term Program for Education Reform and Development (2012-2020) (the Education Reform and Development Outline) proposed “focusing on the construction of Chinese education information public service system and learning society support service system”, in order to realize rapid development of China’s education. After that, the Ministry of Education authorized China’s Ten-Year Plan for Educational Informatization(2011-2020) to confirm the tasks of the Education Reform and Development Outline. Meanwhile, the Ten-year Plan asked to build flexible, personalized IT learning environment which can meet learning needs of different groups and provide high-quality educational resources for everyone.

Under the guidance of central government policies, local governments at various levels have developed a series of policies in response to this trend. Shanghai as China's largest city, with a cosmopolitan, open and strategic vision, on behalf of China's most advanced development. As early as in 1991, Shanghai had already proposed to create a learning society and to practice life-long learning. In 2003, Shanghai Propaganda Department, Information Commission and other two departments jointly issued Opinions on Promoting the City's Community and Cultural Information Integrated Services Construction. Combing with the degree of Shanghai Educational Informatization, this issue asked to use modern information technology to construct educational public service platforms throughout the city, and to motivate community informatization. In 2006, Shanghai multiple government published Guiding Opinions on Promoting the Construction of a Learning Society on the basis of Shanghai’s realities of situation. Two goals are proposed in this document: initially set up "Anybody can Learn
“Anytime and Anywhere” framework of learning society; built diverse, multi-leveled, accessible and open life-long learning system which provides formal education and leisure culture education. *The Outline of Shanghai Medium-and Long-Term Program for Education Reform and Development (2010-2020)* is another typical policy that is proposed in 2010. This policy is aimed at promoting and integrating high-quality educational resources, improving the learning infrastructure and service system, building IT public service platforms”. And this aimed at establishing 21st century city u-learning environment, providing personalized learning service for learners; thereby bring about leapfrog development in the education informatization.

3. Methodology

As guided by national policies, China is building the learning society, and setting up public learning platforms is an important means and guarantee to realize it. Relying on abundant learning resources and learner-centered design, good learning platforms can provide rich learning experience for learners, and stimulate learning motivation. The life-long learning, u-learning and relative polices all emphasize the personal learning support system of learning platforms.

This paper synthesizes learners’ motivation and advantages of u-learning, and analyses the construction of learning platforms with ARCS model. The ARCS model is based upon the macro theory of motivation and instructional design developed by Keller (1979, 1983). Because of the boring content and short learning support, distance learning had high drop-out and low completion rates. The ARCS model was intended to change this phenomenon and stimulate learner’s motivation originally. Although many changes have taken place, the ARCS model is significant in learning design.

The ARCS model defines four major conditions (Attention, Relevance, Confidence, and Satisfaction) that have to be met for people to become and remain motivated.

3.1 Attention

The first condition, attention, is an element of motivation and is also a prerequisite for learning. The motivational concern is for getting and sustaining attention. Although stimulate and sustain motivation refers to many other aspects and through the whole learning process, drawing and sustaining learners’ attention are also the first and the most important step.

3.2 Relevance

Relevance is closely related to the learners. It may not come from the learning content; it can come from something is taught. According to expectations and value theory, the relevance of learners’ learning objectives and learning content can determine their learning depth. To the extent that a course of instruction offers opportunities for an individual to satisfy these and other needs, the person will have a feeling of perceived relevance.

3.3 Confidence

Some people never quite achieve success even when the odds are in their favor; others always seem to excel through no matter what the odds. Differences in confidence, the third major component of the
ARCS model, can influence a student’s persistence and accomplishment.

3.4 Satisfaction

This category incorporates research and practices that help make people feel good about their accomplishments. According to reinforcement theory, people should be more motivated if the task and the reward are defined, and an appropriate reinforcement schedules used. There are several factors that contribute to one’s level of confidence, such as feedback, rewards and evaluation.

In summary, these four categories form the basis of the ARCS model. It is always further improved with the development of education informatization. In this paper, we use this model to analysis the construction of a learning platform – Shanghai Life-long Learning Network.

4. Analysis and Results

In 2000, Shanghai began to construct “ten learning websites and one educational resource center” according to the trend of education informatization. Following the goal of initially establishing "Anybody can Learn Anytime and Anywhere" framework of learning society “Anyone learns at Anywhere and Anytime” by 2010, Shanghai started to build digital life-long learning system on the basis of “ten learning websites and one educational resource center”. Shanghai Life-long Learning Network as an important part of this system has the most extensive study objects and the most comprehensive learning resources.

Shanghai Life-long Learning Network is a highly interactive educational website which opens to people of all educational levels and backgrounds within Shanghai province. The network provides people the opportunity of accessing a vast range of high-quality educational resources, and embodies an integration of multiple functions such as courseware search, learning, exchange, testing and evaluation. It is a large-scaled online learning platform that can help users effectively learn, investigate, manage and collect a great variety of information and materials. Figure 1 is the using flow chart of Shanghai Life-long Learning Network.
4.1 Courses Learning

Shanghai Life-long Learning Network provides a vast range of learning resources. People can use key words, contents or the various guidance of the platform to find the courses they want. The rich learning resources cover basic education, higher education, vocational education and life-long education, including linguistic literacy, information technology, career guides, and other various themes. Learners can choose the modes by themselves to learn the courses they appreciate, such as text reading, video browsing, audio lectures, three screen courseware, and micro learning.

Besides, there are “activities”, “reading”, “learning community” learning modules to provide learners with a wide range of popular e-books and interactive activities in the Shanghai Life-long Learning Network. For example, 2014 Shanghai community family talent show will be hold recently.

Additionally, the personalized resource recommendation system in Shanghai Life-long Learning Network can recommend high-quality courses with high evaluation by similar users on the basis of the learners’ learning records, vocation, and interests as the figure 2 shows. The personalized resource recommendation system is more convenient for users to check the courses, which saves a lot of browsing and course finding time to a large degree and allows more users to be involved in the Life-long Learning Network.

Rich learning resources and activities will attract learners’ attention, and make it easier for learners to acquire relevant knowledge and satisfy their basic motives. And the recommendation system could help learners find relevant courses. These designs meet the “Attention” and “Relevant” requirements of ARCS model.
4.2 Learning Process Management

As figure 3 shows, learners are always being remained or encouraged by learning process management during their learning process. By comparing the personal learning process to the common, Shanghai Life-long Learning Network help advanced learners to build self-confidence and encourage backward learners to do much better. Learning process management is an important way to sustain learners’ attention and help them gain confidence.

4.3 Personal Learning Space

Personal learning space is to allow learners easily master and manage their personal information. With chased curriculums presented in this space, it records all the information of learners in Shanghai Life-long Learning Network, including learning partners, online activities, discussion, and tests and so on. This information can set up a personal file for learners and record their learning activities. It can also help attract their attention to the study and remind the learning situation.
4.4 Learning Interaction

In the learning process, Shanghai Life-long Learning Network provides an “Activities-Forum-Lecture” three-dimensional interactive learning system for learners to confirm the learning success. Learners can join into the course forum to discuss with other students as soon as they choose it. And this can help them find their partners with same interests. Activities are the good way for learners to present their learning outcomes and share something with others. Lectures give opportunities for learners to communication with experts, and let them answer confusion posed by learners. Learning interaction can not only urge learners to complete courses from each other, also can bring confidence and satisfaction for learners.

4.5 Learning Motivation

In order to sustain learners’ attention and desire their learning satisfaction, Shanghai Life-long Learning Networks established the “Credits-Certificates-Titles” the integrated motivation system as figure 5 shows. Users will win credits and certificates through learning. The accumulated credits can also be used to change in-kind incentives.

Figure 5. Motivation system of “Credits-Certificates-Titles”

In addition, Shanghai Life-long Learning Network also provides for each learner a
personal learning passport shown in Figure 6. Personal Learning Passport records history and learning outcomes of learners, demonstrates learners’ awards in it. Learners can also access other people's learning passport, motivate each other and learn together.

![Personal Learning Passport](image)

Figure 6. Personal Learning Passport

According to ARCS model, Shanghai Lifelong Education Network can successfully attract and sustain learners’ attention. Its rich learning resources and various presentation ways makes it easier to find relevant and interesting knowledge. It also has a complete record and motivate system to help learners build up confidence and feel satisfaction.

Since the official opening up of the Shanghai Lifelong Education Network on the 14th of April, 2009, the number of hits to the website within the first two weeks has reached 136,000 and the free online registration has reached 13,211. It is a successful social practice that supported by China’s national policies.

5. Conclusion

The development of life-long learning in u-learning environment has attracted a great deal of attention in recent years that policies are proposed and infrastructure is constructed. Under the guidance of national policies, China has made efforts for the learning society to give life-long learners good learning environment. As the economy center of China, Shanghai is the largest city with the most advanced technologies and ideas. The construction of Shanghai Life-long Learning Network is a good example. Such platform reflects China’s policies, meanwhile, has the potential to inform new policy-making and provides makers a vision towards drawing up better policies.

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Phonic Social Network Software Scaffolds Language Learning in Ubiquitous Learning Environment

Huwen WANG, Jing LENG & Xiaoqing GU*
Department of Educational Information Technology, East China Normal University, China
* xqgu@ses.ecnu.edu.cn

Abstract: Many kinds of applications were developed to support learners in ubiquitous learning environment. Among that, social networking software (SNS) plays an increasingly important role in various educational settings. In this paper, we integrated a phonic SNS papa into language leaning in ubiquitous learning environment. The research investigated the general usages of papa and examined that to what extent the use of papa could effectively improve language learning. The results indicated that the use of papa as a SNS does promote the language learning among lower age students. The ability to speak or talk is also improved.

Keywords: Ubiquitous learning, phonic social network, language learning

1. Introduction

Ubiquitous Learning (u-Learning) refers to a learning model in which the learners can learn anytime and anywhere with the aid of mobile devices and wireless communication (Phumeechanya & Wannapiroon, 2014). The u-learning environment is supported by embedded and invisible mobile devices in daily life (Ogata & Yano, 2003), allowing students to immerse themselves fully into different learning situations (Chin & Chen, 2013) and to interact with others at any time (Weiser, Gold, & Brown, 1999).

With the popularity of mobile devices, many kinds of applications were developed. Most of u-learning applications were extended from ubiquitous computing projects and later were focused on language learning systems to support teaching and learning activities (Chin & Chen, 2013) such as Japanese Polite Expressions Learning Assisting System (JAPELAS), Japanese Mimicry and Onomatopoeia Learning Assisting System (JAMIOLAS) and Language-learning Outside the Classroom with Handhelds (LOCH) (Yin et al., 2004; Yahya, Ahmad, & Jalil, 2010). Among u-learning applications, social networking software (SNS) plays an increasingly important role in various educational settings. Educators are exploring how SNS can be used as teaching and learning tools.

Nevertheless, many related researches focused on English as a foreign language (EFL) or second language learning (SLL) and almost all the information was represented on the social network by text and pictures. This study tries to investigate the potential use of phonic social networking application and how it improves language learning on ubiquitous learning environment. More specifically, the research questions are:

1. What are students' general practices or uses of papa?
2. To what extent the use of phonic SNS could effectively improve language learning?
2. Literature review

SNS, including communication tools and interactive tools, provides the basis for community driven content and social networking. Introducing SNS into classroom and other educational settings results in further empowerment of learners in a new way of communicating, collaborating, and interacting, which has been recognized as potentially powerful enabling tools for educational use. Learning through SNS is advocated by pedagogical theories such as authentic learning. There are four types of learning to ensure authentic learning through SNS: action, situated, incidental and experimental learning (Liu, 2009). Action learning is a social process of solving the difficulties, by involving that learners are doing things and thinking about what they are doing as well as a practical process where students learn by doing, by observing and imitating the experts, and by getting feedback from teachers and their friends. Situated learning is similar to action learning because learners are sent to school-like settings to learn and understand new concepts and theories to be applied later on in practice. Knowledge is developed through the authentic activities and important social interactions. Cognitive apprenticeship methods try to enculturate students into authentic practices through activities and social interaction in a way similar to that evident in craft apprenticeship. Incidental learning in education contributes to unintentional or unplanned learning that results from other activities (Kerka, 2000) through observation, repetition, social interaction, and problem solving (Rogers, 1997). Knowledge from incidental learning develops self-confidence and increases self-knowledge in learning. Incidental learning usually happens in the process of completing tasks using computers (Cahoon, 1996) and/or in the online environment (McFerrin, 1999). One form of the experiential learning is outdoor education which means an outdoor program to apply their new learning during an outdoor experience upon returning to the job in order to gain more insights through challenging activities. Learners integrate thoughts and actions with reflection from the outdoor experiences.

Compared to learning language specifically vocabulary by listening, talking and reading, learning words from abstract definitions and sentences taken out of the context of normal use, which is how vocabulary has often been taught, is slow and generally unsuccessful (Miller & Gildea, 1987). As people generally learn words and practice speaking in the context of ordinary communication by expressing his/her feeling through the words s/he has just learned, it is necessary to provide the context to learners for better language learning. A number of studies examine the use of multimedia tools or online SNS for language teaching and learning, particularly studies on reading comprehension and vocabulary learning. Research of Kabilan et al. indicates that university students consider Facebook as a useful and meaningful learning tool to support, enhance and strengthen English language learning (Kabilan, Ahmad, & Abidin, 2010). Aydin (2014) explored the level of learners’ interactions with their teachers on Facebook when learning English as a foreign language and found that students preferred passive behaviors regarding their interactions with their teachers. Arnold & Paulus (2010) integrated Ning, a publicly available SNS, into a blended course. The outcomes showed that the site effectively served as an information repository and the blogs and discussion forums promoted reflection and review of each other's work. HJEnglish, the most successful second language learning social network in China, engaged users into real English context in synchronous and asynchronous ways.

In a nutshell, SNS has positive effects and can be used on language learning. However, a limited number of studies focus on the first language learning through SNS. For lower age learners, their literacy is little. Being unable to type on the SNS is a great barrier to communication and language learning. The birth of phonic SNS provides a new tool of language learning for lower age learners.
3. Methodology

3.1 Participants

The participants included one teacher, 43 first grade students of 6 or 7 years old from a primary school in Shanghai. All the parents of the 43 students are well-educated and they can tutor their children to use digital products properly. The teacher, a female who was about 26 years old, has a 2-year working experience as a literacy teacher. She was keen on computer-assisted instruction and often integrates learning tools into the class activities. In this research, she interacted with students through papa.

3.2 Research Design

In this research, we chose papa as the tool to enhance language learning. In addition to the common functions of posting, following, sharing, comment, like, and/or adding to favorites of SNS, papa also has recording function. After capturing photos of the real-life contexts, the learners can upload them to papa and record descriptions for the photos. The 43 students were assigned to use papa on iPad during the whole fall semester in 2013.

According to the new National Curriculum Standard of China, first language learning in primary school emphasizes (1) words, vocabularies, sentences and articles; (2) emotional attitude and values; and (3) communication and social skills. In order to achieve those goals, Huang X. H., a primary school teacher agreed that students should seize every opportunity to learn language through (a) textbooks, (b) extracurricular books, (c) people around, and (4) the internet. Based on the requirements for first language learning, the participating teacher led the lesson design with the researchers’ guidance and support. The research consisted of the following main activities:

- Students practiced describing the reading materials the teacher provided once a couple of days.
- Students took photos they were interested in in real-life contexts. They then uploaded the pictures to papa and constructed verbal sentences with the newly acquired expressions and idioms.
  - Both the teacher and students could comment, share, like, and/or add others’ posts to favorites.

3.3 Data collection and analysis

The students were numbered from 1 to 43 randomly. At the end of the semester, contents from participants were transcribed from recordings on papa into words in Excel for analysis. We calculated the quantitative data to know students’ general use of papa. Qualitative analysis came from scaling process of the posts to know to what extent the use of phonic SNS could effectively improve language learning. Likert scale of 5 points was used to scale the content of post. The scaling scheme was adapted from YaoYing’s research about lower grade students’ language competence (YAO & SHI, 2013). The scheme consisted of two parts, (1) Practice reading the provided materials and (2) Describe your own photos. As for the first one, the teacher usually posts photos of a textbook page and assigns students to practice reading the sentences, paragraphs or articles. Each part had three dimensions to evaluate students’ language competence. The scaling process included eliminating posts that were not related to the designed activities and scaling by two assistant researchers according to the scale scheme. Before they started, they got approximately two hours of training to understand the scale and elaborate on the scale process.
4. Findings and Discussion

4.1 Survey results

At the beginning of the semester, a survey was conducted among all the students’ parents to learn whether the family owned any iPads and whether they would like to encourage their children to learn on iPad. 43 students whose parents had iPads and were very glad to share them with their children were chosen to compose an experimental class which was assigned to do this research. The parents were willing to engage in supervising the students’ study out of class and ensuring their kids to acquire the basic skills to operate iPads. Once there were students who had problems using iPads, the teacher or even the parents would offer 1:1 help.

4.2 Students’ general practices or uses of papa

Research question 1: What are students’ general practices or uses of papa?

Profile page, “following” and posts are common features of SNS. In this research, students’ profile pages were personalized, with all of the 43 students uploading photos and 27 students changing the background of their profiles. All participants in this research followed each other’s account on papa. As for “practicing reading the provided materials”, a student posted the records of reading together with the task requirements written on a picture. After the other students saw the picture and listened to the records, they would either click “like” or give some comments. The teacher would also listen to all the posts, and if necessary she would give positive reviews or point out some mistakes so that they could be corrected next time. As for “describe your own photos”, students could post any photos of beautiful sceneries or an interesting stories they took together with their records of photo description and wait for other people’s comments. In this way, the teacher and students could communicate with each other about their works asynchronously. The examples are as follow:

Teacher comments

to Student 13: You used a perfect words to describe the fruitfulness in autumn. But next time please speak slowly.
to Student 24: Good reading! I can see your improvement! But “琴” is pronounced as “qin” not “qing”.

Student 7 comments to Student 34: Don’t laugh when telling a story!
Student 16 comments to Student 28: How can you think of the metaphor?

An obvious interaction among participants on papa is clicking “like”. The data indicated that everybody got “like” and some students were much more active than others, as Student 20 and Student 7, got most “like” (3.5 and 3.2 “like” respectively), and Student 5 and Student 2 got least “like” (0.7 and 0.3 “like” respectively). Everybody is engaged in interaction on papa.

Except clicking “like”, papa achieved a higher level of visible student-to-teacher interaction compared to student-to-student interaction because the teacher has to trace the students’ post and know the students’ progress. It’s her responsibility to correct the errors or mistakes of students in time. The teacher takes on roles as organizers, prompters, participants, counselors or investigators.

4.3 Papa as a SNS that facilitates language learning

Research question 2: To what extent the use of phonic SNS could effectively improve language learning?
To figure out to what extent the use of phonic SNS could positively improve language learning, we calculated the average scores in term of month from the aspect of context, language skill and emotional attitude. Overall, students had a slow and steady improvement during the 5 months according to the values in figure 1. As a phonic social networking software, papa can transmit not only information through words and pictures but also emotion through voice and sounds. Thus at the beginning of the semester, the young students achieved lower scores in emotional attitude but improved greatly after the activity of “practice reading the provided materials” though papa. For the content and language skill, practice is the key influential factor. Through practicing, the student minimum skipped and additive words so as to read more fluently with fewer stutters and pauses.

We also calculated the average scores in term of month from the aspect of context, language skill and emotional attitude. On the whole, the scores indicated that students had an obvious and steady improvement during the 5 months according to the values in figure 2, especially the “content” and the “emotional attitude”. Whenever the students in a real-life context pertained to the newly learned phrases or idioms, sentences or stories are constructed with them and the stimulated passion and emotion were real. As the teacher said, the social practice also contributes to the content and language skill for the teacher and companions can correct it.

In the research there is also an unintended outcome which is showed in figure 3. The average time of “describe your own photos” is gradually increasing from 13.54 seconds in Sep. 2013 to 28.2 seconds in Nov. 2013 and peaks at 38.53 seconds in Jan. 2014, except a slight drop in Dec. 2013. The trend resembles to earlier research findings of Fillmore (1983) who defined “good language learner” as a student who is talkative, eager to communicate with anyone, highly verbal and had mouth that seemed to operate non-stop around the clock. Therefore, if students are willing to say or they do have something to say, at least they have the opportunity to become “good language learner”. We can judge that the students’ speaking and talking ability are improved in this research.
5. Conclusion

Based on the findings it can be concluded that *papa* has the potential to be used as a language learning tool in ubiquitous learning environment in line with the current trend and the use of *papa* as a SNS does promote the language learning among lower age students. In interpreting the results of this study, we must pay attention to a number of limitations. One is that tradition language learning can also improve students’ competence. Therefore the future research should focus on the controlled trial which the controlled group do not use *papa* to examine if *papa* do make improvement in language learning. Beyond that the interactions between students is also worthy to investigate.

Acknowledgements

We would like to thank the participants of this study for allowing us to use their data and sharing their experiences with us. We are also grateful for the reviewers’ valuable comments.

References:


We are going to the ZOO! Virtual Badges in Formal out-of-school 1:1 Learning Journey with Smartphones

Ivica BOTICKI\textsuperscript{a}, Jelena BAKSA\textsuperscript{a}, Peter SEOW\textsuperscript{b} & Chee-Kit LOOI\textsuperscript{b}

\textsuperscript{a}University of Zagreb, Faculty of electrical engineering and computing, Croatia
\textsuperscript{b}National Institute of Education, Singapore
*ivica.boticki@fer.hr

Abstract: This paper presents experiences from a seamless mobile learning project in Singapore. Although the project included a variety of seamless mobile learning designs, this paper focuses on only one, and that is a mobile learning application SamEx in support of a specific learning scenario – an outdoor ZOO field trip. The paper describes SamEx design by focusing on virtual badges gathered by the students during their ZOO trip. The trip was structured by the teachers and scaffolded by SamEx system contextually triggered questions and prompts. The paper describes experiences from the ZOO trip done with SamEx, gives an elaborate example of a student’s learning experience during the trip, and concludes by examining different types of student profiles according to their badge usage and SamEx social engagement.

Keywords: virtual badges, 1:1 mobile learning, out-of-school learning, field trips

1. Introduction

This study presents and examines SamEx, a mobile learning system used by 350 students in a variety of formal and informal learning scenarios in a primary school in Singapore. Students use SamEx to capture media such as pictures, video clips and audio recordings and share them with their peers through discussions.

Although SamEx has been used in a variety of formal and informal learning designs in the project, the focus of this paper is its usage during a mobile learning field trip to Singapore ZOO (Figure 1). 350 students equipped with smartphones and SamEx system embarked on this journey to learn as designed by their teachers. Prior to the trip, scaffolds were set by the teachers and researchers in the form of contextually triggered questions and prompts. By moving through the ZOO, students were prompted to engage in a variety of tasks, collect photos, videos and audios and share them with their peers through SamEx.

As the trip progressed, students were collecting points in return for their digital content submission, question answers, mobility and social interaction. These points were materialized in the form of virtual badges, depicted in one of the SamEx screens.

2. Virtual Badges in Technology Enhanced Learning

2.1 Theoretical Background

Coming from the computer gaming world, badges are earned to indicate the achievement of certain level of skills, acquisition of knowledge, or participation in an activity (Young, 2012). As one implementation option, badges indicate the achieved competence level as defined by the issuer. For example, the integration of badges into existing software is supported by the Mozilla Open Badge Infrastructure (Mozilla, 2013). In the social media context they have five social psychological functions: goal setting, instruction, reputation, status/affirmation, and group identification (Antin &
Badges are nowadays integrated into numerous educational learning tools (Moore, 2013; Sharples et al., 2013), including Khan Academy, BuzzMath and CodeAcademy. However, there are still doubts on whether and how badge scores contribute to the overall student grade in online learning environments (Hakulinen, Auvinen, & Korhonen, 2013). One study shows that ability and motivation of learners have to be considered when choosing the right kind of badges to be used and the kinds of effect they could have on critical learner motivations (Abramovich, Schunn, & Higashi, 2013). TRAKLA2 confirms that and states more research is needed in balancing the badge achievement criteria so that they maximize beneficial learning practices while minimizing harmful side effects; and to understand why the same set of badges had different effects on different populations (Hakulinen et al., 2013).


3.1 Theoretical Background

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3.2 SamEx Mobile Learning Application

SamEx was designed to support self-directed and collaborative learning activities and provides a participatory platform for students to contribute, share, and give feedback. Students can use it to take a picture to collect data or post information they found to be useful for their learning. These postings are shared with other students who can review, give comments and evaluate by giving “Likes” to the contribution.

For the purpose of this study, activities were designed for primary school students who used SamEx throughout a 1-year period. In addition to collecting, storing and accessing multimedia artifacts (Figure 1), SamEx can store contextual users’ information for potential educational use. Depending on the current time and users’ location, the system allows question prompts (Figure 3) to be displayed on students’ smartphones potentially facilitating or scaffolding learning tasks. Students can therefore be guided in outdoor mobile learning trails or just prompted periodically in connection with their homework observations or other work they are recommended or required to pursue outside school.

To reward students’ activity, SamEx leverages on its own badge system, an extrinsic motivational tool (Figure 2). By collecting media, answering location-aware questions, providing comments to other students’ questions and liking other students’ work, students take part in a game to accumulate points leading to the earning of badges.

4. The Analysis Framework for the Study

Throughout our studies, we discovered our students belong to the four fundamental groups according to badge system usage: (1) Badge Hunters, (2) Sharers, (3) Dodgers and (4) Explorers. The students were classified in one of the four groups by performing qualitative and quantitative analysis of their media artifacts, answers, comments and likes. We based our decision by closely observing the behaviour patterns for each student in our data sample (introduced in the following chapter). It is important to mention that there were some borderline cases where a particular student could be placed in two different categories.

5. A Primary School Mobile Learning ZOO Trip

We focus on a whole grade level of primary grade students who are equipped with smartphones with unlimited internet data plans. There are more than 350 students who were given a mobile device with SamEx mobile application preinstalled and preconfigured for use in and out of school. The study employs Design-Based Research (DBR) to develop a deeper understanding of the processes involved in implementing seamless mobile learning. With iterative cycles of studying the processes and outcomes...
of interventions in building teacher capacity, lesson and technology design, we can refine the processes to develop a program for designing technology enhanced learning environments and develop strategies in and out of the classroom (Phillips, 2006). The phases of the DBR approach along with the initial observation and findings are listed in Table 1.

Table 1. Use of SamEx though five main phases of Design-Based Research

<table>
<thead>
<tr>
<th>Phase</th>
<th>Research/activity design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1A</td>
<td>Study a naturalistic process of using SamEx.</td>
</tr>
<tr>
<td>(Pilot phase in the end 2012)</td>
<td></td>
</tr>
<tr>
<td>Phase 1B</td>
<td>Study a naturalistic process of using SamEx.</td>
</tr>
<tr>
<td>(Pilot phase in the end 2012)</td>
<td></td>
</tr>
<tr>
<td>Phase 2</td>
<td>Study a naturalistic process of using SamEx. Incorporated badges in SamEx but did not inform the students.</td>
</tr>
<tr>
<td>(Jan 2013)</td>
<td></td>
</tr>
<tr>
<td>Phase 3</td>
<td>320 Primary 3 students used SamEx in a combination of indoor and outdoor environment in the Zoo to learn about animals and plants.</td>
</tr>
<tr>
<td>(Feb 2013)</td>
<td></td>
</tr>
<tr>
<td>Phase 4</td>
<td>Study a naturalistic process of using SamEx to document students’ self-directed use of SamEx</td>
</tr>
<tr>
<td>(Feb-May 2013)</td>
<td></td>
</tr>
<tr>
<td>Phase 5</td>
<td>Over a 4-week holiday, the students were assigned a task to grow a seed-</td>
</tr>
<tr>
<td>(June 2013)</td>
<td></td>
</tr>
</tbody>
</table>
Take a photograph of the outercovering of the bat.

Take a photograph of another animal other than the bat.

Take a photograph of a plant that provides us with the material to make an eraser.

Take a photograph of a plant that provides us with ingredients to flavour food.

Figure 4. SamEx used in a ZOO trip: a sample of contributions and answers by one student

6. Reflections and Conclusions

Badge Hunters were identified by very a large amount of low quality data over a short period of time. They are only interested in attaining high levels of badges and they only respond to extrinsic motivation and do not care about quality of contributions. Sharers are on the other hand interested in sharing with their peers while earning their badges and their participation consists of higher quality contributions. They make meaningful contributions and ask good questions. Dodgers are not interested in earning badges at all.

Table 2. Percentage of students in each category for class P3A

<table>
<thead>
<tr>
<th>Category</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharers</td>
<td>42.86</td>
</tr>
<tr>
<td>Dodgers</td>
<td>35.71</td>
</tr>
<tr>
<td>Badge hunters</td>
<td>16.67</td>
</tr>
<tr>
<td>Explorers</td>
<td>4.76</td>
</tr>
</tbody>
</table>
Unfortunately, a very low percentage of students (Table 2) was placed in the ideal category of Explorers. They actively participate in SamEx by generating high quality contributions, sharing their observations, initiating conversations with other students and are trying to gain knowledge collaboratively from their peers.

This means badges can currently only encourage the first two groups of students to participate. However, Badge Hunters will stop participating once they achieve their desired level of badges. Both Badge Hunters and Sharers are not interested in learning collaboratively since there is no observable learning with their peers.

Nevertheless, it is important to mention that some of the students who were identified as Sharers have a good potential of becoming Explorers. They usually try to learn collaboratively, only to be discouraged by the lack of feedback from their classmates. To help them bridge that gap between Shares and Explorers, all students need to be encouraged to participate more actively, especially in the tasks which involve interaction with their peers.

References


Building an Online Collaborative Learning Community in Ubiquitous Learning Environment

Ru ZHANG a*, Jing LENG b, Xiaoqing GU c, Guanfeng FU d, Huawen WANG f
a,b,c,d,f Department of Education Information Technology, East China Normal University, China
*ruzhang88@foxmail.com

Abstract: The paper aims at understanding to what extent the learners could engage in online collaborative discussion and generate sustained, productive knowledge building discourse in ubiquitous learning environment in a social context. Online discourse data in an inquiry case and a survey responses were analyzed to examine learners’ effort for idea improvement and attitudes towards online building community respectively. The findings indicate that in ubiquitous learning environment discussions are strengthened by social networks and the collaborative learning community can be built on the social interactions and collective knowledge advancement by generating productive knowledge building discourse.

Keywords: Ubiquitous learning, online asynchronous discussion, collaborative learning community, knowledge building

1. Introduction

With ever increasing advanced capabilities of personal devices and popularity of novel web services, more learners have engaged in online collaboration learning to build shared understanding through social networking and computer-mediated communication, in addition to searching for required information. Rather than just acting as a repository for online reading, online asynchronous discussion forum has become an effective avenue for collaborative inquiry through identifying, examining and reflecting upon ideas (Collison, Elbaum, Haavind & Tinker, 2000). Moreover, it enables a collaborative space for the creation of positive collaboration learning environment and community culture (Wei, 2013; Xia, Fielder, & Siragusa, 2013), where a wide range of learners engage in an inquiry about a problem and collective idea is improved through the progressive collaborative inquiry from the perspective of knowledge building. However, not all the discussions is helpful in creating and sustaining an online community of inquiry. Advances in Internet and ubiquitous computing enable a new means for building collaborative learning community through synchronous discussion where learners could use multiple devices to access learning materials and to support their learning activities, anytime and anywhere.
The paper aims at understanding to what extent the learners could engage in online collaborative discussion and generate sustained, productive knowledge building discourse in ubiquitous learning environment in a social context. Following an overall description of the asynchronous discussion platform, Content analysis on an inquiry case in Zhihu was to examine learners’ effort for idea improvement during the process of collaborative discussion. A survey responses were also analyzed to present learners’ attitudes towards the formation and sustainment of learning community. This paper also tries to enlighten researchers and practitioners on effective ways for promoting learners’ active participation in online discussion and facilitating the collaborative knowledge building processes. Specifically, the research questions are as follow:

1. How do learners engage in the discussion in ubiquitous learning environment?
2. During online asynchronous discussion activities, what are the characteristics of the learners’ behavior contributing to idea improvement in the social context?
3. What are the learners’ attitudes toward building online communities through online asynchronous discussion?

2. Literature Review

2.1 Online collaborative learning

Collaboration is commonly used to encourage learners’ engagement and enhance their understanding through collaborative inquiry in online learning environments. In the past several decades, there has been an upsurge in research on computer-supported collaborative learning (CSCL). To attempt to initiate learners into a knowledge creating culture, researchers have developed the conceptual framework of knowledge building in which learners work together through CSCL to advance collective knowledge and understanding (Scardamalia & Bereiter, 2006). Knowledge building is defined as “the production and continual improvement of ideas of value to a community” (Scardamalia & Bereiter, 2003), which focuses on the social process of collaborative inquiry in asynchronous discussion environment where learners post ideas and comments to generate questions, co-construct explanations, and revise their ideas. In the process, learners’ ideas are regarded as conceptual artefacts of inquiry to be discussed, interconnected, revised, and superseded for achieving idea improvement (Stahl, 2006). Such collective idea improvement is of great value to online collaborative learning community of inquiry where learners collaboratively build upon each other’s knowledge, resulting in the creation or modification of community knowledge through discourse and discussion.

2.2 Online learning environments

Asynchronous discussion forums have been used in a wide range of formal and informal learning setting. Despite the generalized BBS in daily lives, typical instructional management software environments, like Blackboard, Moodle and WebCT are also available to asynchronous discussion forum. It is considered an extension of instructional practices that promotes dialogue, reflection, knowledge construction and self-assessment (Gao et al., 2013). Although many researchers regard online Q&A discussion forums as a valuable learning
resource (e.g., Cheng, Liu, & Shieh, 2012), the quality of online discussion and communication were questioned. Thomas (2002) argued that they “might not be the best technology to support the interactive and collaborative processes essential to a conversational model of learning”. The main problem is that they may fail to foster naturally productive discussions that are focused, interactive and in-depth (Gao et al., 2013), thus failing to promote collaborative learning (Guzdial & Turns, 2000) and militating against deepening inquiry (Scardamalia & Bereiter, 2006). Because the isolation among the learners in asynchronous discussion, can hinder them from interacting and building knowledge together, discussions can be invaluable toward creating and sustaining an online community of inquiry (DeNoyelles et al., 2014). In view of this, it’s need to integrate the emerging technologies to design online learning environments that have the capability to facilitate complex learning and sustain a strong sense of community that supports students’ learning socially and cognitively (DeNoyelles et al., 2014; Gao et al., 2013; Wei & Chen, 2006). Some systems are designed or introduced to enable collaborative learning through discussion forums. Guzdial and Turns (2000) designed a computer-mediated anchored forum to increase the effectiveness of sustained, broad participation and on-topic discussions by using anchors. An anchor is a topic that students find worthy of discussion in the forum, but the anchors are static and not initiated by students. Lin, Hou et al. (2013) used a popular SNS, Facebook, to support students’ asynchronous online discussions of project-based learning activities and found that the essential social nature of Facebook play an important role.

In the same way, LeNoue et al. (2011) suggest that a well-designed social networking site can provide probability for diversified opportunities for learners by facilitating both broad and deep interactions.

2.3 Using ubiquitous computing tools to support discussion activity

The rapid developments of wireless networking technology and powerful mobile devices have led to the landscape of ubiquitous computing as Weiser proposed, and have given rise to the emergence of ubiquitous learning environments where learners can become completely immersed in the learning process or learning activity in any situation (Jones & Jo, 2004). Supported by proper technological affordances and activity structures in ubiquitous learning environments, learners can easily access rich resources and actively participate in learning activities anytime and anywhere through any device (Jones & Jo, 2004; Wei & Chen, 2006). Thus we unconsciously and effortlessly harness their digital abilities as effort-saving strategies for achieving the benefits of distributed intelligence (Pea & Maldonado, 2006). Ubiquitous learning environment was featured by Yahya et al. (2010) in the following characteristics: 1) Permanency, 2) Accessibility, 3) Immediacy, 4) Interactivity, 5) Context-awareness, and 6) Adaptability. Previous studies have proved the great potentiality of ubiquitous computing tools in improving discussion activities accordingly. Researchers have indicated that using mobile devices to support discussion activities may promote acquisition and exchange of authentic learning experience, improve collaborative interaction encourage active learning (Lan, Tsai, Yang, & Hung, 2012; Wei & Chen, 2006). For instance, Yang and Lin (2010) integrated tablet computers with personal digital assistants (PDAs) together to facilitate collaborative discussions and information sharing, and improve learners’ abilities on classifying plants. Wong et al. (2010) presented a seamless learning environment with mobile device where
learners can use smart phones to capture photos of real-life contexts pertaining to Chinese idioms, and engage in in-class or out-of-class sharing and discussions in personal and social learning spaces. Therefore, various types of discussions and learning activities are enabled in ubiquitous learning environment.

3. Methodology

This research employed the method of content analysis to analyze an inquiry case and survey response, to explore the formation and sustainment of a community of inquiry by examining the process and motivation about collaborative knowledge building in asynchronous discussion forum, Zhihu.

3.1 Research context

Zhihu, is a well-known open online question and answer discussion forum based on social networking in China, where many authentic, complex and novel problems are being discussed by the public. It emphasizes on posting problems and seeking help from peers, facilitating collaborative thinking, and building a community. Meanwhile, a mobile App called Zhihu Daily has been designed to present dozens of valuable contents generated in the process of discussion. According to Alexa (a web traffic tracking subsidiary of amazon, http://www.alexa.cn/) , the number of Daily Pageviews per Visitor in Zhihu (http://www.Zhihu.com/) and Zhihu Daily (http://www.Zhihu daily.net/) is higher than similar Q&A sites as Baidu Knows (http://zhidao.baidu.com/) and IASK (http://iask.sina.com.cn/), see in table 1. It means that users in Zhihu tends to be more engaged and deep thinking in the discussions.

Table 1: the number of Daily Pageviews per Visitor in August 11, 2014.

<table>
<thead>
<tr>
<th></th>
<th>Baidu Knows</th>
<th>IASK</th>
<th>Zhihu</th>
<th>Zhihu Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Pageviews per Visitor</td>
<td>4.21</td>
<td>1.45</td>
<td>5.75</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Zhihu and Zhihu Daily can be accessed using a web browser or by using the mobile app, which helps learners to easily engage in a community of inquiry about a problem via different digital devices (e.g. smart phones) anytime and anywhere. Zhihu has adopted typical features of search, endorse, wiki and follow in social networking. Thus as an asynchronous discussion forum, its features enable learners engage in collaborative inquiries to solve authentic and in-depth problems in a more interactive way, such as raising questions for inquiry about a problem; clarifying questions by revising anyone’s question; endorsing and commenting quality answers to actively discuss and construct deep explanation; following up an answer for a discussion in a new thread through commenting; searching and following related problems or inquiry topic, proper learners to engage in the inquiry and a community of inquiry. It turns out that diverse ideas are generated and exchanged, learners engage in sustained progressive discourse to revise, combine, synthesize and produce rise-above ideas to advance the collective knowledge in the online platform. Gradually, a knowledge-building community has been built and their social networks have been reinforced through continuously interaction, thus contributing to effective knowledge work in the community space. In this study, Zhihu is described as a ubiquitous
learning environment for its nature of interaction and community of inquiry, where learners can easily get immersed in the inquiry about a contextual problem and achieve the sustainment of community by means of collaborative effort.

Figure 1. Features of the platform Zhihu.

### 3.2 Data collection and analysis

Our data collection was comprised two parts: notes in an inquiry and a survey in Zhihu. Content analysis were employed to analyze online interaction in the inquiry and survey response. In the study, a typical scientific inquiry case in Zhihu were analyzed to explore how learners engage and advance knowledge in discussion. And the problem in the inquiry is:

Birds’ 「Knees」 bend backward, human knees bend forward, why did they evolve so differently?

The problem was posted on December 30 2013, but the inquiry on it were lasted until now, along with 500 learners following the inquiry. For this study, all the responses (including questions, answers, and comments) involved in the inquiry were collected. Thus we collected a total of 260 notes on the day of August 13 2014, among which 221 notes were comments to quality or interesting answers, excluding the notes without any obvious meaning. But not all the notes were address the problem, some were about social interaction within the community. So we divides each note to idea unit—the smallest unit of text that conveyed a distinct idea or meaning, and each unit were coded into the coding categories (shown in Table 2.).

To understand deeply the motivation of sustainment in the discussion, we analyze a survey “Why did you participate in discussions in Zhihu?” posted in Zhihu. There are over 300 users
participate by answering, commenting and endorsing on the responses to it. We collected 73 responses and used qualitative coding techniques, to code and analyze the responses. We then categorized the codes to explore learners’ attitudes and explain the sustainment of building online community in asynchronous discussion.

Table 2. Coding categories

<table>
<thead>
<tr>
<th>Categories</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>progressive inquiry</td>
<td>Raising questions or making explanations to the problem</td>
</tr>
<tr>
<td>Social interaction</td>
<td>Complimenting, appreciating the answer, greeting, connecting or sharing with other learners and expressing emotions</td>
</tr>
</tbody>
</table>

4. Results and discussion

4.1 How did learners engage in addressing problem in the discussion?

Although the inquiry was lasted about one year, the discussions were continued with active participation and timely responses. In the inquiry, the ideas generated in the inquiry received 2448 endorsements. And once a theory or personal idea was posted, learners can be quickly informed to respond to the idea. The results of coding showed most discourse activities in the inquiry (65%) were related to community building through social interaction, such as complimenting, expressing emotions, appreciating the answer, greeting, connecting or sharing with other learners using the features of social networking (e.g. @ sb.) and so on. 38% of notes were devoted to extending or deepening the inquiry, such as continuing a thread by arguing or quoting from other’s messages, referring explicitly to other messages and raising a new discussion thread, stating learners’ personal ideas. Progressive inquiry was evident in the notes addressing the problem that were characterized in a network of learners’ interaction represented in Figure 1. The network revealed how the learners set forth their ideas and question, and addressed increasingly complex problems. And the ideas were improved in extended discourse about reviewing progress, identifying the synthesis, rise-above new ideas and lines for the collaboration inquiry. For example, the learner (XKC) answer made an explanation on bird’s bones of leg, leading other learners to the understanding that birds are digitigrade. Based on this understanding, learners generated further problems and statements of what they needed to know in comments, such as: “If dogs’ knees bend backwards”? (by CG). They could also comment on an existing thread to build up the argument related to the discussion thread, such as the learner (LL).

4.2 How did learners change their understanding within their discourse space?

In the inquiry, learners used the public space to invite peer input, and to generate potential solutions on the problem. After the first question about the problem of birds’ knees was posted, questions on it were clarified and refined constantly in seven times by modifying or raising new questions. And in the process, the problem was clarified from a misunderstanding to generate a series of good questions, such as “Look carefully, you will find that (the joint bending backwards) is not the knees, but the ankle joint.” [by ZH], “Why would humans followed with their heel?” [by YY], “Comparing to the way of plantigrade, what’s the advantage in way of
digitigrade? ”[by YY]. These results indicate that learners changed their understanding of birds’ knees from a misunderstanding towards a more scientific view.

Figure 1. Network of learners’ interaction in the inquiry.

Table 3 reports the number of notes (a) raising factual problems that’s seeking for factual information for peers to address; (b) raising explanatory problems that’s explanations about “why”, “how” and so on. Empirical data such as experimental results, personal observations, and life experiences were found in 16 notes (64%) among all the explanation in the main discussion thread. According to the two patterns using empirical data proposed by Zhang et al. (2007), empirical data can be used in descriptive or explanatory approach.10 notes were a description of experiments, observations, or experiences without elaboration of ideas, other 6 notes were integrated empirical data to justify and improve learners’ ideas and received most endorsements and comments during the inquiry, that is productive to the knowledge building community (Zhang et al., 2007). So there’re 5 discussions thread continued and 11 new discussion threads raised in these comments altogether in addition to these notes to examine and interpret these evidence critically. Meanwhile, other expert resources were introduced as evidences to support their ideas, which are helpful to deeper understanding in the community. These results indicate how learners changed their understanding of birds’ knees from an observed phenomena in real lives towards a more scientific view.

<table>
<thead>
<tr>
<th></th>
<th>Number of notes raising factual questions</th>
<th>Number of notes raising explanatory questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total in the inquiry</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Total in comments</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

4.3 What are the learners’ attitudes toward building online communities?

What is most essential to the sustainment of online learning community to advance collective knowledge like Zhihu, is the participation of its learners. What motivates learners to essentially provide knowledge services for others without any explicit rewards and teachers’ instruction?
Most of our understanding of learners’ attitudes comes from the survey “Why did you participate in discussions in Zhihu?” in it. In the survey, most learners gave multiple reasons. By far, the most often mentioned reasons were enjoy helping, learning, hobby, which is in accordance with prior research (Lou, Fang, Lim, & Peng, 2013) expectedly. Thus a platform supporting ubiquitous learning can be characterized from their survey responses to explain the community building. We will discuss each in below.

4.3.1 Supporting collaborative inquiry on authentic problems

Although various novel internet technologies have emerged, the argument that "it is difficult to find a place where you would feel funny in the Internet" was common in the survey responses. For learners in Zhihu, it’s a place that can "acquire knowledge in reality along with novel ideas” to meet curiosity and interests, thus getting immersed. Authentic problem held some of learners’ learning motivations and provided question sources for inquiry from a cognitive perspective. It’s important implications for developing a community where learners can pursue their own questions and contribute ideas for inquiry to build on ideas, concepts and explanations about problem through discussion in society. So the community supporting the collaborative work of improving ideas on authentic problem is critical. Regarding Zhihu, Said one respondent:

> When there is a related problem in front of you, you can express and examine your ideas (in Zhihu).

> The problems contribute greatly to collaborative inquiry, as a respondent stated:
> At the beginning (I) contributed a lot of answers to the questions relating my own profession. It’s not only to let others understand the area more comprehensively, but also to tease my knowledge better.
> Then the problems in this area were almost answered. But I found I know little about other area……
> Participating in Zhihu can be considered as an inspiration for me to read more books and to explore more.

4.3.2 Distributed Expertise

A progressive inquiry intends to engage the community in a shared process of knowledge advancement and to convey simultaneously the cognitive goals for collaboration (Muukkonen, Hakkarainen, & Lakkala, 2004). Not only delivering tasks or productions on time, employing socially distributed cognitive resource in the inquiry process is high valued by many respondents in the survey. With the help of social networking, learners can easily assemble right experts to engage in or deepen the inquiry and even generate new knowledge by introducing empirical data and expert resources to build social knowledge network and advance collective knowledge. Diversity in expertise among participants, and interaction with expert cultures, promotes knowledge advancement (Muukkonen, Hakkarainen, & Lakkala, 2004). So benefiting from the distributed expertise, the platform impresses learners that valid solution to problem is right there and it can meet their need of just-in-time learning anywhere. A respondent stated his online learning needs:

> We need systematic fragmentation information……. There’s someone answer your question systematically once question posted in Zhihu without much time…….An anonymous users in it can provide awesome goods, and it’s second to none.
4.3.3 Peer help

Like-minded peers were frequently mentioned in the responses. Peer help with numerous pedagogical advantages (Wei & Chen, 2006) is of great helpful when Web-based learning environments have become quite common without enough teachers’ instructions. Many respondents indicated the ability to dialogue with friends with common topics increased the activity of the discussion, and encouraged a sense of community with helping each other. Hew and Cheung (2011) believed that it’s helpful for knowledge advancement when peers provided comments, showed appreciation and encouragement, and summarized the discussions. The Internet spirit of openness, equality, collaboration and sharing was used to express the cognitive value of social collaboration the cognitive value of social collaboration in a response:

Zhihu is open and equal to all people without any differences in professional and identity. Each questioner would need and respect the exchange of ideas and you. Collaboration: A question will be answered by all kinds of people, eventually integrate of the most appropriate answer through collaboration. Sharing: a useful answer, would pass to people in most need through other people.

A certified public accountants stated the benefits considerably from peer help:

My expertise shared through Zhihu and Zhihu Daily were recognized and praised by many people including knowledgeable expert. This motivation inspired by the recognition is far more than that in other Internet platforms.

5. Conclusion and implications

In this study, we analyzed an online collaborative inquiry in social context to examine learners’ efforts for idea improvement by generation of deepening questions, social interactions focusing on idea advancement, constructive use of empirical data and authoritative sources in notes. The findings show that the social networking provide possibility for learners to continue discussions, facilitate ideas to spread and sustain community of inquiry in communal space through encouragement, drawing in participants, endorsement, appreciation. In ubiquitous learning environment, the community has been sustained by enabling learners to access inquiry process anytime and anywhere. And supporting with collaborative inquiry on authentic problems, distributed expertise, peer help, increased question generation and consequent knowledge construction can lead to a virtuous cycle within the community through productive knowledge building discourse, where learners can ask better questions, construct their own knowledge when participating in collective idea improvement.

As for the limitations in the study, there’s only an inquiry case analyzed to examine the process of idea improvement. And adding more inquiry cases is need. And it is important to use more diverse methods to analyze online synchronous discussions in ubiquitous learning environment. As social learning interactions play an important role, in addition to the use of quantitative content analysis, future researchers should include methods such as social network analysis and sequential analysis.

References:

Identifying User’s Perceptions Toward Integrating Mobile Applications in Science Education

Hyo-Jeong SO*, Hye-Gyoung YOONb, Hyungshin CHOIc, Heung-Chang LEEa & Kyudong PARKa

aCreative IT Engineering, Pohang University of Science & Technology(POSTECH), Korea
bScience Education, Chuncheon National University of Education, Korea
cComputer Education, Chuncheon National University of Education, Korea

*hyojes0@postech.ac.kr

Abstract: Situated under the macro-context of the Korean government’s initiative to provide mobile- and cloud-based learning resources in schools, the goal of this study is to examine potential users’ perceptions toward integrating mobile applications in science education. The sample includes 632 students, 68 teachers and 141 parents from 11 Primary schools in Korea. Results reveal some important implications regarding users’ acceptance of mobile applications for teaching and learning. First, the majority of students do not frequently access and use mobile devices, which might be associated with the school policy to ban or limit the use of mobile devices in the classroom. This finding may imply a conflict between the enacted macro-level policy and the reality of schools. Second, the teacher group is the most conservative in their perceptions toward integrating mobile applications in science education. Teachers’ conservative attitude may be associated with the lack of perceived advantages of using mobile applications in teaching and learning. Lastly, there was a clear pattern observed in users’ perceptions about science topics that are effective or ineffective in integrating mobile applications. Science phenomena that require a long duration of observation were perceived to be highly relevant to integrate mobile applications, supporting the continuity of observation experiences across physical contexts and time scale. Further, we found that mobile applications that provoke students’ imaginations and curiosity, where students do not feel forced to learn, but are intrinsically motivated to learning science in daily life, are likely to be readily accepted and used by student users.

Keywords: mobile earning, science education, digital textbook, needs analysis

1. Introduction

For the past decade, leveraging the unique affordances of mobile devices such as connectivity, immediacy and multi-functionality, several research studies have explored the impact of mobile learning applications (Motiwalla, 2007). Despite the promises of mobile learning, however, the use and adoption of mobile devices and applications in schools have been slow, and we have not witnessed many successful examples of mobile applications or systems widely adopted in classrooms. Still, most-widely used mobile applications in educational settings focus on simple communication, presentation, and productivity functions. There is a lack of successful examples of mobile applications that have fully utilized the affordances of mobility to create a new form of learning experiences. As to the use of mobile technologies in science education, Avraamidou (2008) makes a critical remark that while several research studies presented the positive impact of mobile applications in science education, there is a critical need to “design technology-enhanced curriculum materials that can be implemented and used prevalently in the classroom” (p. 361). We concur with this remark that without widespread acceptance and use of mobile-enhanced curriculum materials among individual users, the promise of mobile learning cannot be realized.

The research project presented in this paper was part of the large-scale project to develop mobile applications that could be prevalently integrated in Primary Science curricula. At a
macro-level, this study is situated under the context of the large-scale ICT in education policy by the Korean Government that has planned the development and implementation of digital textbooks in schools. The key impetus underlying the “Digital Textbook for All by 2015” initiative is to promote self-directed learning practices with the use of digital resources and content. To date, the digital textbooks have been piloted in over 100 research schools to examine design and implementation issues (MEST & KERIS, 2012).

While the Korean government’s plan is to introduce and implement digital textbooks to all schools by 2015, the majority of schools may not be ready to adopt digital textbooks. When moving from traditional printed textbooks to digital textbooks, schools may face transitory issues such as changes in teaching and learning practices, building necessary socio-technological infrastructures, and stakeholders’ adoption of digital textbooks. That is, the transition toward digital textbooks involves not only the adoption of technology-based tools, but also changes in socio-technical structures and cultural practices surrounding the use of such a new form of technologies (Bielaczyc, 2006).

Understanding such transitory issues, we explored a hybrid form of learning where mobile applications are used to support learning with printed textbooks, prior to the full adoption of digital textbooks in schools. The ultimate goal of this project was to develop a series of mobile applications that could be used in conjunction with printed textbooks in Primary Science curricula. As an initial step toward this goal, we conducted a needs analysis study to examine potential users’ perceptions, expectations, and concerns toward using mobile applications in science education. While the main user group includes primary school students, this study also included teachers and parents as important actors affecting the use and adoption of mobile applications in science education.

2. Methods

2.1 Participants

Three stakeholder groups, namely students, teachers and parents, were the participants of this study. As shown in Table 1, the sample includes 632 students, 68 teachers and 141 parents from 11 Primary schools in Korea. We employed a purposive sampling method to recruit participants in various geographical areas in Korea. First, we recruited participants from two schools that were piloting the use of digital textbooks in the science curriculum at Grades 3 and 4 levels. We purposely included the pilot schools since one of the main goals of this project was to examine the possibility of integrating mobile applications as complementary or supporting resources to the science digital textbook. Second, we purposely recruited teachers who participated as authors of the national science textbook since content knowledge and teaching experiences in a science subject area were critical to evaluate the feasibility and needs for developing mobile applications relevant to science curricula. Students and parents in the recruited teachers’ classes were invited to participate in this research via an invitation letter explaining the purpose and process of the research study.

Regarding demographic profiles of the participants, the student group includes 342 Grade 3 students (54.1%) and 290 Grade 4 students (45.9%). The gender distribution was nearly even, 330 male (52.2%) and 302 female (47.8%) students. The teacher group includes diverse age ranges: 19.1% of teachers under 30 years old, 36.8% of those age 31-40, 36.8% of those age 41-50, and 7.4% of those 51 and older. Nearly three quarters of teachers are female. The parents group includes about 60% of those age 31-40 and 40% of those age 41-50. Almost 88% of parents who responded to our survey were female.

Table 1: Survey Participants

<table>
<thead>
<tr>
<th></th>
<th>Digital Textbook Pilot School</th>
<th>Non-Pilot Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>187</td>
<td>445</td>
<td>632</td>
</tr>
<tr>
<td>Teachers</td>
<td>51</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Parents</td>
<td>141</td>
<td>-</td>
<td>141</td>
</tr>
</tbody>
</table>
2.2 Data Collection & Analysis

This study employed both survey and interviews to identify users’ perceptions toward mobile application integration in the science curriculum. The research team developed three different sets of survey instrument for a respective group. We used a Likert scale of 1 (strongly disagree) to 5 (strongly agree) in the teacher survey, whereas a four-point Likert scale (no mid-point) was used in the student survey and parent survey. Common factors measured across the groups are a) usage patterns of using mobile devices, b) prior experiences of using mobile devices and mobile applications in science learning, and c) perceived expectations and concerns toward mobile learning. Specifically, factors examined in a respective group are as follows:

- **Study survey**: a) student’s interests in science learning, b) mobile device usage, and c) expectation toward using mobile applications in science lessons
- **Teacher survey**: a) mobile device usage, b) prior experience of using mobile applications for teaching, c) challenges in teaching science, d) topics in the science curriculum suitable for integrating mobile applications, and e) potential concerns and issues with mobile learning
- **Parent survey**: a) mobile devices usage, b) prior experiences of using mobile applications for child’s learning purposes, c) expectation toward using mobile applications in science lessons, and d) areas in need for using mobile applications at home

In addition to the survey method, we conducted interviews with students and teachers to collect qualitative data concerning the factors abovementioned. The interview sessions were conducted in different formats to accommodate the participants’ needs and schedules. For the student group, we conducted four focus group interview sessions with 28 students at the digital textbook pilot schools. We also interviewed 20 teachers, including 8 teachers from the digital textbook pilot school, and 12 teachers who were the authors of the national science textbook. We used a focus group interview format with the teachers from the digital textbook pilot school, whereas the remaining teachers were tele-interviewed via phone or web-conferencing platform, due to their geographical diversity. We were not able to interview parents due to a low number of parents who volunteered to participate in an interview session.

In the student interview, we asked questions concerning student’s interest, motivation and self-efficacy in science learning, prior experiences of using the science digital textbook, using mobile devices in daily life, expectation toward using mobile applications in science lessons, and ideas/topics perceived to be suitable for using mobile applications in the science curriculum. The teacher interview includes questions regarding their prior experiences teaching the science subject, prior experiences using mobile devices (including both general personal use and teaching/learning purposes), challenges with using the printed mode of textbook, and topics/activities perceived to be highly relevant to integrate mobile applications.

For data analysis, SPSS was used to statistically analyze survey data. Interview sessions were audio-recorded and transcribed. We used an open-coding method to identify key themes emerged from the interview data.

3. Results

3.1 Student Group

3.1.1 Mobile Device Usage Patterns

To understand how Primary school students use mobile devices in daily life, we examined the types of mobile devices, the frequency of usage and the types of activities with mobile devices. It was found that while students typically use smartphones more frequently than other mobile devices such as tablet PCs and portable game players, the overall usage of mobile devices is not high. One-quarter of students reported that they do not use smartphones at all. Nearly two-thirds of students use smartphones less than two hours per day. Top three activities that students do with mobile devices are: 1) playing games (26.3%), 2) communication (24.5%), and 3) watching video clips (18.8%).
3.1.2 Perceived Expectations

Next, we examined the students’ perceived expectations about using mobile applications in science lessons. Overall, the students have positive perceptions of using mobile applications together with the printed textbook. Nearly 80% of students reported that it is not difficult to learn how to operate mobile devices, which imply that young users at this age do not perceive technical difficulties as a hindrance to learning with mobile devices. They perceived that science lessons could be more fun (89.4%), easier to learn (86.5%), and include more diverse types of activities (92.2%), with the use of mobile applications. During the focus group interview, we also observed students’ positive attitude toward using mobile applications in science lessons. Students mentioned that with the use of mobile applications, “lessons could be more lively”, “It would be easy to conduct dangerous experiments”, and “learning with mobile applications would be more fun than learning with the traditional textbook”. However, about 40% of students expressed some concern that lessons could be distracting with the use of mobile applications.

3.1.3 Relative Advantages: Digital Textbook vs. Printed Textbook

We examined how students perceived relative advantages of digital textbooks and printed textbooks. The students mainly mentioned multimedia features such as “we can watch video clips” and “I don't need to take notes” as advantages of using a digital textbook. Limitations of digital textbooks mostly involve technical issues (e.g., frequent error message, difficult to use) and health issues (e.g., affecting eyes and vision). In addition, as a way to compare and contrast digital vs. printed textbooks, we asked the students to generate ideas about science learning activities that are often limited in the traditional printed textbook, but could be better learned with a mobile application. Three distinctive categories of mobile application emerged from student-generated ideas. We categorized them according to the functional framework of mobile applications by Patten et al. (2006):

- **Referential**: scientific term search, learning scientific phenomenon or terms in daily life
- **Data collection**: observation of living and non-living things, raising a virtual pet like Tamagochi, complex/dangerous experiment (e.g., air current, dissection, natural disaster)
- **Microworld**: exploration, discovery-oriented games (e.g., survival in a deserted island, journey to the planet)

3.2 Teacher Group

3.2.1 Mobile Device Usage Patterns

Teachers reported that they use smartphones more frequently than other types of mobile devices. However, when we asked about what device or platform they use to search for teaching-related information and resources, the majority of teachers (97%) responded that they use a computer (i.e., desktop, notebooks). In the survey, about 47% of teachers reported that they had prior experiences using mobile devices for teaching purposes. Interview data reveal that while some teachers had prior experiences using mobile devices in science lessons, most usage patterns involve simple activities like term search, taking a picture, and video recording.

3.2.2 Science Topics Suitable for Mobile Learning

Next, we examined what areas/topics in the science curriculum teachers perceived to be suitable and effective for integrating mobile applications. The question item listed all topics in the Primary 3 and 4 Science curricula, and the teachers were asked to indicate the degree of expected effectiveness for each topic, on a five point Likert scale. From this data, we were able to identify a clear pattern in the nature of science topics that were perceived to be effective or ineffective in integrating mobile applications. Topics perceived to be highly effective are Life cycles of animals (86.8%), Life cycles of plants (86.8%), Change of earth surface (83.8%), and Volcano and earthquake (83.8%), which are
dealing with scientific themes or phenomena that are difficult to observe in a real-life context due to its dynamic nature and gradual changes for a long period. On the contrary, topics perceived to be ineffective in integrating mobile learning applications include Separation of mixture (55.8%), Weight of object (52.9%), Use of magnet (44%), and Materials and matter (39.7%), which tend to cover scientific phenomena easily observable and replicable in school contexts.

### 3.2.3 Relative Advantages: Digital Textbook vs. Printed Textbook

Among 12 teachers interviewed, three of them indicated that they did not have any difficulties using the traditional printed textbooks. It appeared that teachers often restructure and repurpose the content of textbooks to suit their needs, rather than simply follow the given format and structure. Teachers perceived limitations of printed textbooks when they a) teach topics requiring scientific experiments difficult to be conducted in school contexts, b) teach scientific phenomena involving a long duration of observation and field trips, and c) face difficulties accommodating various questions from students. Some teachers indicated that students do not completely understand instructions in textbooks when conducting an experiment. Digital content like video clips and audio materials explaining procedural steps were suggested to solve this problem.

### 3.3 Parent Group

#### 3.3.1 Mobile Device Usage Patterns

There was no dominant type of devices used by parents for searching education-related information. About 46% of parents reported using a computer (i.e., desktop, notebooks) whereas about 42% of them used smartphones to search for information related to their child’s education. Regarding prior experiences, nearly 76% of parents reported that they had not used any mobile application to teaching their children, indicating an overall low usage of mobile learning applications among parent users.

#### 3.3.2 Expectations

On the whole, the parents had positive expectations about using mobile devices and applications in science lessons. Parents responded that science lessons could be more fun (89.4%), easier to learn (86.5%), and include more diverse activities (92.2%) with the use of mobile devices and applications. Regarding the question “Lessons could be distracting”, the percentage of parents who agree with this item (53.95%) was slightly more than that of parents who disagree (46.1%). Similar to the student group, parents tend to perceive the use of mobile devices not technically challenging for children. About 75% of parents indicate that it is not difficult for children to operate mobile devices.

### 4. Discussion & Conclusion

The main goal of this research was to identify potential users’ perceptions toward integrating mobile applications in Primary Science curricula. We examined perceptions of three stakeholder groups, with a consideration that not only students but also both teachers and parents are also important actors affecting the use and adoption of mobile learning applications in science education. Technology use and acceptance is a long-lasting issue that has drawn much research interest. While several researchers have examined determinants of technology adoption in educational settings (e.g., Teo, & van Schaik, 2012), this study is different in that it has a focus to the use and adoption of mobile technologies particularly in the context of science education.

Overall, this research reveals some important implications regarding users’ acceptance of mobile technologies for teaching and learning. First, while access to mobile devices is the foundational condition to meet prior to the use of any mobile learning resources and application, we found that the majority of students do not frequently access and use mobile devices. This finding may be associated with the school policy to ban or limit the use of mobile devices in the classroom. Contrary to the Korean Government’s plan to introduce more mobile- or cloud-based learning
resources, students are not allowed to use a mobile device as a learning tool in schools, which may indicate a conflict between the enacted macro-level policy and the reality of schools.

Second, we found that the teacher group is the most conservative in their perceptions toward integrating mobile applications in science education. Unlike the student and the parent groups who generally showed positive attitudes and toward mobile learning, the teachers expressed several concerns regarding the use of both mobile applications and digital textbooks. We also found that many teachers prefer to use a computer rather than a mobile device to search for teaching-related information and resources. Teachers’ conservative attitude may be associated with the lack of perceived advantages of using mobile applications in teaching and learning. This is consistent with the general Technology Acceptance Model where perceived usefulness and perceived ease of use are important factors affecting user acceptance of technology (Davis, 1989).

Lastly, this study also reveals that there are certain areas or topics in science curricula that are perceived to be more suitable and effective for integrating mobile applications than other topics. Science phenomena that require a long duration of observation were perceived to be highly relevant to integrate mobile applications, supporting the continuity of observation experiences across physical contexts and time scale. Curricula topics involving static phenomena that could be sufficiently covered with printed textbooks and physical objects were perceived to be less relevant to integrate mobile applications. We also found that mobile applications merely reflecting curricula content are not likely to attract student users’ motivation to use them. The students generated several interesting ideas of mobile applications that could be potentially developed as promising learning tools. Using such ideas, mobile applications that provoke students’ imaginations and curiosity, where students do not feel forced to learn, but are intrinsically motivated to learning science in daily life, are likely to be readily accepted and used by student users.

While the present study examined users’ general perceptions, we see needs to conduct future research into mobile technology acceptance and adoption that particularly consider unique characteristics and issue associated with mobile technologies. Such research will contribute to better understanding of the complexity of users’ perception and adoption of mobile devices and applications for teaching and learning (Sarker & Wells, 2003). In conclusion, we believe that this initial user study provides some important insight to how the three groups of users perceive the role of mobile technology and applications in the context of science education, and to what factors should be considered to develop mobile applications reflecting users’ needs.

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References

Integration of multiple external representations in chemistry: a requirements-gathering study

Prajakt PANDE, Sanjay CHANDRASEKHARAN
Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, India
*prajakp@hbcse.tifr.res.in

Abstract: Multiple external representations (MERs) are crucial in the learning and practice of chemistry. Representational competence (RC), the ability to simultaneously process, integrate and transform between MERs, marks expertise in chemistry. A major strand of chemistry education research attributes students’ difficulties in learning to difficulty in understanding MERs, particularly the ability to imagine the various inter-connections between them. A dominant model of RC is Johnstone’s model of three thinking levels, which describes three different levels of representations in chemistry (symbolic equations, molecular models and reaction phenomena), and treats cognitive load as the core problem underlying student difficulties with MERs. This model is used to design a number of computer interventions in chemistry, mostly focusing on lowering cognitive/working memory load, by simultaneously displaying on a screen, molecular animations, graphs and equations. In contrast to this classical information processing framework, our theoretical approach seeks to understand the internal cognitive mechanisms that support the processing of MERs, using recent cognitive theories such as distributed and embodied cognition. At the intervention level, we focus on achieving integration of MERs, through enactive/embodied interaction design approaches (such as fully interconnected and manipulable interfaces). Before developing the actual form factor of the interventions, we wanted to characterize student difficulties, and how students navigated through existing MERs. For this, we presented a categorization task to students, where 3D molecular animations (depicting only molecular level reaction dynamics, without symbols, text and other representations), graphs, chemical equations and videos of some chemical reactions were given to 6 chemistry undergrad students. Eye-tracking was used to obtain fine-grained data about participants’ gaze and eye movement patterns while they viewed these representations. Addition of molecules, molecular aggregation, heat source and increase in velocity of the molecules were frequently attended-to features. Only one student made chemically meaningful groups with animations. Her eye-movement analysis reveals systematic mapping of animation features to chemical equations and other representations.

Keywords: Representational competence (RC), multiple external representations (MERs), chemistry education, molecular animations, categorization, eye-tracking

1. Introduction

Chemical phenomena are understood at multiple levels of detail (electronic configuration, stereo-chemistry or spatial conformation of molecules, stoichiometric ratios etc.), using multiple external representations (MERs) such as reaction mechanisms, molecular diagrams, graphs and equations at each level. A critical aspect of learning chemistry is developing expertise over these MERs. The ability to generate and use MERs in an integrated fashion (for conceptualization, discovery and communication) is indicative of expertise in chemistry. This skill-set is collectively known as representational competence (RC) in chemistry (Kozma & Russell, 1997).

Many problems and difficulties in teaching/learning chemistry are attributed to difficulties in understanding the different MERs in chemistry (Johnstone, 1991, 1993; Kozma & Russell, 1997; Gilbert & Treagust, 2009a & b). The achievement of RC, through many representational transformations, as well as the integration of MERs, is central to learning chemistry.

Currently dominant theoretical approaches, for instance Johnstone’s model of three thinking levels (Johnstone, 1982) and versions thereof, describe the different levels of MERs (such as symbolic level, molecular level, etc.) based on the type and level of detail of the chemical phenomenon represented in those representations. This model is combined with working memory models, to
develop a cognitive-load-based characterization of RC in chemistry, which is used to also address student difficulties in dealing with chemistry MERs. This approach considers the simultaneous consideration of MERs by a learner as increasing her cognitive load, while an expert is better able to minimize/handle cognitive load by employing cognitive strategies such as information chunking.

Johnstone's model has inspired and guided the development and use of a number of computer interfaces in chemistry teaching/learning, typically used for making sense of MERs and also developing concept, phenomenon and procedure understanding using MERs (Kozma & Russell, 1997; Kelly & Jones, 2008). Many of these interfaces focus on the simultaneous, dynamic, display of MERs on a screen. However, the effectiveness of such computer interfaces in helping develop RC has been mixed. One possible reason for this could be that these designs are guided by classical information processing theories of cognition, where the role of the interface is to decrease the learner's cognitive load, particularly working memory load. Emerging theories of cognition, such as distributed and embodied cognition, postulate that the roles played by external representations are wider than decreasing cognitive load. For instance, external representations can support operations that are difficult, and sometimes impossible, to do in imagination (Kirsh, 2010). Further, actions could be a way of promoting integration (Chandrasekharan, 2009).

Current characterizations of RC in chemistry, and the interventions inspired by them, do not seek to provide a detailed understanding of the cognitive mechanisms underlying the processing of MERs, and thus offer only a rather superficial account of MER integration. Our research attempts to characterize RC by developing models of the cognitive mechanisms underlying the processing of MERs, particularly integration of MERs (which is how we define RC), and suggest design principles for interventions. Our theoretical approach, as well as interaction designs, are inspired by distributed and embodied cognition perspectives. In this paper, we report findings from an ongoing requirements-gathering phase for an intervention design. For this, we presented a categorization task to students, where 3D molecular animations (depicting only molecular level reaction dynamics, without symbols, text and other representations), graphs, chemical equations and videos of some chemical reactions were given to 6 chemistry undergrad students.

We used Tobii X2-60 static eye-tracker to capture fine-grained data on student eye-movement and gaze patterns across MERs presented to (and handled by) them. This data provides a deeper understanding of how students move through the representations (see e.g. Figure 2). Our preliminary analysis confirms earlier reports on novices' surface-feature-based exploration of MERs, but adds details of eye-gaze and movement patterns. Students struggled/failed in mapping dynamic features from animations to corresponding features in equations.

2. RC characterization and investigation approaches in chemistry

A significant strand of research in chemistry education reports descriptions of students’ use of multiple representations, transformations of these representations, and the difficulties students face while doing both of the above. Studies show that students lack a clear understanding of basic concepts such as oxidation numbers, ionic charge, atoms and atomic structure, formal rules for writing molecular formulae, as well as meaning of subscript numbers and brackets and coefficients (Garforth, Johnstone & Lazonby, 1976; Savoy, 1988), and eventually fail to associate the symbols and numbers with substances and phenomena (Yarroch, 1985; Herron and Greenbowe, 1986; Nurrenbern & Pickering, 1987; Hinton & Nakhleh, 1999; Sanger & Phelps, 2007). Ben-Zvi, Eylon, & Silberstein, (1988) propose that students' thinking about phenomena relies primarily on perceptual/sensory information but since current pedagogical practices hardly provide perceptual/sensory assistance, students do not understand chemical symbols in terms of their macro and micro-level instantiations.

A more direct approach to characterize RC describes expert-novice differences in the use of MERs of chemical phenomena and their transformations (Kozma & Russell, 1997; Kozma, 2003), by using (in combination or in isolation) the influential working memory model (novices have less skills to manage cognitive load; Johnstone, 1982), context and practice (novices are less exposed to these; Ben-Zvi, Eylon, & Silberstein, 1988) and conceptual understanding (novices lack rich conceptual ground to counter cognitive load; Cook, 2006; Nitz, Nerdel & Prechtl, 2012). Kozma and Russell (2005) identified specific skills among chemistry experts, viz., (a) using representations to describe chemical phenomena, (b) generating and/or selecting appropriate MERs according to specific needs,
(c) identifying and analyzing different features of MERs, (d) comparing and contrasting different MERs, (e) making connections across different representations, relating/mapping features between MERs, (f) understanding that the MERs correspond to phenomena but are distinct from them, and (g) using MERs to support claims, draw inferences, and make predictions.

Experts also seem to better transform between static (such as equation & graphs) and dynamic representations (such as reaction mechanisms; Wu & Shah, 2004; Kelly & Jones, 2008; Nakhleh & Postek, 2008) while students face difficulties in producing static representations (e.g. sketches; Madden, Jones & Rahm, 2011) of the (imagined) dynamic particulate interactions. Understanding chemical phenomena involves building of internal (mental) models that simulate the behaviors of many individual molecules/atoms, their collective behaviors and properties (Levy & Wilensky, 2009) and effects of various parameters on such behaviors.

To improve students’ conceptual understanding by linking and transforming between representations, interventions (guided by the above research and theoretical approaches) have focused on the use of computer interfaces, mostly based on the classical information processing approach to cognition, particularly Baddeley’s working memory model (e.g. SMV Chem, visChem, 4M:Chem, EduChem HS, eChem, etc.). These interfaces, seek to lower the load on students’ memory, by allowing learners to view multiple representations simultaneously on screen.

In contrast to this traditional memory-based approach focusing on simultaneous display, recent work, such as the Connected Chemistry Curriculum, focuses on interlinking representations through manipulable simulations and animations. Based on the Netlogo 2D interface, the manipulability feature may help students better transform between static and dynamic representations. The developers of this curriculum report, through control-experimental group studies, that the curriculum improves generation, handling and understanding of chemistry MERs, particularly the submicroscopic ones, among students, when compared to conventional text/lecture based curricula (Stieff & Wilensky, 2003; Stieff & McCombs, 2006). Such manipulable simulation interfaces have often been coupled with other scaffolds (such as exercises, quizzes, activities and teacher guides; Zhang & Linn, 2011) and have been effective in improving students’ representations and understanding. Computer interfaces for RC assessment have also been explored, and could prove useful in characterizing RC. For instance, by examining students’ use of a multi-representational molecular mechanics animation using eye-tracking, researchers show that students mainly use graphical and model representations in animations, often ignoring the equations (Stieff, Hegarty & Deslongchamps, 2011).

Despite this rich set of studies, there is no theoretical account of the cognitive mechanisms underlying RC, or efforts to develop interventions based on recent cognitive models.

3. Study and Research Questions

Here we report an ongoing requirements-gathering phase for an intervention design. The studies in this phase seek to characterize specific problems faced by students, and how they navigate through existing MERs. 3D molecular animations (depicting only molecular level reaction dynamics, without symbols, text and other representations), graphs, chemical equations and videos of some chemical reactions were given to 6 chemistry undergrad students. Our primary research question was:

How do students understand the reaction dynamics through animations and other representations? At the operational level, our questions include:

- What are the commonly/frequently attended-to features in bare/raw animations, and how are they used to establish links with other representations?
- Do students make chemically meaningful groups/correspondences between bare/raw animations and other representations?
- What are the correctly and incorrectly referred-to features in bare/raw animations, and other representations, in cases of chemically meaningful correspondences?

4. Materials, sample and methodology

Materials for the categorization experiment included, for five pre-determined general chemical reactions, bare 3D molecular animations, laboratory videos, chemical equations and graphs. We
developed bare/raw 3D molecular animation for five general chemical reactions. Each animation depicts only the molecular dynamics/mechanism of that reaction, and does not have any other embedded representations, such as text, narrative, or symbols. Free and open videos of the five chemical reactions (being performed in laboratories) were procured from on-line sources. Equations and approximate graphs were generated using an image editing software. Each representation was validated for content, conceptual and representational correctness, by two chemistry experts and one cognitive science expert. Figure 1 shows the preparation and execution of the experiment in detail.

![Experiment overview](image)

**Figure 1.** Material development and experimental design details

Six chemistry undergrad students (3 girls) from a nearby college participated in the categorization experiment; each of them performed the task individually.

Sources of data collection: (a) for on-screen phase – dynamic eye-movement and fixation data superimposed on the screen-capture video, (b) for off-screen phase – categories made by the participants, their verbal justifications, dynamic eye-movement and fixation data superimposed on the top-view video of the task-process, and side-view video recording of the categorization and justification sessions. The study session ranged from 40-60 minutes for each participant.

**5. Findings and discussion**

The number of animations used in chemically meaningful ways, and the explanations of categories (see table 1), suggest students found it difficult to understand animations.

All students, except G2, tended to map surface-features of animations to other MERs. For instance, the heat source in an animation was mapped with 'Δ' (symbol signifying 'heating') in an equation (e.g. equation for effect of temperature on NO₂ equilibrium) and/or with burner shown in videos. Addition of molecules, molecular aggregation, breaking of molecules, illumination of heat source and increase in velocity of the molecules on heating were the most frequently referred-to features in animations. Students often said, ‘...they (animations) all look alike...’ while explaining their categories. None focused on the structure of individual molecules in the animations.

Graphs play a mediating role for linking static (equation) and dynamic (animation) content. An ideal way of examining the graph could be moving across its slope, and imagining the dynamics of the corresponding molecular behavior. None of the students’ eye-movements match such a pattern,
nor did any of the students group graphs in chemically meaningful ways, except for B2. However, his eye-movement patterns are not indicative of simulating molecular/reaction behavior from graphs.

Table 1: students’ usage of animations in the first round of categorization (each given 5 animations)

<table>
<thead>
<tr>
<th>Participant</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total animations used (correctly + incorrectly)</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Animations used in feature-based + chemically meaningful way</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Animations used in only surface-feature-based manner</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Animations used in only chemically meaningful manner</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

G2's results were close to expert-level, so we present brief findings from a preliminary analysis of the task only for G2. She made 4 categories with the 19 representations, placing 4 out of 5 animations with 4 chemical equations (NO$_2$ equilibrium, precipitation, AgCl-NH$_3$ equilibrium and aqueous cobalt chloride equilibrium), each animation corresponding to one equation. One pair was incorrect (cobalt chloride equilibrium paired with animation representing neutralization reaction). The remaining animation was grouped with two graphs and two videos (all four representing effect of temperature on equilibrium).

While viewing the animations, G2 tended to follow only one molecule at a time, and was attentive to changes in the number molecules, and their bonding and breaking. G2 did systematic scanning of the equation, looking for molecular formulas and subscripts. Figure 2 shows one segment of G2's gaze sequence, while she viewed an equation. For instance, G2's second fixation (point No. 2) was on the subscript (aq) that denotes aqueous state of KNO$_3$, at fixation point 3, G2's attention is on subscript (s) that denotes the solid state of PbI$_2$. Immediate next fixation (point No. 4) occurs on subscript (aq), aqueous state of KI. A similar pattern is observable while G2 viewed other equations. G2 seems to trace the states of elements before and after their displacement. There are both forward (in the direction of the reaction) and backward (opposite to the direction of reactions) eye-movements. Such movements may generally be associated with sequential imagination of reaction dynamics. Her chemically meaningful categories, combining animations and equations, and her gaze pattern, suggests that she imagined the step-wise dynamics of molecular mechanisms, using the symbols in the equations. A detailed analysis of her gaze pattern, and comparison with other participants' gaze patterns, is ongoing. We expect to present details of this analysis at the workshop.

Figure 2. An instance of student G2's eye-gaze sequence

6. Conclusion

Students have difficulties in chemically relating animations to other representations such as graphs and equations. They tend to focus on surface features and ignore important dynamic features in animations. Molecular dynamics are difficult to understand, and integrating them with equations and graphs requires generating dynamic features using static equations and graphs. This imagination of dynamics, and the cognitive mechanisms underlying such imagination, appear critical to the development of RC in chemistry. A preliminary study was done to characterize student difficulties, as a requirements-gathering phase for interaction designs for gaining RC. The study replicated some results from literature, and adds further details about how students move their eyes as they navigate (through) the MERs. Further analysis would help isolate eye-movement and navigation patterns related to RC.
References


How does representational competence develop?
Explorations using a fully controllable interface and eye-tracking

Aditi KOTHIYAL*a, Rwitajit MAJUMDARb, Prajakt PANDEb, Harshit AGARWALc, Ajit RANKAd, Sanjay CHANDRASEKHARANb

aInter-disciplinary program in Educational Technology, Indian Institute of Technology Bombay, India
bHomi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, India
cIndian Institute of Technology Roorkee, India
dBirla Institute of Technology and Science Pilani, India

*aditi.kothiyal@iitb.ac.in

Abstract: Representational competence (RC), defined as “the ability to simultaneously process and integrate multiple external representations (MERs) in a domain”, is a marker of expertise in science and engineering. However, the cognitive mechanisms underlying this ability, and how this ability develops in learners, are poorly understood. In this paper, we present a fully manipulable interface, designed to help school students develop RC, and a pilot eye and mouse tracking study, which sought to develop a detailed understanding of how students interacted with our interface. We developed an analysis methodology for eye and mouse tracking data that characterizes the interaction process in analytical terms, and operationalizes the process of MER integration. We present preliminary results of applying our analysis methodology to student data obtained in our pilot study.

Keywords: multiple external representations, representational competence, distributed cognition, embodied cognition, equations, graphs

1. Introduction and Related Work

Representational competence (RC) is defined as “the ability to simultaneously process and integrate multiple external representations (MERs) in that domain” (Pande and Chandrasekharan, 2014). MERs are used extensively in science and engineering, and students have difficulties in learning owing to problems in working with MERs (Pande and Chandrasekharan, 2014 has a review). Students understand and are able to use and generate graphs and equations independently (Sherin, 2001; Hammer, Sherin and Kolpakowski, 1991). However students often have difficulty understanding how the two representations are related and can be used together (Kozma and Russell, 1997; Knuth, 2000). This indicates that there is a clear need for development of RC among students.

Computer interfaces with MERs have been widely used for the improving conceptual, phenomenon and procedural understanding in science and engineering (Rutten, van Joolingen and van der Veen, 2012). Despite this, the effectiveness of available computer interfaces for learning has been mixed (Ainsworth, 2006; Rutten, van Joolingen and van der Veen, 2012; Bodemer et al, 2004). One possible reason for this is that interface design is currently guided by information processing theories of cognition, wherein the role of the interface is to decrease the learner’s cognitive load, particularly working memory load (Ainsworth, 2006; van der Meij and de Jong, 2006). However, emerging theories, such as distributed and embodied cognition (Glenberg, Witt and Metcalfe, 2013), postulate that external representations play more roles than decreasing cognitive load (Kirsh, 2010; Kirsh and Maglio, 1994). Further, actions could be a way of promoting integration of MERs (Chandrasekharan, 2009). Tangible interfaces, based on embodied cognition theories, have been used for learning (Marshall, 2007). But there is no consensus on how such representations should be combined for effective integration, the benefits of various approaches, or the cognitive effects of combining representations (Marshall, 2007).

Finally, there is a dearth of research which focuses directly on the development and assessment of RC using computer interfaces. Examples are Johri and Lohani (2011), Stieff, Hegarty and Deslongchamps (2011) and Wilder and Brinkerhoff (2007), and these are also based on working
memory load design principles. Approaching the RC development problem from new theories of cognition could help in developing better interaction designs that facilitate MER integration.

In this paper, we report on the design of such a computer interface. We applied insights from embodied and enactive theories of cognition, particularly common coding and tool use (Maravita and Iriki, 2004) and theories of how building and manipulation of external models could lead to conceptual change and discovery (Chandrasekharan, 2009) to identify interaction features that will result in the integration of MERs and the development of RC.

The interface is designed for self-learning by a grade 7 student, and includes specific tasks that encourage exploration. We developed a stable initial prototype of the interface and performed a pilot study to understand the interaction process in detail. We recorded student eye movements and mouse clicks using an eye-tracker with the goal of developing a way to capture the RC development process. Our specific research question (RQ) was: “How can eye tracking data analysis give us more insight into the process and mechanism of MER integration?” In this paper, we report preliminary results of our ongoing work towards answering this RQ.

2. Design of the Interface

We chose the concept of oscillation of a simple pendulum as the medium to examine the development of RC. This is because the concept is easy to understand for a 7th grade student, and we didn’t want conceptual complexity to interfere with the learners’ integration of representations.

Our learning objectives (LOs) for this interface were that the student should understand (i) the idea of equation and graph as dynamic entities (ii) the idea of equation as a controller of systems, and (iii) different numerical-spatial and dynamic-static transformations and develop an integrated internal representation, consisting of the physical system, equation and graph.

Our design, unlike simulation models with similar elements, such as Netlogo (Wilensky, 1999) and PhET (Perkins et al, 2006), is derived from basic research, particularly education research examining RC, and recent cognitive science theories and models, including distributed and embodied cognition, that investigate the cognitive roles played by different kinds of representations and their underlying cognitive/neural mechanisms (Marshall, 2007; Kirsh, 2010; Kirsh and Maglio, 1994; Chandrasekharan, 2009). One feature derived from basic cognition research is the full manipulation of the interface, which seeks to promote integration of MERs. This link is derived from an embodied cognition idea - that actions and manipulation, i.e. motor control, requires integrating multiple cognitive and perceptual inputs, and feedback loops. This suggests that actions and manipulations performed on MERs in an interface would trigger/prime the neural processes involved in integration of inputs; thus it would help in integrating the multiple representations as well. This line of thinking led to making the equation components manipulable. This also introduces the controller role of the equation, a feature not seen in other interactive visualizations.

In this design, students control and ‘enact’ the equation, and integration is hypothesized to result from this control feature. Thus the (eventual) testing of the development of RC based on our design would also involve testing this hypothesis, and by extension, the cognitive theory that underlies it. Applying these cognitive theories to our interface leads to features such as full learner manipulation of the pendulum via clicking and dragging, controlling the equation parameters using vertical sliders, and complete interconnection between the three modes. By contrast, a PhET pendulum simulation Error! Reference source not found. does not have the equation and graph, and there is only one interaction on the pendulum, while the other variable is manipulated via horizontal sliders. The design of the interface evolved through three iterations and was based on a set of design principles from distributed and embodied/enactive cognition theory (Kirsh, 2010, Kirsh and Maglio, 1994, Chandrasekharan, 2009) which are shown in Table 1, along with our operationalization of these principles. Other mappings are possible.

In order for the LOs to be met, students need to be able to do the following: (i) Map a physical system to a graph, (ii) Map a physical system to an equation and (iii) Map an equation to a graph. We designed a series of three tasks, requiring the student to manipulate the equation and pendulum to match a given graph. We hypothesized that these tasks were complex enough to result in extensive exploration and manipulation of the interface by the student, leading to the three representations being integrated.
Screenshots of the first two versions of the interface are shown in Figure 1, while a screenshot of the final version used in the pilot study is shown in Figure 2.

Table 1: Design principles and operationalization

<table>
<thead>
<tr>
<th>Principle</th>
<th>Operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>External representations allow processing not possible/difficult to do in the mind.</td>
<td>The interface plots the graph of the equation/motion of the pendulum for various lengths and initial angles of the pendulum.</td>
</tr>
<tr>
<td>Cognition emerges from ongoing interaction with the world.</td>
<td>The interface is fully manipulable, i.e., the learner can control the pendulum, equation and graph, to see how change in each affects the other elements.</td>
</tr>
<tr>
<td>Features of the world are used directly for cognitive operations. Hence the interface features should support integration directly.</td>
<td>The interface has the physical system, equation and graph, along with different numerical values. The dynamicity of elements, and their interconnections are made transparent, so that learners can integrate across spatial-numerical and dynamic-static modes.</td>
</tr>
<tr>
<td>The active self is critical for integration of features.</td>
<td>The exploration on the interface is guided by tasks which the learner must do.</td>
</tr>
<tr>
<td>Action patterns can activate concepts, hence actions and manipulations of the representations should be related to existing concepts.</td>
<td>The learner can interact with the pendulum by changing its length and initial angle by clicking and dragging the mouse. The parameters in the equation can be changed using vertical sliders - moving up/down increases/decreases parameter values. This is related to the finding that numbers are grounded by associating small magnitudes with lower space and larger magnitudes with upper space (Fischer, 2012). By contrast, a PhET pendulum simulation (Perkins et al, 2006) does not have the equation and graph, and there is only one interaction on the pendulum, while the other variable is manipulated via horizontal sliders. These interactions distinguish our interface from other variable manipulation simulations, wherein the mode by which values are changed (slider, input box or multiple options) is not relevant. Our interface seeks to make the learners do actions that mimic the behaviour of the system, so that the system can be 'enacted' - the learning is thus through a form of participation with the system.</td>
</tr>
<tr>
<td>The interface should allow coupling of internal and external representations.</td>
<td>The task requires student to match a given graph. Learners change the parameters of the pendulum/equation to generate the graph, and visually match the task graph to their graph. This develops learner’s imagination and coupling between their internal model and the external representation.</td>
</tr>
</tbody>
</table>

Figure 1. First version of interface (L). All 3 components (pendulum, graph and equation) are manipulable. The second version of the interface (R) only pendulum and equation manipulable.

3. Methodology
A pilot study was done with the broad research goal of developing an analysis methodology -- i.e. how to characterize interactions with our interface, and how to connect this to RC. Our specific RQ was, “How can eye tracking data give us more insight into the process and mechanism of MER integration?”

Our (convenient) sample consisted of twelve (6 female) 7th grade school students from two urban schools in Mumbai. Each student was allowed to work independently with the interface for as long as he/she wished, proceeding through the screens and tasks by clicking the “Next” button. When students had a question the experimenter provided appropriate hints. When the students indicated that the tasks were completed or that they wished to quit, they were interviewed regarding their background and their impressions of the interface. They were then administered an offline assessment task.

Our data sources were:

1. Eye Tracker: Eye movements recorded using a Tobii X2-60 (static) eye-tracker, capturing how students’ loci of attention shifted as they explored the interface.
2. Assessment task: To evaluate the extent to which students are able to imagine and mentally simulate the movement that they observed on the interface. Consisted of 3 multiple choice questions, asking students to imagine the position of the pendulum from the graph, and 3 marking questions, asking students to mark points on the graph corresponding to the pendulum’s position.

4. Analysis Approach

The goal of our analysis is to pull out interaction patterns from eye and mouse tracking data and explore what it means for a learner working with our interface to develop the thinking skill of RC. For this, we needed to identify patterns in the student interaction that could be markers for integration of MERs. To do so, areas of interest (AOIs) as depicted in Figure 3 were defined, and the eye fixation and mouse click co-ordinates in the respective AOIs were extracted from the eye-tracker. The data was analyzed at multiple levels of abstraction as shown in Figure 4.

![Figure 2. Final interface with sliders and tasks](image1)

![Figure 3. AOIs used for the analysis.](image2)

![Figure 4: Levels of Analysis](image3)

The data obtained from the eye tracker includes eye fixation durations and number of mouse clicks on different areas of the screen (level 1 analysis). In level 2, we determine sequences of fixation events and mouse click events, and classify them into events occurring in the perception-action cycle, and events occurring in the simulation/imagination cycle. The perception-action cycle refers to students manipulating features on the screen (e.g. sliders), playing the simulation, and looking at the dynamic features of the screen (for e.g. the plotting graph). The simulation/imagination cycle (or thinking) happens when the simulation is paused and involves students looking at the static features on the screen (e.g. length/angle values and the graph).
In level 3 analysis, we define markers that signify integration, and abstract out the data further to calculate these markers. An example of a marker is returns, i.e. a learners’ eye gaze returning to a particular area of interest after going elsewhere, as this indicates that the learner is retaining a particular feature in memory and returning to it. A second example is eye gaze transitions between a numerical area on the screen (e.g. the equation) and a spatial area on the screen (e.g. the graph) as this specifies integration between numerical and spatial modes. The third example is the learner manipulating a feature on the screen (e.g. pendulum) and looking at another area of the screen (e.g. graph) as this indicates the integration of two representations via the systematic variation offered by control. Once these markers are obtained, we define a goodness measure for these markers by comparing against marker values of experts, or marker values of learners who perform well on the assessment tasks.

The final stage of abstraction is to generate process patterns of how the learners interacted with the interface, using a graph theoretic framework, wherein the AOIs are the nodes and the transitions between the various AOIs are the weights of the branches. The duration of returns, and the sequence in which returns occurred, will also be added to this graph. These graphs will then be compared to the graphs of experts or learners who perform well on the assessment tasks to evaluate learner process. The comparison of graphs is a complex problem, and this is not implemented yet. Thus, results of the analysis at levels 2, 3 and 4 will answer our RQ, “How can eye tracking data analysis give us more insight into the process and mechanism of MER integration?” by allowing us to correlate interaction behaviours such as returns with MER integration (i.e. high performance on the assessment tasks).

5. Indicative results

For lack of space, in this paper we present indicative results, applying our analysis methodology to the data of one student who performed well on the assessment task. This is ongoing work, and we have not completed the level 4 analysis, and correlated the results to assessment task performance, which would give us an answer to our RQ. The data at level 1 of analysis, namely fixations and mouse clicks, is reported elsewhere (Majumdar et al, 2014). Here we report analysis of the fixation data at levels 2 and 3. Figure 4 shows an example event sequence for the learner between two consecutive clicks on the play button and the legend is shown in Figure 7 (also see AOIs in Figure 3). The sequence of events between the play and the pause button are events in the perception/action cycle, while events after the pause button are in the imagination cycle. This sequence shows that the student transitions between spatial and numerical regions both in the action and imagination cycles.

![Figure 4: An example of a sequence of events for a good performing student](image)

Next we present two markers of integration at level 3 of the analysis. The first is eye gaze transitions between numerical and spatial areas on the screen (Figure 5) and the second is the transitions
between mouse clicks and eye gazes on different areas of the screen (Figure 6). In these figures, the thickness and numbers on the arrow from A to B indicates the number of A-> B-> A transitions made by the student. For instance, Figure 4 shows that this student looks from the spatial area of the graph to the spatial area of the task and returns 11 times. In the final level of analysis, the return data will be combined with duration of each return, to create a rich graph representation of the students’ interaction process, which will then be compared to the processes of an expert and a low-performing student.

6. Conclusions and Future Work

In this paper, we presented the design of an embodied computer interface for the development of RC. We evaluated the interface in a pilot study, developed an analysis methodology for extracting process patterns (i.e. how students interacted with our interface) from eye and mouse tracking data and evaluating how these process patterns translate to MER integration. We also presented preliminary results using this analysis. Once complete, our methodology becomes a template for analyzing the process of how learners interact with a new design, using eye and mouse tracking and evaluating whether MER integration occurs using that design.

References


Using Ontology for Representing Role Change Design in Nursing Service Thinking Education

Wei CHEN a*, Liang CUI b, Koji TANAKA a, Hirotaka NISHIYAMA a, Noriyuki MATSUDA c &Mitsuru IKEDA ab

a School of Knowledge Science, JAIST, Japan
b Research Center for Service Science, JAIST, Japan
c Faculty of Systems Engineering, Wakayama University, Japan
*wei.chen@jaist.ac.jp

Abstract: This study aims to develop a learning design representation framework to support the modelling of an in-service education program for fostering the meta-thinking skill of nurses. In this paper, we describe the development of the ontological framework for representing the design intention of the learning goals of the meta-thinking skills and also the relationship of the learning experiences gained from changing learner’s roles.

Keywords: instructional design, ontological engineering, metacognition, nursing service education

1. Introduction

In the social constructivist view of education, the focus of learning transfers from knowing facts and procedures to acquiring knowledge and skills for solving the authentic, contextual and social problems which do not always have a clearly correct or universal answer. The characteristics of these problems are that i) they can be formulated or defined from various perspectives; ii) their solution is not unique, and the criteria for choosing a better solution is implicit or situation-dependent (Munneke, et al., 2007).

Nursing education is one of the forefronts of the professional education areas which aim to foster the abilities for solving the patient related problems. To acquire these problem solving abilities, it is crucial to acquire implicit knowledge and skills based on the experience of reflecting on one’s own thinking. Various educational methods, including narrative method and reflective journal have been conducted in the professional education of nurses in order to support the learning of these knowledge and skills (Bulman, 2013).

In this research, we focus on the design of meta-thinking skills education. The terminology “meta-thinking” is a particular concept. The meta-thinking skills are defined as the skill of monitoring and control of thinking which targets to clarify beliefs behind the conflicts of different perspectives. Compared with the concept of Dewey’s reflective thinking, the meta-thinking is the narrowly-defined concept that focuses on the careful consideration of belief clarification. We consider that improving the nurse’s meta-thinking skills is crucial to build the foundation for the patient-centered medical service. For example, in the realistic setting of medical service, the patients have a tendency to lie to the doctors for protecting the private information. On the contrary, the doctors want to know more information for diagnosis. It is helpful to improve the meta-thinking skills for promoting the quality of medical service with due consideration of the rationality of medicine and the patients’ humanity.

For supporting the design of learning goals, learning content and education methods, various theories (Gagné et al., 2004; Keller, 2009) and techniques (Hayashi, 2004; Paquette, 2006) have been studied. For example, Hayashi et al. (2009) proposed an ontology-based
theory-aware and standards-compliant authoring system to provide a general knowledge-base for linking educational theory and practice.

However, it is difficult to create a clear model for education which targets the fostering of experientially-acquired skills (especially thinking skills). This study aims to develop a learning design representation framework which supports the modelling of meta-thinking skills education for nursing services. This paper describes the development of an ontological framework for representing the design intention of the learning goals of the meta-thinking skills and also the relationship of the learning experiences gained from changing learner’s roles. The entire ontological framework built through the study will be reported separately.

2. Education Program for Fostering Meta-thinking Skills

An education program named Nursing Service Thinking Method Workshop was designed to foster nurses’ meta-thinking skills. The educational objective is that, through building the skill of the thinking representation (identification of thinking logical structure), nurses are expected to 1) understand both of examining their own thinking and considering about other’s perspective through identification of thinking logical structure; and 2) to be motivated to continue to learn meta-thinking skills by themselves after the end of the education program (Cui et al., 2014).

As shown in Figure 1, the workshop consists of six parts: Lecture, Case-writing Practice, Case-writing (homework), Case Reviewing, Discussion and Reflective Lecture. It is conducted in 2 day-long sessions spaced approximately one month apart; the workshop is conducted three times per year. It is also necessary for the learners to attend the entire program of the workshop for three years, because they need to change their role after learning in the workshop for each year.

![Figure 1. Overview of Nursing Service Thinking Method Workshop](image)

2.1 The Characteristics of the Workshop

a. Using a Reflective Case-writing Supporting Tool named Sizhi (Figure 2) as the core learning material for improving the quality of thinking reflection through the support on the identification of thinking logical structure (Chen et al., 2011).

b. A form that combines the self-thinking reflection experience from case-writing and the group-thinking reflection experience from discussing the case with other learners to help participants recognize the connections between those two kinds of experience and promote the acquisition of meta-thinking skills.

c. A step-by-step learner’s role designed to utilize the learning experience from the previous step to trigger the useful learning experience in the successive step to promote the acquisition of meta-thinking skills. The definitions of the learner’s role are:

   - Member (1st Year Attendance) attends six sessions of the workshop, acquires fundamental knowledge and skills related to thinking representation logical thinking.
   - Leader (2nd Year Attendance) attends the case-writing practice session and the discussion session. In the discussion, the Leader does not take the initiative in presenting a viewpoint but views discussion from the higher perspective and guiding it. Based on the experience of learning in the role of a Member, monitoring and controlling of group thinking skills can be promoted.
Facilitator (3rd Year Attendance) does not attend the workshop but supports the learning of members through revising and giving comments to the cases written by members (Nishiyama et al., 2014).

While understanding the feeling of the family, the safety and treatment of the patient were given first priority.

Respect the mother’s hope while closely monitoring and minimizing life-threatening factors.

It is important that medical staff look after the best interest of the baby to prepare the baby for surgery under the best conditions. Given that the baby might die during the operation because of the difficulty of the surgery, it was necessary for the staff to encourage family time with the baby. However, holding their baby in their arms does not always palliate the parents’ anxiety or tension. Nevertheless, considering the tie that parents, especially mothers, establish with their baby, assisting the mother in holding her baby close to her body to make her feel emotionally close to her baby may provide the mother with psychological support. However, this creates a conflict that requires attention.

Before changing becoming a Leader, a Member needs to attend the workshop three times in one year to acquire fundamental knowledge and skills from their learning experience. Some of the learning experiences Members undergo are implicitly designed to promote further learning as a Leader. This relationship of learning experiences is an important design aspect of the learning of meta-thinking skills.

3. Ontology-base Representation Framework

In order to represent the implicit design intentions mention above, we develop a learning design representation framework that consists of the graphic representation form and the ontology representation form. The graphic representation form can provide a descriptive medium to represent the elements of learning design such as learning goal, learning strategy and etc. The merit of the graphic form is that it can marshal the different elements of learning design in a structured way. The ontology representation form is created for representing the learning design intentions in a further precisely and systematically, which is difficult for the text or graphic representation from to be done.

An example of the basic form of the graphic representation is shown in Figure 3. The whole of the box in the figure is named Learning Unit. The learning unit is created for integrating the concepts related to the design of the education program, including Object of Learning, Attainment Level of Learning, Learning Goal, and Learning Strategy. The row that represents Learning Goal states the goal which the learning unit aims to achieve. The content in the row that represents Object of Learning refers to the kind of skill, knowledge or attitude. The content in the row that represents Attainment Level indicates the attainment level of learning on the object of learning. For example, the learning unit shown in Figure 3 indicates that the learners are expected to achieve the learning goal “Group Thinking Monitoring Skill for Grasping Situation of Group Thinking Process” to the attainment level of “Cognitive”, by the learning strategy learning from observation of group thinking process in discussion. The Group
Thinking Monitoring refers to the realization of group thinking condition through analyzing and evaluating the process of group thinking. The level of Cognitive means knowing fundamental knowledge or knowledge on how to practice skill. Moreover, the learning goal is not independent but a part of a continuous learning process which regards the program dependence meta-thinking skill of “Group Thinking Monitoring” as the Object of Learning. This implies that this skill is intended to be acquired gradually within the program through several steps.

By using the learning unit described above, the learning design of the workshop can be organized and represented in an easily viewable way. In addition, the learning experience gained from what kind of Member’s activities influence which part of Leader’s learning can be represented. For example, in Figure 4, the learning unit on the left side represents the member’s learning experience gained from externalizing the result of logical thinking in Sizhi. The learning unit on right side represents the leaders’ learning on the meta-thinking skill through attending and observing the discussion. One of the purposes of the case-writing is to help the participants become aware of the logical structure of thinking by externalizing his/her thinking. This awareness also benefits the discussion, because this awareness is expected to trigger the action of realizing the logical structure of group thinking process.

![Figure 4. An Example of Relation between Member’s Experience and Leader’s Learning](image)

In this research, we use the Hozo ontology editor (Hozo Ontology Editor) to build the representation framework (Chen et al, 2014). The most significant feature of the Hozo ontology editor is that it provides a function to support users to build ontologies being aware to distinguish role concept from basic concept (Mizoguchi, et al, 2007). For example, in schools, the teacher role is set up and the person who is assigned the teacher role is considered as a teacher. In this example, the person is basic concept and the teacher role is role concept. The concept of teacher is named role holder. This feature is practical to explore and represent the essence of the concept which is always easily-confused.

The ontology related to the facilitation by experience is shown in Figure 5. A–E of the figure indicates the concepts in a hierarchy. The concepts in upper levels (such as A) represent more general concepts; lower levels (such as E) represent more specific concepts. E shows a specified concept of Facilitation by Experience with Role-change (FER) named FER of Member’s Case-writing Experience to Lead’s Learning in Discussion. As described in Figure 4, the member’s experience of coaching from externalizing result of logical thinking in Sizhi is expected to be helpful for facilitating the leader’s learning conducted with the learning strategy of Discovery from observation of group thinking process in Discussion. By using ontology, this influence can be represented. Because the role change in this example is from member to leader, the pro-role is restricted with concept of member [RH] (e1) and Target role is restricted with the concept of leader [RH] (e2). RH means role holder according to the ontology theory that Hozo is based on. In the workshop, the person who is assigned the member role is defined as member [RH] and the person who is assigned the leader role is defined as leader [RH].

In the learning experience (e3), the attributes of member [RH] as the holder (d4) and Identification on logical structure (e5) to self-thinking result (e6) as the outcome are defined.
The meaning of this definition is that the action identification on the logical structure of self-thinking result is involved in the member’s learning experience of coaching from externalizing result of logical thinking in Sizhi. Similarly, in the learning strategy (e7), the attributes of leader [RH] as the holder (e8) and Identification on logical structure (e9) to group thinking process (e10) as the action are defined. The meaning of this definition is that the action identification on the logical structure of group thinking process is involved in the leader’s learning conducted with the learning strategy of Discovery from observation of group thinking process in Discussion.

The relation same-person (R1) between Pre-role and Target-role represents that the same person plays the different role in the workshop and role-change is conducted from Pre-role to Target-role. The relations sameAs (R2 and R3) mean that the learning experience belongs to the person who is assigned the member role and the learning strategy belongs to the same person who is assigned the leader role.

![Ontology related to Role Change (Part)](image)

By defining the concepts of learning experience and learning strategy, it is represented that the concepts of Identification on logical structure (e5) and Identification on logical structure (e9) have the same name, but the meaning of these two concepts are different, because they play different role for the concepts which they belongs to. Furthermore, the relation of e5 and e9 is indicated with the relation of triggering (R4). It represents how an outcome of the member’s learning experience from the case-writing influence the leader’s learning.

As described above, by using ontology, the implicit relation of learning experience is represented. Although the learners will not use the ontology directly, representing the learning design by ontology is useful to encourage the designer to consider about the improvement. For example, in leader’s learning, it is necessary to help them to realize the similarities and differences of self-thinking and group thinking and to support their conduct of the action Identification on logical structure in the discussion.

4. Conclusion and Future Work

The meta-thinking skills are difficult to facilitate but crucial for the nurses, because it is important to reexamine and integrate self-thinking, the thinking of patients and the thinking of
co-workers and other healthcare professionals through the dialogue with self and other people to achieve high-quality patient-centered medical service. We have been working on this practical research in collaboration with medical institutions. This study is intended to create a foundation for the process of design, implementation and redesign for the educational practice in nursing service. For facilitating meta-thinking skills, besides the design of the role change model described in this paper, we are creating several other models. In this study, the circulating procedures of model creation, ontology construction through segmenting the concepts, and the refinement through practice are conducted repeatedly. The workshop is designed as one turn in three years and the current research is at the stage of completion of former two years. Using this representation framework is helpful to share the design intentions of the meta-thinking skill fostering workshop which is conducted in a long term. We are currently working on the creation of the facilitator’s educational model and its application. In addition, we plan to reorganize and report the overview of the entire model after completing other parts.

In summary, the graphic and ontological representation framework is used in the design and creation of textbooks and exercises in the implementation of workshop, in the development of evaluation methods and even for sharing the design intentions between the people who are in charge of different parts of learning design cycle. The feedback from those practical learning design activities is positive. In the future, we will develop a supporting tool for sharing the design intentions to the learners to help them to realize the learning goals. Furthermore, we will also study the supporting tool for assisting the facilitator role learners to improve or customize the workshop according to the demands of their medical institutions.

References

Hozo Ontology Editor, http://www.hozo.jp
Self-assessment rubrics as metacognitive scaffolds to improve design thinking

Madhuri MAVINKURVE & Sahana MURTHY
Inter-Disciplinary Program in Educational Technology, Indian Institute of Technology Bombay, India
mavinkurvemk@gmail.com

Abstract: An important goal of engineering education is to develop design thinking competency among students. These competencies include: structuring open problem, information gathering, divergent and convergent thinking, and multiple representations. We have developed Engineering Design Interactive Visualizations (EDIVs), a technology-enhanced learning environment for students’ self-learning of engineering design competency. The EDIVs contain activities to promote decision-making, concept integration and overall synthesis, which are necessary cognitive mechanisms to attain design competencies. However, in addition to cognitive strategies, students require metacognitive scaffolds to help them reflectively and mindfully apply these strategies to new contexts. Hence, we included self-assessment rubrics in EDIVs to act as metacognitive scaffolds for the process of design. In this paper, we describe the role and structure of self-assessment rubrics for the engineering design competency of Structure Open Problem, and report results of an experiment where students worked with EDIVs in two conditions – with and without rubrics. We find that the rubrics prompt students to perform formative assessment of their own performance, and correct themselves if necessary, thus leading to improved performance in a new design problem.

Keywords: Design thinking competency, Technology enhanced learning environment, interactive visualization, scaffolding, metacognition, self-assessment

1. Introduction and related work

The development of design thinking ability is an important goal of engineering education. Professional organizations, accreditation bodies (ABET, 2014) as well as educators (Sheppard, 2003) have emphasized that graduating students should be able to design effective solutions for given needs. However, design thinking is complex and teaching design is difficult (Dym, 2005). Efforts to teach engineering design thinking mainly include stand-alone design courses based on a version of project-based learning (Dutson et.al, 1997). These courses have been reported to be beneficial to students, especially in promoting student interest and retention (Wood et.al., 2001). Challenges have been reported too in running such courses, such as extra faculty time, special training, and lack of assessment techniques. Thus design courses are not common in universities, which translate into lack of design ability among students (May & Strong, 2006).

The above problems are compounded in part because of the lack of a unique definition of what comprises engineering design thinking. Plenty of definitions and perspectives abound (Atman et.al, 1997; Crain et.al, 1995). What is common in all approaches is that engineering design is a systematic and thoughtful process, in which “designers generate, evaluate, and specify concepts for devices, systems, or processes” (Dym, 2005). The designed artifacts must satisfy specifications and constraints in order to meet the user’s requirements. For example, in electronics system design, in order to design function generators, one needs to consider the type of waveforms, amplitude and frequency range etc. as specifications. Based on these definitions, we take a competency-based approach, and envisage the design thinking process in terms of a set of engineering design competencies that need to be developed and applied while solving design problems. These competencies include structuring open problem, information gathering, divergent and convergent thinking, and multiple representations.

In recent years, the affordances of ICT has led to the development of technology enhanced learning (TEL) environments to promote various thinking skills. There exist numerous TEL systems for modeling ability such as WISE (Linn et. al. 2003) and Co-Lab (van Joolingen et. al., 2005), scientific argumentation (Scheuer et. al, 2009 contains many examples) and designing virtual experiments (Hemlo, Nagarjan & Day, 2002), but fewer for engineering design thinking. We have developed Engineering Design Interactive Visualizations (EDIV), a TEL environment for students’ self-learning of engineering design competencies.
In a prior experimental study (Mavinkurve & Murthy, 2012), we have investigated the effectiveness of EDIVs that target Structure Open Problem competency. We have shown that students who learnt with EDIV were able to develop certain sub-competencies such as identifying specifications in an open problem, and were able to apply them to a new design problem. However, students did not satisfactorily demonstrate the development of sub-competencies such as being able to synthesize and write a structured problem statement in the context of the new problem. Subsequent interviews with students revealed that they are often not aware of the cognitive processes that need to be performed at a particular time that would have led to the development of this sub-competency. Unlike experts, novice students have not internalized these cognitive processes. Hence they need to reflectively abstract these processes from the learning context, and mindfully apply them to the new context (Perkins & Salomon, 1992).

In this paper, we focus on the problem of helping students to reflectively and critically apply cognitive processes needed to write a structured statement for a given open design problem. One strategy to help students achieve this is to include metacognitive scaffolds. The inclusion of scaffolds for complex tasks has been recommended to promote students learning of not only conceptual and procedural knowledge, but also flexible thinking skills (Reiser 2004; Etkina et. al., 2010). Scaffolds can promote students’ metacognitive thinking, which includes planning, monitoring, evaluating, revising and reflecting (Jacobs & Paris, 1987). Metacognitive thinking is a crucial component for design activities (Davidowitz & Rollnick, 2003). Scaffolds that promote metacognitive thinking help students learn from the experience so that they can apply knowledge and skills in new contexts.

To provide metacognitive scaffolds for design thinking, we added formative assessment rubrics in the EDIVs (Section 2). These rubrics allow students the opportunity of self-assessment, which is a powerful way of implementing formative assessment (Black & Wiliam, 1998). The rubrics provide students feedback on their responses to the EDIV activities so that they can monitor their learning process themselves with respect to the learning goals. At the same time, they focus students’ attention on the important cognitive processes needed for accomplishing the complex task at hand. Thus the inclusion of the rubrics are intended to develop students’ design competencies. In Section 3, we report results of an experiment where students worked with EDIVs in two conditions – with and without rubrics, and discuss the role of self-assessment rubrics in developing students’ design thinking.

2. Learning Environment: Engineering Design Interactive Visualization

The process we followed to develop the learning environment for various design competencies involved the following steps: i) identify and operationalize specific measurable units of the competency (which we refer to as ‘sub-competencies’), ii) analyze the cognitive tasks that need to be performed to attain the sub-competencies, and iii) decide features and activities in the EDIVs that trigger students’ cognitive mechanisms to perform these tasks. In this section, we discuss the design of EDIVs that target the competency of ‘Structure Open Problem’, which is one of the first tasks involved in design thinking (Sheppard, 2003).

The competency of ‘Structure open problem’ (SOP) is operationalized into four sub-competencies: Student should able to i) identify specifications in open-ended problem (SOP1), ii) use specifications to structure problem (SOP2), iii) sequence steps of design process to (SOP3) and iv) write structured problem statement (SOP4). To attain each sub-competency above, students need to perform a set of cognitive tasks. For example, to be able to identify relevant specifications needed to structure open problem (SOP1), the set of cognitive tasks to be performed are: identification of all possible specifications, deciding relevant specifications and interpretation of chosen specifications with respect to the concepts. When these tasks for all sub-competencies were analyzed, we found that there are three common cognitive mechanism required to execute these tasks: A. Decision making, B. Concept integration and C. Synthesis.

A. Decision making mechanism. Decision making process is defined as mentally generating possible options for given situation and evaluating options based on set of information (Gresch & Bögeholz, 2012). Decision making is a process that all designers have to engage in throughout the design process (Dym, 2005). It involves an iterative series of divergent-convergent thinking in which students need to generate many options based on the set of information available, evaluate them based on domain knowledge expertise. Decision making is an essential triggering cognitive mechanism in the attainment of SOP1 (identification of specification) and SOP2 (use of specifications), as both
these competencies require students to think of multiple options and select appropriate ones. Each EDIV contained activities and features which trigger the above cognitive mechanisms. Decision making can be triggered using question prompts (Ge & Land, 2005) as well as providing opportunity for knowledge integration through experimentation and reflection (Etkina et. al., 2010). To trigger this cognitive mechanism, we added ‘Decision Making Task Questions’ with multiple options and formative feedback. The EDIVs also contained simulative manipulation activity (Chen et.al., 2011) in which students are provided variable manipulation for experimentation, followed by questions with feedback on students’ responses. This provides opportunity for reflection. Fig. 1 shows a Decision Making Task Question activity in which students have to make decisions about the selection of specifications. Fig. 2 shows a simulative manipulation activity related to selection of amplifier circuit to satisfy specifications.

Fig.1. Decision Making Task Question activity  Fig.2. Simulative Manipulation activity

B. Concept Integration mechanism. This is the process of connecting various concepts using information association and knowledge integration (Aurisicchio et.al, 2007). The cognitive mechanism of concept integration expects students to associate different pieces of information based on domain knowledge. This is mainly required for SOP3 (sequence decision steps) wherein students should able to recall and connect appropriate concepts based on domain knowledge. Concept integration also requires knowledge of multiple representations with visual thinking. The third major cognitive mechanism, synthesis forces student to think about entire system. Concept integration primarily expects information association activity, for which the EDIVs contain Concept Enforcement Questions (CEQ) questions In addition, EDIVs contain controlled animation with dynamically linked representations to help students to associate information. To trigger system thinking process, EDIVs contain information agents like design tips and information box along with Decision Making Task Questions and Concept Enforcement Questions.

C. Synthesis mechanism. Synthesis can be defined as integration of all the cognitive mechanisms mentioned above and monitoring of the achievement of these mechanisms (Dym, 2005). Synthesis is required to attain SOP4 (write structured problem), as an entire system-level thinking is required for this sub-competency, including decision making with appropriate concept integration. To trigger system thinking, EDIVs should be able to provide opportunity to monitor learning process. This can be achieved through metacognitive strategies which were added in EDIVs via self-assessment rubrics, based on the scientific abilities rubrics (Etkina et. al., 2006). These rubrics are descriptive rating scales which consist of pre-established criteria to evaluate student’s performance on each design sub-competency. The rubrics for the sub-competencies related to Structure Open Problem competency are shown in Table1. After activities such as Decision Making Task Questions and Concept Enforcement Questions, students are provided the relevant rubric items. Since the rubrics contain descriptors not only of the target performance level, but also of non-ideal performance, they prompt students to carry out formative assessment of their own performance in the activity, and correct themselves if necessary. This helps students not only to monitor their level of achievement of cognitive task, but also plan learning based on expected target level.
3. Evaluating effectiveness of self-assessment rubrics in EDIVs

3.1 Method

In a prior study (Mavinkurve & Murthy, 2012) we had shown that features of EDIVs to promote decision making and concept integration (such as decision making task questions, simulative manipulation, concept enforcement questions etc) led to the improvement of design sub-competencies of SOP1, SOP2 and SOP3. Here, we report a two group quasi-experiment to investigate the importance of including self-assessment rubrics as metacognitive prompt in the EDIVs, which targets SOP4 (write structured problem statement) via the cognitive mechanism of synthesis. The two conditions in the experiment were the presence or absence of self-assessment rubrics in the EDIV.

Participants. The study participants were students from 2nd year Electronics Engineering (N=45) major. Students were familiar TEL environments, as well as with the content in the EDIV, as they had learnt it in the theory course. However, they were not exposed to design in this topic.

Procedure. Students were randomly assigned to two groups. The experimental group consisted of 23 participants, control group had 22 participants. The equivalence between the groups was tested on basis of their previous semester’s grades and no statistically significant difference was found between them (t=-0.08, p=0.9). Two sets instructional materials on the topic of amplifier design from electronics domain were developed. The experimental group received an EDIV which contained self-assessment rubrics. The control group received the same EDIV but without the self-assessment rubrics. Students in both groups studied their material for 30 minutes, after which they attempted the post-test. The post-test contained an open design question on a topic related to (but not the same as) the instructional material for which students had to describe (on paper) their design.

Instrument. To assess the development of students’ design competencies we used assessment rubrics, similar to the self-assessment rubrics as shown in Table 1. These rubrics were validated prior to the experiment. Inter-rater reliability was found to give 86% agreement between 3 instructors.

3.2 Results

The scores on the post-test are ordinal data, hence we used a Mann-Whitney U-test for analysis. The mean ranks for each sub-competency for the two groups are shown in Table 2. The results show that the mean ranks for the experimental group are higher in each sub-competency. However, the difference was statistically significant only for SOP3. We further analyzed the data by categorizing students based on SOP sub-competency scores. Students who scored 0 or 1 were categorized as ‘unsuccessful’ on the design task and students who scored 2 or 3 as ‘successful’ on the design task. For each sub-competency we calculated the number of students from the control and experimental group in the successful and unsuccessful categories respectively. We used the Statistical Attribute Tracking (SAT) diagram (Majumdar & Iyer, 2014) to represent and analyze the data (Fig. 3).

Table 1: Rubrics items for various sub-competencies of Structure Open Problem competency

<table>
<thead>
<tr>
<th>Design sub-competency</th>
<th>Target performance</th>
<th>Needs improvement</th>
<th>Inadequate</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is able to extract required relevant specifications from given open ended problem</td>
<td>All relevant visible and hidden specifications are identified and interpreted accurately. No irrelevant specifications identified.</td>
<td>An attempt is made to identify specification. Most of them identified but few hidden ones missing or needs more interpretation.</td>
<td>An attempt is made but specifications identified are most of them are wrong or irrelevant or incomplete.</td>
<td>No attempt is made to extract specifications</td>
</tr>
<tr>
<td>Is able to structure open problem using specifications</td>
<td>Specifications are used to identify interconnections of the system in order to structure problem.</td>
<td>An attempt is made to use specifications but minor specifications are not used, or used incorrectly.</td>
<td>An attempt is made to use specifications but required specifications not used or wrongly applied.</td>
<td>No attempt is made to use specification to structure problem</td>
</tr>
<tr>
<td>Is able to sequence the design steps based on specifications</td>
<td>All major and minor design steps are identified and sequenced correctly based on specifications.</td>
<td>Most designs steps are sequenced correctly. Few steps are missing or not sequenced correctly.</td>
<td>Design steps are not sequenced at all or not based on specifications.</td>
<td>No attempt is made to write design steps.</td>
</tr>
<tr>
<td>Is able to write structured design problem statement</td>
<td>Problem statement is written clearly including details of specifications and design steps.</td>
<td>Problem statement is written clearly but few minor details are missing.</td>
<td>Problem statement is not written clearly but scattered information is available.</td>
<td>No attempt to write coherent statement.</td>
</tr>
</tbody>
</table>

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Table 2: Comparing SOP sub-competency scores of experimental and control group

<table>
<thead>
<tr>
<th>Sub competency</th>
<th>Group</th>
<th>N</th>
<th>Median</th>
<th>Mean Rank</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP1</td>
<td>Control</td>
<td>22</td>
<td>2</td>
<td>20.162</td>
<td>1.4</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Expt</td>
<td>23</td>
<td>2</td>
<td>25.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOP2</td>
<td>Control</td>
<td>22</td>
<td>2</td>
<td>20.48</td>
<td>1.24</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Expt</td>
<td>23</td>
<td>2</td>
<td>25.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOP3</td>
<td>Control</td>
<td>22</td>
<td>2</td>
<td>19.61</td>
<td>1.9</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>Expt</td>
<td>23</td>
<td>3</td>
<td>26.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOP4</td>
<td>Control</td>
<td>22</td>
<td>1</td>
<td>19.84</td>
<td>1.56</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Expt</td>
<td>23</td>
<td>3</td>
<td>26.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3. Stratified Attribute Tracking Diagram for successful and unsuccessful design

We found that for the sub-competencies of ‘identify specifications in open problem’ (SOP1), ‘use specifications to structure problem’ (SOP2) and sequence steps of design process (SOP3), more number of students fall in successful designer category than the unsuccessful category for both control and experimental groups. Since both groups worked with the basic design thinking activities in EDIVs, this confirms our previous results that EDIVs are useful to develop these sub-competencies. To examine the role of self-assessment rubrics, we compared the number of students in the successful designer category from the control and experimental groups. We found that majority of students in the successful designer category are from experimental group (e.g. 19-expt. group, 13-control group for SOP1). For the sub-competency of ‘write structured problem statement’ (SOP4), we found that equal number of students lie in successful and unsuccessful categories respectively. But in the successful designer category, majority students were from experimental group (15) compared to control group (8). This indicates that addition of self-assessment rubrics guides students towards successful design.

Following the post-test, we conducted interviews with 5 students from the experimental group. The interview questions focused on which activities students preferred while learning with EDIV and why. Here, we show a quote from a student which indicates students’ perceptions of how self-assessment rubrics helped: “If I know what is wrong in my answer and how I can achieve score 3, it helps me in learning, as most of the time we don’t know what is wrong in my answer”.

4. Discussion and Conclusion

The sub-competency of writing structured problem statement from open problem requires students to perform synthesis operation by integrating various decisions and concepts. Attainment of this sub-competency leads to the overall goal of structuring of open problem, which is a key step in the engineering design process. The self-assessment rubrics trigger the process of synthesis by providing students metacognitive scaffolds in the form of the description of the target performance as well as lower levels of performance. They prompts students to carry out formative assessment of their performance, monitor and revise their achievement level and plan their learning based on target level.
Design tasks are open-ended and the development of design thinking involves complex cognitive processes. The EDIV activities such as decision making task questions, concept enforcement questions, and simultaneous manipulation trigger students to perform the cognitive processes involved in design thinking. Self-assessment rubrics provide students the opportunity for thoughtful reflection and improvement of their work in these activities. The rubrics help simplify the complex design tasks by providing transparent criteria of evaluation to students. In future work, we will include self-assessment rubrics as an integral part of EDIVs to help students to engage in system thinking and to monitor the essential cognitive processes of design thinking.

References


The Application of QR Codes in Outdoor Education Activities: Practice and Discussion

Wen-Shian LEE a, Chun-Yen Chang a*, b, c

a Graduate Institute of Science Education, National Taiwan Normal University, Taiwan
b Science Education Center, National Taiwan Normal University, Taiwan
c Department of Earth Sciences, National Taiwan Normal University, Taiwan

Address for correspondence: Prof Chun-Yen Chang, Professor and Director, Science Education Center and Graduate Institute of Science Education and Department of Earth Sciences, National Taiwan Normal University, No. 88, Section 4, Ting-Chou Road, Taipei 11677, Taiwan. Email: changcy@ntnu.edu.tw.

Abstract: We developed a mobile study program based on a cognitive theory of multimedia learning (CTML) and designed a novel outdoor mobile learning system (QR Code Information Greenmap, QRCIG). Learners use smart phones or similar devices equipped with decoding software to decode QR codes embedded in a Green Map that deliver images and voice assistance to learners about relevant content. We observed and measured 120 fifth and sixth grade elementary school students’ outdoor activities and analysed the data by using the Technology Acceptance Model (TAM). The results demonstrated that students’ behavioral intention to use and attitudes regarding the QRCIG were significantly positive (correlation coefficient = 0.597**). Moreover, according to the analysis, the greater the skill of the students in using the QR code was, the higher their behavioral intention to use and frequency of adoption were (correlation coefficient ranging from 0.341 to 0.852). By conducting analysis using the TAM, we proved that an education program integrated using wireless mobile devices and message image (QR code) is highly applicable in outdoor education.

Keywords: CTML, QR Code, Outdoor education, Green Map

1. Introduction

Using surrounding resources to educate students for multi-learning purposes is a popular outdoor education method today (Elma & Martin, 2010). The Green Map System has been developed collaboratively since 1995, and the system has been extended to more than 65 nations and 845 cities. In this system, simple icons are used to help people understand their surrounding environment and cities (http://www.greenmap.org/greenhouse/en/about). This system is effective for deploying local resources and provides an alternative channel to outdoor education. However, outdoor environments are more complex than classrooms are. Information technology is a valuable tool for students; therefore, integrating information technology with outdoor education activities is expected to be a future trend (Shavinina, 2009). The mobile learning pattern constructed in technology-based activities involves urgency in occasional learning, an initiative nature in knowledge acquisition, and flexibility in space. Hence, learners must initiate efforts to learn their surroundings by using ubiquitous resources to improve their learning efficiency. This pattern is suitable for facilitating lifelong learning and developing flexibility (Chen, Kao, & Sheu, 2003). Smart phones and tablets have great potential because millions of people use these devices. Moreover, these devices can be used extensively in behavioral investigation, testing, and experimentation (Miller, 2012). Because mobile learning devices have wireless connection capabilities, learning is mobile and can occur at any location, from classrooms to outdoors. Therefore, valuable information can be acquired at any location (Sharples, 2000). As a result, the purpose of this study was to develop an integrated system composed of QR codes, Green Maps (GMs), mobile kits, and wireless technology. By using the integrated system, students enjoyed audio-visual guidance outdoors, and educators maximised the positive effects of texts and materials.
1.1 Multi-learning styles in Outdoor Education: The application of Green Map

In the United Nations Decade of Education for Sustainable Development (2005-2014), UNESCO Education Sector (2005) indicated that many political authorities worldwide are aware of the value of educating citizens on sustainable development. These authorities ask their civil servants to teach climate change and related environmental issues in the school. They have held numerous conferences and seminars to train educators about the project. Therefore, it is expected that the environment can be preserved through implementation of these ideas in national policy and education curricula. In addition, through a project named Carbon School, the European Union (EU) connected scientists, teachers, and students and encouraged them to use obtainable resources in conducting research on climate change and its influence on the earth, and to take appropriate action (Elma & Martin, 2010). This type of inquiry and project-based learning method helped children engage in healthy interaction with the earth and develop correct perspectives about the environment. This method is expected to enable the next generation to be more fervent and innovative regarding environmental protection than the current generation is.

Outdoor education is an interdisciplinary activity comprising multiple interactions. Educators must focus on diversification, targeted content, and methodology. Teachers must have practical experience to become competent in understanding environmental parameters (Pleasants, 2007; Thorburn & Allison, 2010). Many studies have indicated that the effective practice of technology use can stimulate students’ motivation, help them write notes, and enforce their independence in self-learning (Rogers et al., 2005; Chen, Kao, Yu, & Sheu, 2004). Moreover, the use of mobile devices can broaden students’ experiences in outdoor education (Rogers et al., 2004; Squire & Jan, 2007). Outdoor education does not only involve improving knowledge, but also involves gaining experience through the process (Rickinson, 2001). Therefore, only when educators have a clear vision and teaching materials can they provide outstanding education (May, 2000). This is the main goal of educators today. They are expected to use new technologies for curriculum design and development. Zuber (1999) and Green and Swanitz (1991) demonstrated that GMs are a suitable material for stimulating students’ motivation to learn about green issues. A GM is a map that promotes nature, sustainability, and ecology (please refer to http://www.greenmap.org/greenhouse/files/gms/GreenMapIcon_V3 Chart.pdf). In a GM, the relationship between people and the environment is clearly marked and illustrated, which makes it an effective material for enabling inhabitants and students to engage in environmental exploration (Green Map Activity Guide, 2005). GMs are widely applied in outdoor education, and by the end of 2012, 842 registered Green Map projects were conducted in 68 nations (http://www.greenmap.org/greenhouse/en/node/12842). Therefore, we used GMs as teaching materials for outdoor education and embedded QR Codes into the program, thereby facilitating ubiquitous learning.

1.2 Design of M-learning on Environmental Education

Today, the development of GMs is nearly mature; therefore, students experience little difficulty in using and learning a GM in ordinary maps. We used this advantage to digitalize and apply QR codes to the map, enabling students receiving outdoor education to quickly identify links to information. This application is suited to the current educational goal of governments worldwide, which is to develop the ability of citizens who have basic skills in information technology use (Hiltz & Turoff, 2005; Lim & Kim, 2003). QR codes are two dimensional, the information capacity is 1,000 words, and images and signals can be contained without the limitations of sizes and colours. If the code image is damaged and the damaged area does not exceed 30% of the original image, then the information is retrievable. QR codes have been popular worldwide for years (Lai, Chang, Li, Fan, & Wu, 2012). Accordingly, we adopted a cognitive theory of multimedia learning (CTML) to integrate information into m-learning in outdoor education. Mayer (2001) stated that multimedia information designed based on a mental mechanism provides more meaningful messages to learners than multimedia messages that are not based on a mental mechanism do; therefore, if multimedia tools are involved in a responsive learning environment as a primary tool, then students’ understanding is promoted. This wireless learning information system provides appropriate immediate learning at any location. People can use wireless devices equipped with a digital camera to decode QR codes and
capture multimedia information at their present location. Quinn (2000) indicated that m-learning, which is defined as learning that occurs through mobile devices, is suitable for education in numerous places.

We used QR codes to design a service that facilitates learning that is not limited by space or time. Learners can access digital information and teaching materials and learn from this method. Asynchronous learning was (Chen et al., 2003) integrated with the Internet and QR codes, enabling learners to acquire necessary information in a short period of time asynchronously. As shown in Figure 1, digital content was linked through decoding and wireless connections and transferred to the mobile devices of learners.

Figure 1. Digital content accessed using mobile devices facilitates achieving the goal of asynchronous learning

As shown in Figure 1, digital information is decoded and connected to the web server, and the existing information is subsequently presented to learners. The official QR code website indicated (http://www.qrcode.com/en/index.html) that the three squares around the four corners are designed to help decoders relocate; therefore, they do not need to scan it precisely. We used QR codes to design a service that is not limited by time or space, providing learners digital information and learning materials and helping them to acquire knowledge. Asynchronous m-learning (Chen et al., 2003) was integrated with the internet to enable users to access fruitful multimedia information. The process is quick and precise, and the acquisition is immediate.

The innovation involved in the present study is the integration of natural science and social science. Integrating a GM with QR codes improves it compared with the original text version. Furthermore, voice and animation were added to the scenic introduction and embedded in the digital platform. This system must be supported by a wireless network and a mobile device with a decoding function (Quick Mark barcode scanner, from http://www.appbrain.com/app/quickmark-barcode-scanner/tw.com.quickmark). When the device decodes a QR code, the service provides animation or voice guidance through the Internet. This service is called the QR Code Information Greenmap (QRCIG). The structure of the QRCIG is illustrated in Figure 2.
Learners use mobile devices equipped with a decoder (QuickMark barcode scanner, from http://www.appbrain.com/app/quickmark-barcode-scanner/tw.com.quickmark) to familiarize themselves with certain areas on the GM by using QR Code, and then acquire the website address and the corresponding content.

Learners use mobile devices equipped with a decoder (QuickMark barcode scanner, from http://www.appbrain.com/app/quickmark-barcode-scanner/tw.com.quickmark) to familiarize themselves with certain areas on the GM by using QR Code, and then acquire the website address and the corresponding content.

Learner interface – the choice of language and answering questions: In specific content, learners can select audio-visual or voice guidance for their learning project, and the service is provided in multiple languages. The teachers ask students questions regarding their exploration in teams. Teachers then evaluate the performance of each team’s work. The questions can be arranged before the activity through use of the following web page: YouTube http://youtu.be/3bQh7Wm71IU

Figure 2. Integrated QR Code Learning System Architecture
Mayer (2001) and Mayer & Moreno (2002) stated that students acquire more information and achieve more positive learning goals when viewing animation presented using voice-overs than when viewing dubbed animation without voice-overs. Based on this previous study, we adopted the modality principle from the CTML to integrate text, images, and animation. The methodology is explained as follows:

A. Text: We used a universal icon system to signify ecological and cultural locations on the map. The locations were then verified by fieldworkers, and descriptions are presented together.

B. Image: Photographs captured during fieldwork are presented as a reference for users when they are reading the text.

C. Animation: Films captured during fieldwork are used to assist students in their learning, which is supplemented by oral explanation. The audio-visual guidance was linked using the QR code platform.

The procedure of the aforementioned system is introduced as follows:

A. School teachers, advisory professors, and association members from societies participated in the procedure, and then designed the system based on the majority’s viewpoint, producing a GM with icons.

B. We introduced icons in GM scenic spots by using audio-visual information, making them audio-visual materials.

C. We input the audio-visual materials into Multimedia U-learning platform server and assigned each datum corresponding QR codes.

D. We positioned the encoded QR codes at the corresponding locations on the GM.

The pre-study (Lai et al., 2012) showed that teachers positively evaluated the application of audio-visual guidance in presenting text, images, and voice functions simultaneously. In that study, the coefficient factor modulus between the ease of use and usefulness of the QR codes was 0.749**. This result demonstrates that the high ease of use of the QR code application triggered teachers’ perception of the usefulness of the system, and the coefficient factor modulus between the usefulness of the QR code and people's acceptance of using QR codes was as high as 0.872**, which indicates a highly positive correlation between QR code usefulness and QR code acceptance. The analysis also demonstrated that teachers who were skilled at using QR codes tended to have higher behavioral intention to use and acceptance than those who were not. This indicates that QR codes can be accepted by teachers as a tool for use in outdoor education activities. Because the analysis of teachers’ perceptions of the program were well conducted and the results proved to be positive, the present study focused on students in outdoor education.

2. Methodology

We adopted a TAM pattern to investigate behavioral intention to use towards using and acceptance of the method. The TAM is a tool developed by Davis (1989) based on behavioral theory (TRA) that is used for interpreting cognition and emotion parameters that affect the use of technology. TAM can be used to inspect people’s inclination towards new technology. The pattern was developed to integrate the simplest methods of applying research theory and provides insight into personal exploration. Therefore, researchers can observe the factors affecting people’s beliefs, attitudes, and intentions when they are using technology (Davis, Bagozzi, & Warshaw, 1989). Because of this advantage of easiness, we infer that the TAM pattern is the pattern adopted most frequently internationally when researchers are examining people's acceptance of technology (Davis, 1989; Venkatesh & Morris, 2000). Davis (1989) indicated that when users perceive accessing certain information to be simple, they tend to feel positive about the system. When users positively evaluate certain information regarding its cognitive usefulness, their positive attitude towards that information is higher. Furthermore, when users more highly evaluate the cognitive ease of use of certain information, they tend to more positively evaluate its cognitive usefulness.
We administered a questionnaire in which the answer is graded based on a 4-Point Likert scale. The content is divided into seven categories, namely, “personal information,” “self-estimation of information accessibility,” “preference investigation of the QRCIG and conventional GM,” “ease of use of the QRCIG,” “usefulness of the QRCIG,” “attitude towards the QRCIG,” and “behavioral intention to use regarding the QRCIG.” The Cronbach’s alpha value was 0.925, indicating that the questionnaire is highly reliable. The questionnaire was designed to investigate whether students understand that the function of QR codes could affect the application of the QRCIG in outdoor education and to evaluate the behavioral intention to use of users regarding the QR codes. The questionnaire was also designed to determine whether students perceive the QRCIG as easy to use (ease of use), which enables students to use the system to achieve learning goals and improve their knowledge acquisition (usefulness). Finally, the questionnaire assesses whether it can assist the design of the QRCIG and promote students’ intention to use this system in the future, and analyses their adaption of it.

3. Results

This section presents the responses observed in the experiments under different investigations and the corresponding samples. The observations were meticulously analysed and explained. Among the 123 returned questionnaires, 120 copies were valid and 3 were invalid. The section contained three subsections for different explanations. In the first subsection, different backgrounds are used as parameters to discuss the ease of use and usefulness of, as well as the attitudes towards, the QRCIG. In the second subsection, students’ preference for either the QRCIG or conventional Green Maps was used as the parameter to discuss differences in preference. In the third subsection, the correlations among information accessibility, ease of use, usefulness, and attitudes regarding the QRCIG were analysed.

3.1 Different backgrounds as the parameter for the discussion of ease of use, usefulness, and attitudes regarding the QRCIG

3.1.1 Descriptive statistics and t test results of the perceived ease of use and usefulness, and the attitudes regarding the QRCIG of students who used QR codes prior to the study

Table 1: Descriptive statistics and t test results of the perceived ease of use and usefulness, and the attitudes, of students who used QR codes prior to the study.

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Use</td>
<td>18.30</td>
<td>2.30</td>
<td>1.936*</td>
</tr>
<tr>
<td></td>
<td>17.26</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>18.40</td>
<td>1.99</td>
<td>2.331*</td>
</tr>
<tr>
<td></td>
<td>17.22</td>
<td>2.39</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>14.38</td>
<td>2.03</td>
<td>2.378*</td>
</tr>
<tr>
<td></td>
<td>13.33</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>Behavioural intention to use</td>
<td>14.33</td>
<td>2.04</td>
<td>1.812</td>
</tr>
<tr>
<td></td>
<td>13.52</td>
<td>2.12</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

According to questionnaire analysis revealed there were 93 students had been read QR Code icon, it was over 1/4 of all samples. As shown in Table 1, whether students used QR code or related functions prior to the study is an important parameter that significantly affected the perceived ease of use and usefulness, as well as their attitudes, regarding the QRCIG. This indicates that QR code knowledge affects students’ perceptions of the ease of use (t test = 1.936*), usefulness (t test = 2.331*), and attitudes (t test = 2.378*) regarding the QRCIG.
3.2 Students’ preference for either the QRCIG or conventional green maps as the parameter

<table>
<thead>
<tr>
<th>Item</th>
<th>QRCIG</th>
<th>Conventional Green Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which item do I prefer to acquire knowledge?</td>
<td>115 (95.8%)</td>
<td>5 (4.2%)</td>
</tr>
<tr>
<td>Which method do I prefer to reach the goal?</td>
<td>116 (96.7%)</td>
<td>4 (3.3%)</td>
</tr>
<tr>
<td>Which learning method is better for me?</td>
<td>111 (92.5%)</td>
<td>9 (7.5%)</td>
</tr>
</tbody>
</table>

As shown in Table 2, students received both conventional Green Maps and the QRCIG as the learning methods used to reach the goal of outdoor education, and over 90% preferred the QRCIG as the method for their education. This demonstrates that the design of the QRCIG promotes students’ intention to learn.

3.3 Correlations among information competence, ease of use, usefulness, and attitudes towards the QRCIG

<table>
<thead>
<tr>
<th>Category</th>
<th>Information Accessibility</th>
<th>Ease of Use</th>
<th>Usefulness</th>
<th>Behavioural Intention to Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Use</td>
<td>0.361**</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>0.404**</td>
<td>0.785**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes</td>
<td>0.341**</td>
<td>0.641**</td>
<td>0.611**</td>
<td>--</td>
</tr>
<tr>
<td>Behavioural Intention to Use</td>
<td>0.405**</td>
<td>0.757**</td>
<td>0.712**</td>
<td>0.852**</td>
</tr>
</tbody>
</table>

*p < .05, **p < .01

As shown in Table 3, the Pearson correlation coefficients of students’ information accessibility, ease of use, usefulness, attitudes, and behavioral intention to use were between 0.341 to 0.852, indicating that students are responsive to information accessibility, ease of use, usefulness, attitudes, and behavioral intention to use regarding QR codes at medium to high level.

4. Discussion

We introduced QR-coded learning to an outdoor education m-learning program. The project inspired curriculum design, methodology design, students’ perception, and students to learn through various ways. These inspirations helped both teachers and students to practically explore the curriculum and interact positively with the environment. This contribution satisfies the goal of diversification in education. The present study is based on Mayer’s proposal (2001) that voice-over multimedia information is easier for students to understand than dubbed multimedia information is. In addition, we used the TAM for system analysis and found that students are interested in QR-coded mobile learning in outdoor education.

Lai et al. (2012) used QR codes in Green Maps based on the CTML and designed a multimedia learning system. Their results showed that teachers expressed highly positive attitudes towards applying the QRCIG in outdoor education. Therefore, to investigate the inclination of students to use this system in outdoor education, we used information accessibility of student as external variables in an analysis of fifth and sixth grade elementary students’ questionnaire feedback after they participated in activities based on the TAM.

The present study demonstrated that, among two learning models, namely, the QRCIG and conventional green maps, more than 90% of the students preferred the QRCIG as the method for attaining the goal of outdoor education. In addition, the m-learning QRCIG was integrated with
outdoor education and the parameters were students’ backgrounds. “Whether students used QR codes or related function prior to the study” was the main parameter affecting ease of use, usefulness, and attitudes. This parameter is crucial for learning how to use the QRCIG for elementary school students. Moreover, ease of use (Pearson correlation coefficient = 0.361**), usefulness (Pearson correlation coefficient = 0.404**), future behavioral intention to use (Pearson correlation coefficient = 0.405**), and the capability students had before they used the QRCIG were also crucial parameters. These results supported Davis’ statement (1989) that, when users’ recognition of perceived ease of use of information is high, they tend to hold positive attitudes towards the information system. When the attitude is positive, users tend to hold positive attitudes towards the usefulness of the information.

A TAM pattern derived from information accessibility, ease of use, usefulness, attitudes, and behavioral intention to use perceived by students regarding the QRCIG by using path analysis, as shown in Figure 3. According to Figure 3, the Pearson correlation coefficients indicating students’ perceived ease of use and usefulness, attitudes, and behavioral intention to use regarding the QRCIG ranged from 0.341 to 0.852, indicating that these parameters are highly relevant at a medium to high level. This result is consistent with that of Mayer & Moreno (2002), who studied multimedia aids.

5. Conclusion

We designed a learning system integrating information technology and outdoor education; this system inspires novel ideas about curriculum design, pedagogy, and the learning of students. Moreover, the system links teachers and students and encourages students to use various methods to achieve educational goals and to have positive interactions with the environment. The analyses demonstrated that the tools used in the present study triggered high perceived ease of use and perceived usefulness among subjects, causing them to hold positive attitudes about their intention to use the system.
positive learning outcomes and positively evaluated the system.

References
The Application of Instructional Media and IRS in Environmental Education - Focus on the Rocky Terrain in Northern Coast of Taiwan

Wen-Mao Chung a, Te-Shin Tsai b & Chun-Yen Chang c*

a Graduate Institute of Science Education, National Taiwan Normal University, Taiwan
b Keelung Municipal Dung Xin Elementary School, Taiwan
c Science Education Center, National Taiwan Normal University, Taiwan
*changcy@ntnu.edu.tw

Abstract: Based on the rock and mineral in environmental education, this paper designs instructional media, with the aim to let the users realize the beautiful sceneries on the coast around Taiwan and learn about the rocky terrain at the same time. Using the IRS system, the author tries to make the computer classes for interaction between individual and personal computer, including the lecture-listen teaching model, as well as interaction between teacher and student which could provide a different teaching style. This research shows that this instructional media enables six grade students in primary school learning the relative knowledge about the rocky terrain in northern coast of Taiwan happily and effectively, while the employment of IRS could enable students concentrate more attention to their study and promote their learning interest as well.

Keywords: environmental education, instructional media, IRS, science education

1. Introduction

Taiwan is a seagirt and has graceful and magnificent coastline. These abundant marine resources are precious gifts from nature. Therefore, cultivating students with experience about the marine ecological environment around; promoting their knowledge and strengthen their awareness of protection about marine ecological environment is really significant.

In the respect of instructional media design, it mixes nature, life, science, technology and society together. Thus, students may learn the basic rocky styles, rocky characteristics, and rocky distribution in Taiwan, which could enable students further acquaint the enrichment, diversification and beauty of rocky terrain of northern coastline in Taiwan, and experience a variety of grotesque rocks shaped by various miraculous natural power. Hence, the students would concern about the changes of seashore rocks and ecological environment so as to protect and cherish the rocky mystery which was formed tens of thousands of years. According to the curriculum guidelines for science and life technology (MOE, 2008), fifth- and sixth-graders in primary schools are able to learn about the formation and characteristics of rocks. Matching the available nature and cultural characteristic in the local environment, these two kinds of learning fields integrate closely. The author hopes that through learning and understanding the different formations of seashore rocks and terrain landscape, students will arouse the concern of changes in marine geographic environment, and then show solicitude for local marine geographic ecological environment.

With the development of science and life technology, application of mobile devices in education could be seen more frequently (Ellaway, 2013). Although it brings lots of convenience for teachers and students, in the current situation of education in Taiwan, the popularizing rate of mobile devices are still lower than the computer class undoubtedly. With the updating of IRS, IRS could be operated in desktop in the way of browser. Except the flash interactive multi-media, this research relies more on the advantages of IRS and plus the section of interaction between students and teachers, not individual-machine only, to complement the function of record for students’ answering condition. Thus, it makes the interaction between teachers and students more comprehensive and more appropriate for teachers to know the learning condition of students.
2. Literature Review

2.1 Theoretical Basis of Instructional Media in Aided Teaching

Instructional media has been wildly spread for its advantages, such as drive learning motivation (Liu et al, 2011) increase attention (Sun, 2014), protect and update the textbook easily, and so on. The theoretical basis of teaching by media can be divided into 2 parts:

ZPD theory, suggested by Vygotsky, states that people have 2 levels of development, one is practical development level, and the other is potential development level. Practical development level is what Piaget so-called children developmental stage, that is, possess abilities in its period; and potential development level is the ability to deal with some difficulties with the help of parents or partners. The gap between the two is called Zone of proximal development (ZPD). While students are learning something, the teachers just provide with a temporary support to give assistance to students transform from practical development level to a potential development level, which is called scaffold in deed. This scaffold is a kind of instructional strategy or teaching aid. Along with the improvement of student ability, the dominant right of learning will return to students gradually. At this time, even students don’t get the help of scaffold could they get knowledge and skill successfully.

In addition, Gardner has put together multiple intelligence theories, which emphasize that everyone has entire intelligence and its exclusiveness. Gardner states that educators should do what they can to dig out the learning styles and trend of students, and then take good advantage of them to forge a most suitable education style. Multimedia integrates with film, cartoon, voice, script, pictures and some other materials and could be operated, listened and viewed for another, which enable good learning tools for different intelligent students.

2.2 Usage of IRS

IRS, Interactive Response System, is a kind of teaching application system used for feeding back information for teachers in classes through mobile devices and electrical tools. It is one of the most important information application apparatures for improving classroom teaching quality in recent years and wildly used in classroom teaching in Europe and America. Taiwan has carried out quite a few experimental curriculums and interactive rooms in recent years. However, what is the interactive room? The so-called interactive room installs IRS acceptors in the classroom, and the teachers and students have a remote control in hands in order to continue the interactive teaching activities which but also reduces the burden on teachers (Huang et al, 2001). IRS has benefits for teachers and students both as below (Liu et al, 2006):

For students:
(1) The motivation of active participation: provides prompt visualizing feedback for the response of questions from students, and further strengthens the motivation of active discussion.
(2) Enables students to focus on learning content: students should choose the best answers aims to the questions which could help students thinking about the problem purposefully.
(3) Assist students to conduct further conceptual understanding: students should tell the reason for your answer so as to promote students’ thought on inner nature.

For teachers:
(1) Assists teachers in diagnosing learning status and offers decision references: the system would help to collect the answers from students; this allows teachers to find out the learning problems of students immediately and allows teachers to make some evaluations of the condition, so that they could clear out the vague concept and enlighten subsequent discussion.
(2) Improves the interaction between teachers and students: it allows all students to possess an equal learning chance by assisting teachers to control the equivalence while communicating.
(3) Improves the frequency of teaching: it allows students to focus on learning points so as to save teaching time, and make class colorful and interesting but in control at the same time.

IRS has both numerous advantages, and disadvantages. For example, IRS is not the main part in class; it can’t take the place of teachers. Appropriate leading and in-depth feedback from teachers will result in in-depth study (Wang et al, 2002). IRS has the feature of in-time interaction which can inspire
the interest, but may also lead to over excited students. Thus, IRS needs to be guided and managed professionally to keep a proper teaching environment.

3. Methodology

3.1 Objects of Study

This research based on purposive sampling method, and selected 118 sixth-grade students in 2 primary schools from northern Taiwan and 112 students as the valid sample size. It should be implemented in flexible classes by matching science and life technology curriculum after the normal class Rock and Mineral.

3.2 Instructional Media Design

Instructional media was made by flash and matches Nature and Life class in 6th grades; it contains: (1) various kinds of rocks with different characteristics and recognizable peculiarities. (2) changes of rocks effected by weathering, erosion and deposition. (3) present rocky terrain in coastline and flourish students to cherish and protect and appreciate geological environment in coastline. (4) describes district and regional marine rocky terrain characters. Here are the operating instructions of media as follows:

<table>
<thead>
<tr>
<th>This is the title. Put on different buttons will help you with different learning travels.</th>
<th>This page is the distribution of sedimentary rocky coast in northern Taiwan, and displays different coast appearances in north and northeast with live-action.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This is the introduction of igneous rock with 3 buttons for different styles; pressing on the mouse will link the student to different pages where you can learn about different kinds of rocks.</td>
<td>This page shows the rocky terrain in northern coast of Taiwan and has marked out volcanic and sedimentary rock by animated mapping. 5 buttons for learning various terrain scenery.</td>
</tr>
</tbody>
</table>

Figure 1: The Interface of the Instructional Media. (1)
This instructional media adopts a pattern of self-directed operation and independent study with a large number of image-text information as well as voice materials, which are from natural landscape nearby. Beside the learning level, this media includes a self-challenge, a puzzle, and a Link Game, as well as choice questions and other forms of interaction, for self-examination after classes.

Puzzle fun. Set the pictures into the frames. The color will become deeper and the picture can’t be moved once set into the correct position. The picture in top right corner is a reference.

Link Game. The above line shows various kinds of rocks, with the names below.

Figure 2: The Interface of the Instructional Media. (2)

3.3 Application of IRS

IRS, the abbreviation of Interactive Response System, is a kind of system used for interacting with teachers and students during the classes, through computers or mobile devices. It was pointed out that IRS could increase learning interest and add more interaction in classes, which gives play to peer instruction well.

This research employed Socrative 2.0 system, a system has something to do with teaching feedback, assessment test and teaching report and could be applied to mobile devices. Moreover, Socrative 2.0 has broken the limits in different platforms, but appeared in the form of WEB. In other words, Socrative 2.0 system could be easily and conveniently operated only if the appliance has a browser in it, and internet service is available in the environment around. In the research, the teachers conduct a pre-test by IRS first, and then with guidance of it, the teachers will refer to the results after a test to shepherd students continuing discussion and in-time interaction. The students can be guided to self-learning by operate the instructional media actively. A test is conducted to test the students before the class ends. The pattern as below:

(1) To go on a pre-test by IRS.
(2) To go on class discussion and in-time interaction by IRS
(3) To go on self-learning by operate instructional media actively for students.
(4) To go on post-test and collect the attitude by questionnaires.
(5) To organize and analyze the data.

3.4 Data Compilation and Disposition

In the research, questionnaire could be divided into 2 parts. One is for learning efficiency, and it is the single choice aiming at teaching objectives. Compared with the 2 tests before and after class, it is found that after learning by instructional media, the accuracy of every single choice has risen. If the instructional media has been properly used, the learning efficiency would be improved at the same time. The data are shown in Table 1 below:
Table 1: Comparison of passing rate before and after class

<table>
<thead>
<tr>
<th>No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test passing rates</td>
<td>62.5</td>
<td>92.9</td>
<td>67.9</td>
<td>35.7</td>
<td>96.4</td>
<td>55.4</td>
<td>73.2</td>
<td>35.7</td>
<td>51.8</td>
<td>41.1</td>
<td>60.4</td>
</tr>
<tr>
<td>Post-test passing rates</td>
<td>87.5</td>
<td>100</td>
<td>91.1</td>
<td>66.1</td>
<td>100</td>
<td>89.3</td>
<td>94.6</td>
<td>69.6</td>
<td>82.1</td>
<td>66.1</td>
<td>83.4</td>
</tr>
<tr>
<td>Ascensional range</td>
<td>25</td>
<td>7.1</td>
<td>23.2</td>
<td>30.4</td>
<td>3.6</td>
<td>33.9</td>
<td>21.4</td>
<td>33.9</td>
<td>30.4</td>
<td>25</td>
<td>23</td>
</tr>
</tbody>
</table>

Although the passing rate has risen, the passing rates after class of question 4 and question 10 are still flat. Question 4 is “what kind of coastline does northern coastline of Taiwan from Jinshan to Beiguan should be?” The correct answer is “sedimentary rocky coastline”. Question 10 is “what kind of rock does northern coastline of Taiwan from Jinshan to Beiguan should be?” The correct answer is “Sandstone”. While compared with similar question concerning Danshui or Jinshan, the passing rate of reached 91.1%. Most of students didn’t where the Beiguan is after inquiry. Because of the time limitation when operate the instructional media, the passing rate of such questions is lower than other questions.

The questionnaire about learning experience adopted Five-point Likert scale. The questionnaire can be subdivided into instructional media and IRS. Table 2 shows the results. In the first part, all students believe that learning by operating media is happy, and the mean could arrive at 4.71. What’s more, students also think that it’s conformed to their needs to operate instructional media by themselves which is suitable for their tempo and interest, so that they are able to operate several times when they couldn’t understand the point. The mean could reach 4.54. In the part of IRS, most students deem that using IRS in class will drive you pay more attention to class because you have to communicate with teachers all the time. The mean reaches 4.77. Owing to this kind of interactive teaching model, you are able to put up your opinion at once and elevate your learning interest since it is full of freshness. The mean reaches 4.45. The data are shown in Table 2 below:

Table 2: The questionnaire results after the end of the course

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Ordinary</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel happy to use instructional media for learning</td>
<td>71.4%</td>
<td>28.6%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2. Operating the instructional media myself meets my learning demand.</td>
<td>62.5%</td>
<td>30.4%</td>
<td>5.4%</td>
<td>1.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3. This approach aimed to upgrade my attitude of learning science</td>
<td>30.4%</td>
<td>41.1%</td>
<td>25.0%</td>
<td>3.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>4. Using IRS during class make me feel at ease without pressure.</td>
<td>30.4%</td>
<td>33.9%</td>
<td>23.2%</td>
<td>7.1%</td>
<td>5.4%</td>
</tr>
<tr>
<td>5. It’s fun to use IRS in class.</td>
<td>55.4%</td>
<td>35.7%</td>
<td>7.1%</td>
<td>1.8%</td>
<td>0.0%</td>
</tr>
<tr>
<td>6. Using IRS in class makes me concentrate better</td>
<td>76.8%</td>
<td>23.2%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>7. I am satisfied with my learning performance.</td>
<td>53.6%</td>
<td>28.6%</td>
<td>12.5%</td>
<td>5.4%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

It’s worth noting that although using IRS in class is popular among most students, still 1/8 students feel more stressed compared with traditional teaching method. After tracing the following students, it is found that the instantaneousness from IRS puts more stress to students. They may feel anxious once they cannot answer some questions needed thinking or unable to keep pace with teachers. Some students said that the instructional words were not in Chinese, but in English, and they cannot figure out if this language barrier would put more stress on those poor English students. On the other hand, the learning scale of science and life technology would be wilder and the questions would be more difficult if students go to senior class, still 28.6% student are not favor of this subject even instructional media and IRS are used in class, which should be concerned by related educators.
4. Conclusion

While conducting correlated curriculum of environmental education, the proper usage of instructional media may help learners study happily and improve their learning efficiency if the learners are able to operate the media according to their interest and demand. In this research, the usage of IRS is conducive to attention focusing and learning interest inspiration. However, even in an age where mobile devices is prevailing, many schools are unable to provide enough mobiles for using. Fortunately, superexcellent alternative solution—computer rooms are suggested to replace the former two by each school. Utilizing WEB pattern of IRS, such as Socrative software, can allow teachers and students enjoy many benefits of IRS teaching without any mobile device or special equipment. In addition, IRS may as well assist in dealing with data. It is a kind of facilitating device. However, teachers need to focus on students’ stress while using IRS, no matter on operation style or language ports. It is suggested to training teachers proficiently before using it in due form. More importantly, teachers are able to grasp the information about those who are unable to keep pace with class or have less interest in study because of the immediacy of IRS, and show their concern and consideration. The usage of IRS makes students feel excited, thus, educators should acknowledge that machine is not the main role in learning but the proper guidance for teachers. Only through proper application from teachers can the instructional media provide the most value.

References

Effect of Inquiry Web-Based Learning Competition for Gifted Students in Junior High School

Yen-Hung SHEN\textsuperscript{a*,} Wen-Gin YANG\textsuperscript{b}

\textsuperscript{a}Graduate Institute of Science Education, National Taiwan Normal University, Taiwan
\textsuperscript{b}Science Education Center, National Taiwan Normal University, Taiwan
*syhdrums@tp.edu.tw, wgy@ntnu.edu.tw

Abstract: The study was designed to explore how to proceed an Subject-Inquiry-Based Learning and enhance their knowledge about weather through joining the Inquiry Web-Based Learning competition held by the Department of Education of Taipei City Government. The purpose was to find out how they completed the assigned tasks and what they learned from the process of this Web-Based Learning competition. The subjects were 30 gifted students in one junior high school. The results show that most of the gifted students completed the tasks by using the database in Central Weather Bureau and Taipei Weather Inquiry-Based Learning Network (TWIN). After the Web-Based Learning competition, they learned how to reflect better from their peers' reflection and gained additional knowledge about and emotional support from their peers' comments. There are some effects such as their attempt to apply the knowledge into practice, change of their beliefs and the gain of additional perspectives.

Keywords: Inquiry, Web-Based Learning, Environmental Education

1. Introduction

Inquiry-Based Learning is a kind of way of learning which is concerned about how students study actively by themselves. It could be practiced widely in all kinds of subjects. Recently, more and more nations have started to care about the students' abilities of inquiry, problem solving and so on. However, the implementation process of Inquiry-Based Learning still meet a lot of restriction and difficulties (Edelson, 1999). In this modern Information Age (or New Media Age), if we could merged Inquiry-Based Learning into teaching through new Web-Based Learning models, we would offer a new beneficial environment for students to study easily.

Web-Based Learning Competition is constantly held by the Department of Education of Taipei City Government. Through the Web-Based Learning Model created by themselves, the government hopes to encourage students studying junior high school or elementary school to use the learning model as a kind of tool to express their ideas and communicate with one another, and increase the ability to evaluate through the reflection and peers' comment. The topic is about the phenomenon of the weather such as climate change, global warming or extreme weather. First, all the participants are asked to form a team including 1 to 3 members and at least one coach who could be teacher or parent. Then, they are able to begin to collect the information such as the temperature or rainfall as much as possible to come to their own conclusion. They are suggested to use the database in Central Weather Bureau, Taipei Weather Inquiry-Based Learning Network (TWIN), or others.
2. Relevant Literature

The technology of computer network is able to not only satisfy the learning motivation, provide the multiple content and create a kind of learning environment full of resources but a online social network. (Linn, 2003) Online social networks (OSNs) are increasingly attracting the attention of academic and educational researchers intrigued by its affordances and richness. OSNs provide powerful means of sharing, organizing, as well as finding contents and contacts. A large-scale measurement presented the study and analysis of the structure of OSNs. According to Chinn et al. (2011), the general conceptualization about the nature of epistemic cognition development not only makes its theoretical and empirical boundaries wider, but it also represents one of the main hypotheses of several stage-development models.

Moreover, the website for the Inquiry Web-Based Learning competition is capable of recording the discussion between participants and coaches so that all the participants could watch other's ideas and reflections. Writing reflection enables school teachers to examine the relevance of the training content and improve their teaching practice to meet the constant change of students’ learning needs (Killeavy & Moloney, 2010). We could regard it as another advantage for all the participants during the process of this competition.

3. Method

3.1 Research Design

The study was designed to explore how to proceed an Subject-Inquiry-Based Learning and enhance their knowledge about weather through joining the Inquiry Web-Based Learning competition held by the Department of Education of Taipei City Government. All of the students were asked to complete all the tasks in different stages in the Inquiry Web-Based Learning Competition including Learning Sheet, searching the useful data and writing their reflections. We collected all the information recorded in the Taipei Weather Inquiry-Based Learning Network and analyze it, and then interview some of them if we need and the teacher.

3.2 Subjects

30 8th grade students were involved in this study led by a science teacher who had some experiences in the Inquiry Web-Based Learning competition. Those students are gifted students studying in the advanced science class. All of them were asked to join the Inquiry Web-Based Learning Competition and finish all the tasks.
3.3 Materials

The process of the Inquiry Web-Based Learning competition is divided into four stages. Each student has to complete the task on time so that they can enter to the next stage. The goals of the task in different stages are as follows: (1) to decide their own research questions; (2) to decide the data which will be chosen, the range, and how they intend to collect the data; (3) to analyze the data and draw the chart or diagram; (4) to finish their own report about the Inquiry-Based Learning. Not only completing the task but peers’ comment between different coaches could each team pass into the next stage so that all the participants are capable of collecting more ideas to modify their research.

3.4 Data Collection Procedure

This study adopted the constant comparison approach. All reflections and comments posted onto Taipei Weather Inquiry-Based Learning Network were copied onto a word document. The reflection expressed by the first participant were read carefully in paragraphs, and the way of writing reflection was color coded for easy recognition later. After analyzing all reflections of the first participant, the researcher compiled the codes to further consolidate common themes. The coding process continued in a similar way with the rest of the participants. If a new theme was emerged, it was added to the theme list. After reading through all reflections, common themes were summarized. The themes were further compared and combined. A list of two to four themes was finally generated. The same approach was applied to analyze the comments.

4. Results

4.1 Reflection

Altogether 120 individual reflection were found in Taipei Weather Inquiry-Based Learning Network and 132 codes were labeled. Three main themes emerged from the reflection, which were: (1) elaborating on the content; (2) applying the new information into practice; and (3) changing beliefs.

Reflecting on the topic content was a basic requirement for the individual reflection. The participants elaborated on the content in a little different ways. The most of them often used was that they simply repeated what they had learned from the data downloaded or added certain personal understanding without in-depth explanations (N = 40, 30.3%). Another way was that they elaborated on the content further by adding some new information (N = 34, 25.8%). It was evident that they went to the Internet to search for additional information for better understanding of the contents about the topic that were new to them. In their reflection, they shared the additional information. An additional way of writing reflection was they elaborated on the content by connecting it to previous lessons, reflection, or content learned from other classes (N=10, 7.6%). It seemed that they attempted to integrate the newly learned content into their existing knowledge structure.

Two ways of applying the new learned information into practice was found. One way was that they applied those new information into practice (N=22, 16.7%). The other way was they attempted to explain certain existing weather phenomena by using the new learned information (N=15, 11.4%). Some of them even mentioned that they might share those information with their family members. Another theme emerged from the reflection was the new information inspired them to rethink about their original beliefs and as a result their assumptions started to change (N=11, 8.3%). For example, before joining the Inquiry Web-Based Learning competition, some of them thought that the network was only a tool for sharing information with classmates. They seldom thought that it could be used as a type of learning tool. After finishing the Web-based competition, their opinions started to change and recognized that using technology to study was not that difficult. Besides, some of them also mentioned that they have learned a lot of knowledge about the weather they did not know before.

4.2 Comments

Altogether 40 individual comments were found in Taipei Weather Inquiry-Based Learning
Network and 88 codes were identified. Also, three major themes became obvious in their comments: (1) commenting on the content; (2) expressing encouragement; (3) commenting on the way of writing reflection.

Peers used to further elaborate on the reflection content in their comments (N=32, 36.4%). To some extent, different ways of making comments were noticed. One way was that they picked up certain keywords or points from the reflection and elaborated further by adding new information or explanations. Another way was they tried to offer some useful explanations to the problems mentioned in the reflection or to explain why the problems existed. Part of them might add personal experiences or additional arguments to support the opinions expressed in the reflection (N=25, 28.4%), or disagreed with certain ideas in the reflection by providing with different examples or perspectives (N=8, 9.1%). In some comments, peers also stated what they learned from the reflection (N=6, 6.8%). Some of them indicated that they benefited from the reflection in an indirect way as certain ideas in the reflection stimulated them to search for more information or study further.

Peers also expressed encouragement in their comments (N=10, 11.4%). Generally, peers gave encouragement in two varied situations. One was that they gave positive comments or encouragement when the reflection writer presented good ideas, comprehensive summaries, or constructive suggestions. The other way was that peers gave encouragement when they realized the reflection writer had certain problems or difficulties. In this case, they encouraged them to face the difficulty positively. Sometimes they did not comment on the reflection content, but on the way of writing reflection (N=7, 8.0%). What impressed them most was the responsible way of writing reflection, or the positive attitude towards reflection writing or learning in general.

4.3 Interview of the teacher

According to the reflection of the teacher after the Inquiry Web-Based Learning competition, there are some points mentioned. Among the positive responses, the following reasons appeared: (1) writing reflections through Taipei Weather Inquiry-Based Learning Network could help students study more efficiently; (2) with the aid of Taipei Weather Inquiry-Based Learning Network, students get more useful ideas and encouragement during the process of learning; (3) students are able to learn how to tell and pick up what is the useful information and improve their ability of inquiry.

However, there are some restricting part mentioned by the teacher as follows: (1) some students may not have enough time to finish their task completely; (2) before joining the Inquiry Web-Based Learning competition, all students need to be well-taught to have the ability to search the data and explain it correctly.

5. Conclusion and Suggestion

The study has some implications for using Taipei Weather Inquiry-Based Learning Network. Some participants were more experienced or responsible and their reflection was in more depth. The others commonly indicated that they learned how to reflect from these learners. Besides, the result also suggest that involving some higher ability or more experienced learners would show a positive sample to others and hence has the possibility to promote collaborative reflection to a higher level. In this study, all the participants are gifted students in the same class. That is why they could explain the same content or phenomenon from different perspectives, or give varied interpretations so directly. This result also implies that being familiar with one another would increase the likelihood of gaining more benefits from peers in the collaborative reflection process.

Furthermore, in addition to learning content directly from the lesson or the instructor, the participants in this study also shared their understanding with peers. Through the sharing, peers learned additional information, different perspectives, or the way of writing from the reflection. Collaborative studying can also lead to higher level thinking and transformational changes. It involves both cognitive and affective processes.

References


Evaluation the situation somatosensory game digital learning for global warming misconception

Hsin-Chih Lai a, Chi-Chen Lee b*

a Department of Engineering & Management of Advanced Technology, CJCU, Taiwan
b Department of Information Management, CJCU, Taiwan

* kbarfnh@gmail.com

Abstract: This study designed an innovative learning material based on game-based learning theory and situational somatosensory game digital learning modules (Situational Somatosensory Game Digital Learning modules). It is a funny, interactive and educational tool in the sense of a combination of role-playing game with somatosensory. The main structure is built up by Role-Playing Game masters and Kinect Flexible Action and Articulated Skeleton Toolkit programs. The content of learning modules is developed by the relevant literature and cognitive conflict strategy, the scientific misconception of sea-level rise is designed to be solved during the gamed based self-learning processes. Through a pre-test/post-test questionnaire the descriptive statistics, ANOVA analysis of quantitative data and open questions are discussed. The results shows: 1. the learning (experimental group) effective use of scenarios and games, in addressing the global warming misconception have good study on the effectiveness of, and superior to the control group (F = 6.31, p <.05); 2.the learning module has over ninety percent of high satisfaction, and can effectively lead to motivation, and overall satisfaction than the control group. Based on the findings, the somatosensory game situational learning led to a strong and highly motivated satisfaction.

Keywords: Global warming, Somatosensory Technology, Role-Playing Game, Misconception

1. Introduction

Scientific knowledge of Global warming mitigation and adaptation is getting more and more important in present world, but through the domestic researches and survey, students and the general public still hold considerable misconception on global warming issues, taking action to provide correct knowledge and learning tools should be the first priority we need to go. To convert misconceptions in non-formal education is not easy, the first step is to inspire the motivation by interesting learning processes but not the unsuitable traditional learning. Therefore, this study tries to combine new technology based on the theoretical, the design and development of a new way of learning science to solve global warming misconception, and further validate its effectiveness and satisfaction.

According to the motivation of this study, research questions are listed below.
Q1: Try in a good theoretical basis and practical framework for the design and development of an innovative way of learning.
Q2: Explore the effectiveness of an innovative way of learning
Q3: Evaluation of the satisfaction of an innovative way of learning.

2. Literature review

Digital game is getting more and more popular recently through combining new technology, it could interest the users to learn by funny, highly interactive and instantaneity, it also can help the users to bring their mind up in how to knowing, using, solving and creating. Traditional pedagogy is not easy to learn because it's highly complexity in class, but digital game can help to solving the problem, learner can get knowledge or technology when they have fun (Trotter, 2004). Digital game is an E-media, it's inoculation for teenagers with casual, relaxed and diversity, thus the teenagers are more willing to learn new knowledge. As a Game-based learning materials, the first priority to develop is how to get achieve
a complete efficacy, such as problem solving, role-playing and Situation Simulation, that is to say how creativity and advisability blend into the content of courses and how to make a breakthrough in combining new technology. It's more interested the learner in RPG game genre than the others (Paraskeva, Mysirlaki, and Papagianni, 2010). Generally, the digital games need basic skills, it's not easy to the people that who has creative but unskilled to join the games industry (Blow, 2004).

**Kinect**
From Nintendo has been launched to the Wii, and the Kinect had been developed by Microsoft, they are the type of NUI. Kinect users can control the game directly by moving the body but needn’t to hold the remote controller or wear device. It is easy to apply in many fields including the real life, education learning, entertainment, health care and other fields. Somatosensory interactive games can make learner involve into game situations easier and faster than traditional game with keyboard or mouse. The advantage of kinect game are with high interactivity, simple operation and less susceptible in age restrictions; however the weaknesses is that players need to standing continuously in the game. By study abroad, somatosensory technology have very good results in various fields, including the motivation, learning achievement and learning and memory. (Chao, Huang, Fang, & Chen, 2012; Chun-Yen Chang, Yu-Ta Chien, Cheng-Yu Chiang, Ming-Chao Lin & Hsin-Chih Lai, 2013).

**Role-playing game**
Role-playing is a game to be satisfied with role recognition, major interface is mainly with text have provided a environment with challenging and similar real-life situation. The most features of the protagonist have different characteristics, attributes or skills that players could accumulate experience points, level up and enhance the value of health points. Raybourn (2006) proposed role-playing game have the most helpful to solving complex problems and conflict mediation in learning. When learners actually play a role have experienced their point of view, the problems and solutions will become clear (Shifroni & Ginat, 1997), At the same time, role-playing is the most favorite game modes (Buchanan, 2004) applied to the assisted learning materials also have good learning effect.

**Situated Learning**
Situated learning placed the learner in real or simulated situations to learn through interaction between the learner and the situations, so that learner will apply what they have learned in actual life. When the scientific concept is abstract, complex and different with life experiences, it's process will be difficult to change the prior scientific concepts. Kathleen and Deborah (2004) considered the traditional digital learning is to provide knowledge and information, and less interaction with learner. Also Brown, Collins, & Duguid (1989) emphasize the learners construct knowledge by interactive with learning environment. Therefore, if the situational learning theory into the teaching content, it can development of situational learning, explores problems and solves problems. It will be more helpful for improves learning effectiveness. (Guralnick, 2008).

**Global warming misconception**
Global warming is part of the climate change. It becomes more wider and wider with its complexion than traditional science, the influence including scientific, political, economic and living. Moreover, it is cross-cutting, cross-generational and cross-border to make misconception of learning. Currently, people get many special messages from print media or electronic media in reporting global warming news, the news are not to be digested to accept. (Rye, Rubba, and Wiesenmayer, 1997). A lot of reason of the Scientific misconceptions are caused, Driver (1981) believe the misconception from the behavioral process in children and human interaction, as well as through their own observations and experiences obtained. And Gilbert, and Watts (1983) have proposed three perspectives: 1.children explore the world based on self-view; 2.child interested in doing something special for the scientific explanation does not consider whether the correct natural science; 3.They don't distinguish between different the scientific language and language of everyday life. Head (1986) also made five reasons: 1.daily experience; 2.analogy confusion; 3.fuzzy unknown confusion on the meaning of words; 4.learning with peer; 5.from individual nature of ideas.
3. Situational Somatosensory Game Digital Learning modules

Research framework

Situational somatosensory game digital learning modules which is applied by Game learning and situational learning theory and based on Piaget's theory of cognitive to solve the science misconception. Also it is Combining the role-playing game with kinect to effectively integrate in the learning method, learning tools and learning content (Figure. 1).

- Learning method: game-based, it integrated cognitive conflict strategy into digital material to make using characters as self-exploration and self-discovery. The learning method build cognition and break the original misconception for learners.
- Learning tool: somatosensory technology with role-playing games is used to develop better situational learning environment. Every movement in the game is meaningful to enhance the learner's interest in learning and impressions to reach entertaining.
- Learning content: features of the story to perform tasks and talking, with somatosensory control, learner can play easier and take into the situation for fun and challenge.

4. Global Warming Misconception of material design

Learning strategies and processes

In this study the use of cognitive conflict is in three steps: (1) understand the learners’ prior knowledge; (2) provide students with contradictory information; (3) assessment learners' cognitive change between pre-test and post-test. Figure 2 presents the strategies of learning design. First of all, make sure the learners’ knowledge about the Antarctic and the Arctic ice melting to cause the sea-level rise of cognition before playing the game; second, play the game, through the game's story and dialogue, presenting a conflict with the results, learners can self-discovery and think for themselves; third, post-test to assess whether there are changes in cognition after the game, assessment points are misconception resolved and cognition established. Finally player will see a movie to consolidate this new concept, “seeing is believing” can help strengthen this perception.
Learning material design

The main objective is to establish a scientific knowledge and to solve misconceptions, this study focus on the case of the melting of the Arctic sea ice will cause sea levels rise. Design a self-learning process using the Antarctic, the Arctic ice melting caused by differences in sea-level change situation. There are five stages of the game content (Figure 4), the first step is to accept the task and play the role into the game situation, simultaneously, game will show learners the body operation to control the game; the second stage simulates the real and funny experience of marine environment of Antarctic and Arctic by real photos and virtual screen for learners; the third stage presents differences in structure of the Antarctic and Arctic by plot and dialogue, also guide the learners think about the influence of the land ice and ice land; by situations of life, the fourth stage by the game of saving polar bears and penguins, solving the misconception of "Arctic ice melt will cause sea levels to rise".
5. Discussion
Quasi-experimental method is adopted to assess the performance, using of the somatosensory system is assigned as the experimental group and the control group is using a conventional keyboard device for learning, the total number of test facilities is 426 (165 in the experimental group and control group 261), through a pre-test/post-test questionnaire the descriptive statistics, ANOVA analysis of quantitative data and open questions are discussed.

According to quantitative data analysis shown that: 1) All of the testing scores show significant improvement by using the game-based learning processes in solving the global warming misconception (experimental group mean improvement 1.15, control group mean improvement 0.92), also we found the outcome of somatosensory-combined design is better than traditional keyboard ($F = 6.31$, $p < .05$). These results indicate the innovative somatosensory game situational learning can effectively improve the global warming misconception as well as highly confidence in future adaption and promotion; 2) From the investigation, the testers’ knowledge of global warming are coming from television media, teachers and the network, it is consistent with domestic research. But the cross analysis from pre/post test scores showed that the source of information got by learners with proper scientific understanding in their prior experiment is come from schools and teachers; 3) By the assessment results, the satisfaction for physical operation is up to 86.3% in experimental group learners, and for the game interesting, memory degrees, smoothness is higher than 90%. Moreover the willing to using the same learning module but different contents is totally agree (100%), that shows the design of this study, said somatosensory game situational learning, lead to a strong and highly motivated satisfaction.

6. Conclusion
This study has successfully developed a low cost Situational somatosensory game digital learning module, it is the first exploration in using somatosensory technology with role-playing games, to solve scientific misconception, than through formal teaching experimental results show that the concept for the global warming misconception resolved, and the establishment of proper scientific knowledge, a good upgrade results. Specific results are concluded below:
1. A successful use of low cost and easy to entry with RPG Maker and a free FAAST to develop the production of the game materials, cost of production has a good advantage in the subsequent promotion of environmental education.
2. Features of role-playing game including the dialogue, the plot and visual presentation to guide the effective thinking and learning in the teaching content. The results show the learners have high satisfaction in innovative learning method that can triggered strong motivation and interest, and to achieve learning objectives and effectiveness for happy learning.
3. Both of the experimental group and control group has good satisfaction higher than 90%, and experimental group were better than control group. Specifically, the willing to using the same learning module in different contents is totally agree (100%), that shows the Situational somatosensory game digital learning modules of this study, led to a strong motivation and highly satisfaction.
4. From this study of pre/post test showed that the source of information got by learners with proper scientific understanding in their prior experiment is come from schools and teachers, so it is recommended that correct conduction of scientific knowledge, and to accept the message of environment and situation are highly correlation between. But the message (learning content) is best through integration and design, in order to establish the correct perception.

References


The Environmental Education of Migration Birds Using a Near Time Web-based Design

Chow-Jeng WONG\(^a\)*, Chen-Jeih Pan\(^b\), Yi-Jong TSAI\(^c\)

\(^a\)School of Physics, Universiti Sains Malaysia, Malaysia
\(^b\)Institute of Space Science, National Central University, Taiwan
\(^c\)Kenting National Park Taiwan
\(*\)wongcj.usm@gmail.com

Abstract: Raptor Migration is one of the most famous ecosystem mystery phenomena around the world. Both Malaysia and Taiwan are located on the flight path of the migration tracks of raptors in East Asia. For the past years, researchers associated with the Kenting National Park used a Doppler Weather Radar (Central Weather Bureau) to investigate the migration tracks of raptors, few episodes achieved very successful results. This study is to build up an information system which uses satellite images and Doppler Weather Radars to identify the raptor signal from the radar echoes. It is also going to build up a data flowchart, data base and Geographic Information System (Google Earth) for a near-time display. This system will provide the migration information for academic research, surface surveying and also for tourists and amateur bird watchers. Based on the near time track skill improvement, this study designed a web-based migration bird education for the public, we used web skill to demonstrate the near time migration track of raptors, the watching locations, as well as the e-book to introduce species of raptors.

Keywords: Raptor Migration, Web-Based Learning, Environmental Education

1. Introduction

Raptor Migration is one of the most famous ecosystem mystery phenomena around the world. Both Malaysia and Taiwan are located on the flight path of the migration tracks of raptors, especially where the Asian Monsoon directly affects the weather, Taiwan is a very important site for studying migrating raptors in East Asia. For the past years, to using a Doppler Weather Radar to investigate the migration tracks of raptors is a new skill to improving the track watch, Taiwan and Malaysia start the international project originated from the use of meteorological radars in monitoring the conditions of clouds and rains with radar.

The Doppler weather radar at Kenting, first set up in 2001, is especially useful in monitoring severe weather systems like typhoons that may inflict terrible damage to the southern part of Taiwan. It occasionally also detects echoes reflected from flocks of migratory birds. That gave the bird-loving KTNP Headquarters the idea of tracking birds with radars. The first attempts failed as the data received was too complicated and required human interpretation, which was time-consuming and error-prone. After the NCU scientists put in place an information system which uses an all-sky camera to identify radar echoes and conduct surface surveys, and also to build up data flows, a database and Geographic Information System (Google Earth) to form a real-time display system. Weather, sea and man-made noise is removed automatically and only the raptor information is displayed. It has met with great success in collaborations with KTNP in tracking birds by radar. Now, not only can noise in the radar be identified and eliminated, but the directions and routes as well as the times and locations of landing can be accurately monitored and forecast. This is an important advance in both bird conservation and bird-watching activities.

Usually, it is a matter of “Luck” for bird-watchers to enjoy following raptors in spring as the
birds usually come in from the sea. Unlike autumn, in spring the raptors stay overnight in the Kenting area before leaving Taiwan to continue their flights. People then can enjoy watching the raptors land in the evening as well as rising in the morning. Even the most experienced officers of KTNP cannot guarantee where and when one will see the birds in spring. With the help of radar, it is easier to know where and when the raptors are going to land in spring. On the other hand, we know where they are leaving for in autumn.

Analysis of radar echo data shows that it is now known that these birds have already decided where they are going to land when they are about 100 km from their destination. Researchers can tell from the radar data the birds’ migration habits, flight altitude, speed, and other elements. They can even recognize when there is a coup among a flock of birds. However, more care must be taken in providing the information and promoting bird conservation; otherwise the project will help not just bird watchers but also hunters, and cause irreversible harm to the ecology.

Based on the near time track skill improvement, this study designed a web-based migration bird education for the public, we used web skill to demonstrate the near time migration track of raptors, the watching locations, as well as the e-book to introduce species of raptors.

2. Design of the Migration Raptor Tracking System for Education

The educational purpose of this information system is to attract people who is interested in nature environment and bird watching. It is very important to show the target of the system on the homepage (figure 1). Users can get the information what they want to know by selecting the functions that provide from the website, we use Java scripts to make the Raptor Migration Information System running faster and a few part functions to design a new type of inquiring function to help the users find their request.

![Figure 1. The welcome page of the Migration Raptor Tracking System](image)

On the welcome page (Figure 2), the information includes project introduction and Features. We display animation about the successfully identify of raptor migrate case in recent years, help the users with knowing how the Raptor Migration Information System works easily. Renew display photo function, linked the upload photo in backend database and display photos at Homepage. An timely automatic statistics dynamic charts and bar charts regarding to the count of raptor migrate in Spring and Fall at bottom are also shown. The right sidebar is about the Sharing function, Visitor numbers, Member login, Raptor-expert message board, Raptor migrate of the season and related link.

We also design the Green Map (GM) of Raptor in Kenting for presenting the most species of raptors in the local area (Figure 3), GM is a map that promotes nature, sustainability, and ecology (please refer to [http://www.greenmap.org/greenhouse/files/gms/GreenMapIcon_V3Chart.pdf](http://www.greenmap.org/greenhouse/files/gms/GreenMapIcon_V3Chart.pdf)), it is usually used to demonstrate the relationship between people and the environment. From 2005 to present the GMs are
widely applied in outdoor education, even in Malaysia and Taiwan, a lots of GM are used to introducing schools, national parks, cities…etc., therefore, we used GMs as materials for raptors. Our design also embedded QR Codes into the program (Lai et al, 2013), it is a linked function provided the raptor information in Kenting area and video player by click the different raptor pictures.

**Figure 2.** The raptor information of the Migration Raptor Tracking System

**Figure 3.** the Green Map (GM) of Raptor in Kenting

An e-book (as known as electronic book) is a book publication in digital form, consisting of text, images, or both, readable on computers or other electronic devices. ([http://en.wikipedia.org/wiki/E-book](http://en.wikipedia.org/wiki/E-book)). It can be viewed in screen associated with computers, tablet PC, hands on smartphones. Now not only adults read an e-book, but also applied in children’s education, it is over 50% of Americans by 2014 had a dedicated device, either an e-reader or a tablet, that is a great potential for the education in using e-book. By introducing the near time migration message could be involved in the e-book, a database of the successfully identify of raptor migrate cases are loading in the e-book system.
Added a database of the successfully identify of raptor migrate case (Figure 4), the identify system is one of the most features functions. By identify the signal on radar while the raptor migrate and display on website in time, there are many successfully identify cases are sorted in database, users can known the raptors's processes and habits when they were migrating by this cases.

Figure 4. The e-book of the Migration Raptor Tracking System

3. Discussion

From 2009 to 2010, camera field experiments were conducted to improve the radar echoes validation. We find the all-sky camera is a very useful instrument in conjunction with the weather radar to distinguish the raptors and clouds. Since 2010 we focus on the radar image recognition with more accuracy to create a complete information platform of the birds. The satellite image appending tests were carried out in spring and autumn to improve those parameters deduced by the weather radar.

The study has also worked an international cooperation in migration raptors education, there are 5 countries, hundreds of people were using the website to understand the raptors. It was also promoting in an international workshop hold in Penang, Malaysia (Figure 5), the participants were all experienced the system and made clear understanding with the migration raptors. This study will continue to serve in Spring and Autumn, and develop more convenient path as well as tools to help people in environmental education.

Figure 5. The international education path in using the Migration Raptor Tracking System

References

Development of Sign Language Training Machine using Depth Sensor

Yuichiro MORIa*, Akie FUKUHARAa & Shogo HAYASHIDAb

aDepartment of Information Science, Kochi University, Japan
bGraduate School of Information Science, Kochi University, Japan
*ymori@is.kochi-u.ac.jp

Abstract: In this paper, we describe a development of Japanese sign language training machine using depth sensor that targets a beginner of Japanese sign language user and supports a learner by feeding back mistake information. This system consists of two parts, one is an input device of sign language and the other is a personal computer for study. That input device consists of flex sensors and accelerometer installed on gloves, and a depth sensor. The depth sensor (Xtion) is used to acquire the position of the hand and head, because this information is very important to analyze a sign language. Correct or incorrect determinations of input sign language motions are very important to achieve the sign language study accurately. Therefore, this thesis especially describes the correction judgment of sign language. For the internal processing, we defined fundamental motions and forms of a sign language, and modeled sign language motions by combination of fundamentals. These fundamentals are defined by some information of the shape of the hand, the inclination, the position and the direction of the movement. The number of sign language words necessary for communication with a hearing impaired is about 2,000 words. As the first step, we selected 231 words that an elementary conversation is possible and constructed the system. As a result, we are able to achieve correction judgments that have high accuracy. On the other hand, the problem in a present method is clarified, too.

Keywords: Japanese Sign language, Hearing-impaired person, Xtion, Data glove

1. Introduction

The United Nations adopted 'Convention on the Rights of Persons with Disabilities' in the 61st general meeting in December 2006. In this convention, there is the following item.

Accepting and facilitating the use of sign languages, Braille, augmentative and alternative communication, and all other accessible means, modes and formats of communication of their choice by persons with disabilities in official interactions;

So, it is a policy of aiming at the environment that can easily take communication even if sign language is selected and used as a communication tools. This convention is ratified by 138 countries in October 2013, keeps increasing now, and the spread activity of sign language is advanced all over the world. In Japan, 'Basic Act for Persons with Disabilities' was revised on in 2011, and sign language was taken formally as a language (Cabinet Office Japan, 2013). To make the environment where it is easy to live for a hearing-impaired or speech-disabled person, a sign language broadcasting and a sign language window, etc. are set up now. However, sign language cannot be used in other places, consideration to a handicapped person is not complete. To make that environment, it is necessary to increase a place where sign language can be used more than now. And to do that, an able-bodied person should study sign language and well understand them. There are three typical communication way between hearing impaired and able-bodied person, it is writing communication, lip speaking and sign language. However sign language requires much training, a lot of people are using it recently because the information carrying capacity is very high.

There are roughly separately two kinds of study methods of studying sign language. One is a image/video teaching material such as a book or DVD, the other is a sign language school. The book
and DVD have a weak point that learner's mistake cannot be pointed out. Therefore, there is uneasiness that the learner is learned wrong motion and does not pass in practice. On the other hand, that weak point does not exist in a sign language school. However, the cost is high, and some restrictions of time and place are very large. Therefore, we developed the sign language training machine that targets beginners of sign language, and there are no restrictions of time and place, furthermore it supports the learner by feeding back mistake information.

2. Framework of Sign Language Training Machine

2.1 Outline

As shown in Figure. 1, this system consists of two parts, one is a input device of sign language and the other is a personal computer for study. This input device consists of flex sensors and accelerometer installed on gloves, and a depth sensor. The depth sensor (Xtion) is used to acquire the position of the hand and head. In our laboratory, we used a depth sensor from Kitagawa et al. (2013), and used both hands version of data glove from Matsushita (2014).

![Figure 1. Configuration image of Sign Language Training Machine](image)

Information of correct sign languages are registered in the database of this training machine as a teacher data. In the process of study, this system compares sign language information acquired from the learner with teacher's data, and judges the correction. When the learner makes a mistake, the reason is pointed out from the system, and the learner advances study again considering the mistake pointed out.

2.2 Sign language input device

That input device consists of flex sensors and accelerometer installed on gloves, and the depth sensor that is used to acquire the position of the hand and head. In present performance of a depth sensor, Xtion cannot acquire the shape and motion information of hands and fingers. Then, we use a data glove together, and acquire detailed shape, movement, and inclination of the hand.

2.2.1 Data glove

The role of the data glove in this system is acquisition of the information of hand's shape, movement, and inclination. As shown in Figure. 2, the flex sensor is installed in each finger, and we can observe the curved condition as a change in resistance. So, we convert this change into the change of voltage by principle of partial pressure ratio. We use PIC (Peripheral Interface Controller) to treat information from each sensor. Concretely, PIC digitalizes the voltage with A/D converter, and its data is sent to PC with USB communication. Similarly, the acceleration sensor also outputs the acceleration as a change in the voltage, it is converted with A/D converter in PIC, and it transmits to PC. There are a lot of signals that should convert A/D, one group is 5 signals from flex sensor of each
finger, the other group is 3 signals (xyz-axes) from acceleration sensor of the hand. In total of both hands, they become 16 signals. Because the number of A/D channels of PIC is not enough, analog switches are connected outside, and data is acquired by switching the sensors. These switches are called a multiplexer (MUX), and we show MUXes in Figure 2.

![Figure 2. Data glove (left) and the peripheral circuit (right)](image)

2.2.2 Depth sensor (Xtion)

This system uses depth sensor (Xtion) as a sensor to acquire the location information of learner’s hand. By using skeleton tracking function (Figure 3) of Xtion, we acquire the three-dimension location information. As a depth sensor, we selected Xtion, which has the function equal with Kinect. Because Xtion is smaller than Kinect, and AC adaptor is not needed (USB Bus Power). Moreover, Xtion uses OpenNI, we can widely select a environment.

![Figure 3. Real RGB image (left) and its skeleton tracking image (right)](image)

3. Targeted words of sign language learning

The sign language word of about 2,000 words are necessary to take communication freely with a hearing impaired person, as shown in Table 1. Therefore, a practicable sign language training machine should be able to study more than 2,000 words finally. As the first step of this study, we selected 231 words that elementary conversation is possible and constructed the system. This 231 words are necessary for the level 5~7 of Sign Language Proficiency Test in Japan (Sign Language Proficiency Test Association, 2014).

<table>
<thead>
<tr>
<th>Level</th>
<th>No. of words</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ~ 2</td>
<td>about 2,000</td>
<td>A free communication is possible.</td>
</tr>
<tr>
<td>3 ~ 4</td>
<td>about 1,000</td>
<td>A daily conversation is possible.</td>
</tr>
<tr>
<td>5 ~ 7</td>
<td>about 200</td>
<td>An easy conversation is possible.</td>
</tr>
</tbody>
</table>
4. Correct or incorrect determination of sign language motion

In this system, sign language recognition is not a purpose. In the process of sign language study, the user perform sign language word requested by the system, and the system judges the motion which is correct or incorrect, and at the same time points out a mistake point. Seemingly, the system seems to recognizing a sign language. However, this system's processing is very simple compared with recognition. Extracting process of sign language word from time-series data can be simplified, because the user begins performance of sign language after the system directs the beginning point. Moreover, because system side knows what word motion of the input, there is no necessity for recognizing what it is, and it only has to judge the correction compared with a correct answer. If a recognition processing is requested, we need very complex processing (Toyokura et al., 2006 and Matsuo et al., 2013). However, processing can be simplified like these.

In the determination process, we should think about acceptable errors compared with the right motions. Recognition is not a purpose in this system as previously described. If this system aims at recognition, there is a necessity for considering about a tolerance of individual variation (habit) and error margin. It is a correction judgment ability that this system needs when training. Therefore, for the training of correct motion, we dared to reduce the tolerance of error margin and individual variation. So, these tolerance settings are very tight for recognition.

4.1 Determination process

In a judgment of a sign language motion, we resolve the sign language motion to fundamental motions, and are using the modeling method, which is modeling a sign language motion by combining the fundamentals. Moreover, it is possible to correspond to an increase of words in the future, because this method can express a new word by combining the fundamentals. In Table 2, we show various basic patterns of the hand used to define the fundamental motion.

Table 2. Patterns for fundamental motion definition

<table>
<thead>
<tr>
<th>Basic pattern</th>
<th>No. of patterns</th>
<th>Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>24</td>
<td>Flex</td>
</tr>
<tr>
<td>Position</td>
<td>6</td>
<td>Depth</td>
</tr>
<tr>
<td>Tilt</td>
<td>6</td>
<td>Acceleration</td>
</tr>
<tr>
<td>Relocation</td>
<td>53</td>
<td>Depth &amp; Acceleration</td>
</tr>
<tr>
<td>Shake</td>
<td>2</td>
<td>Acceleration</td>
</tr>
</tbody>
</table>

Even if which enumerated information in this table is missed, an accurate judgment is difficult. It became possible to acquire those information easily by not using a picture processing and using a depth sensor. Especially, the acquisition of the position of hands and head shown in Figure 4 are very difficult by using only existing sensors.

![Figure 4. Position relation between hands and head](image-url)
This system has teacher’s database expressed by combining fundamentals, and correction of learner’s motion is judged by using it. In most determination process, only initial state and end state of a sign language motion are modeled by fundamentals, and correction judgment processing is done by using it. Because the system knows the correct answer that should be judged, the correction judgment is enough by this method.

5. Learning system

At the learning part of this system, we implemented a basic function, as shown in Figure 5. The teacher’s demonstration video and explanation of the sign language can be browsed. These are not different from video learning materials. Afterwards, the learner performs the sign language motion, and the evaluation is obtained. This is the feature of this system. When making a mistake, the learner confirms which part of motion is wrong by playback own video. Of course, an incorrect part is pointed out by the system. The learner can remember correct sign language motion by repeating this process. The study result is preserved by the system, and the learning scheme is made based on it.

The environment of this system is shown below.

- **CPU**: Intel® Core™ i7-2670QM 2.2GHz
- **Memory**: 8 GB
- **OS**: Windows 7 64bit
- **IDE**: Microsoft Visual Studio C# 2010
- **Framework**: OpenNI & NITE ver.1.5.2

![Figure 5. Screen shot of training machine](image)

6. Evaluation

The determination accuracy of motion should be high to achieve correct sign language study by using this system. In other words, there is not a meaning if feedbacks of this system are not based on correct information. So that, we first executed evaluation of the determination capability.

As examinee's condition, we assumed a user of this system. It was a sign language beginner and if lecture was received, it was assumed level to be able to do correct motion. In other words, it is not a person who can do sign language with strange habits.

6.1 Determination capability

We experimented on all of 231 words this system targeted. Examinees were five of sign language beginners. First, the examinee selected a word with manual operation, confirmed the sign language motion, and afterwards, judged the motion by the system. Those experiments of each words were
done after enough practice, and all motions were correct in check with eyes. And so, the Table 3 shows the determination rate when the examinee does correct motion. The average determination rate of the system became 88.7%, and shows a high performance. It can be said that this result has enough capability for use to learning system. On the other hand, the feature of the motion that failed in the judgment became clear, too.

Table 3. Determination rate

<table>
<thead>
<tr>
<th>Examinee</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Ave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determination rate(%)</td>
<td>90.5</td>
<td>90.5</td>
<td>90.0</td>
<td>86.1</td>
<td>86.1</td>
<td>88.7</td>
</tr>
<tr>
<td>No. of faults</td>
<td>21</td>
<td>23</td>
<td>23</td>
<td>32</td>
<td>32</td>
<td>26.2</td>
</tr>
</tbody>
</table>

This system has high determination accuracy. However, it is necessary to solve the following problems to improve accuracy from the result of experiment.
- Malfunction of skeleton tracking because of hands overlapping
- Shortage of definition of basic motion pattern "Hand's vibration (i.e. shake)"

The first is a typical problem of skeleton tracking by depth sensor. When hands overlap, it does not see from depth sensor, and malfunction occurs. It is necessary to prepare processing when losing. In addition, the middleware side should not lose even if it overlaps, too.

The next is a problem of definition of the fundamental motion based on information from acceleration sensor. In this part, we define the fundamental motion of a hand's inclination and vibration that is small shake motion. In these motions, there are a lot of individual variations more than our assumption. In this problem, it causes the policy of exclusion of individual variation and reduction of acceptable error.

7. Conclusion

In judgment of sign language motion, the position of hand and head is very important to say nothing of the shape and motion of hand. In an existing method, the location information was acquired by recognizing hand and head position by image processing. However, the processing is not easy. At the present day, that information can be easily acquired by using a depth sensor according to skeleton model with human body. And, we can acquire the motion and shape information of hand and finger accurately by using data glove. Accurate fundamental motions of sign language can be defined by combining these technologies. As a result, high determination accuracy could be achieved.

On the other hand, the problem in determination processing became clear, too. At the stage of practice of sign language, the learner should exclude an individual feature (habit), and do basic correct motion. We are aiming at a more accurate determination based on this policy now. However, when this system is enhanced to recognition processing, the individual variation problem cannot be avoided. Therefore, we should carefully consider these problems as the next one.

References

Significance and Possibility of E-Learning for Choreographic Skills in Contemporary Dance

Bin UMINO* †, Asako SOGA ‡ & Motoko HIRAYAMA †

*Faculty of Sociology, Toyo University, Japan
†Faculty of Science and Technology, Ryukoku University, Japan
‡Faculty of Health and Sport Sciences, University of Tsukuba, Japan
*umino@toyo.jp

Abstract: In this paper, we introduce a learning methodology for choreographic skills in contemporary dance using the “Body-part Motion Synthesis System (BMSS),” which actualizes “analytic-synthetic choreography.” The software allows students to select body-part motion clips of basic dance movements and compose a short dance motif, which is previewed using 3D animation. Experiments on learning choreographic skills with the software were conducted in order to evaluate its usability. Data were collected from 26 students using a questionnaire. From the results of the experiments, we verified that the software’s usability is acceptable and that our e-learning method for contemporary dance is effective for learning choreographic skills.

Keywords: E-learning, choreographic skills, motion data, contemporary dance

1. Introduction

Although computational methods for dance creation have advanced significantly over the past two decades, there are only a few dance teachers who utilize computers to teach dance skills in their classes. Using computers in dance education has always been contentious because dance has the distinction of being both somatic and artistic. Somatic skills essentially need to be learned through physical practice, and it is currently difficult for computer devices to support the experience of physical action unless the teacher has access to costly hardware. Artistic skills need to be learned through an individual’s creativity, but dance people generally believe that it would be almost impossible for a computer to inspire creative feelings or intuitions in a purposeful manner.

However, some researchers in dance education have reported the impact of computer technology on dance learning (e.g. Smith-Autard, 2009; Leijena, Admiraala, Wildschut and Simons, 2008). In particular, 3D animation and motion capturing technology have expanded the capability of e-learning for dance. Karkou, Bakogianni and Kavakli (2008) developed a web-based learning environment using 3D animation for traditional dances in the U.K. and Greece. Moreover, both Matsumoto, Miura and Kaiga (2011) and Shibata, Tamamoto, Kaiga and Yokoyama (2012) developed e-learning tools that could display 3D animation of model performances made from motion capture (MoCap) data for traditional dances in Japan.

The authors have been working on dance education and creation using 3D motion data that were captured from performances by professional dancers. This paper introduces a specific teaching methodology for choreographic skills in contemporary dance utilizing e-learning software that we have been developing in order to actualize “analytic-synthetic choreography,” which is described in Section 2. The methodology targets undergraduate and postgraduate students who are studying contemporary dance choreography. The software is called “Body-part Motion Synthesis System (BMSS),” and it is described in Section 3. Experiments on learning choreographic skills with the software were conducted in order to evaluate its usability. Data were collected from 26 students in Japan and the U.S. using a questionnaire, which is described in Section 4.
2. Pedagogy of Choreography

2.1 Top-down and Bottom-up Approaches

In general, a choreographic process is carried out in a top-down approach. A choreographic work is composed of many artistic elements other than dance movements, such as narrative, music, sound effects, lighting, scenography and visual effects, costumes and stage make-up. Professional choreographers attempt to integrate all of these elements into their work coherently according to their own choreographic planning. The planning usually precedes the creative process of dance movements and theatrical audio-visual elements. Choreographers sometimes choose a specific narrative or a given musical score as a point of departure for their creation, but after that the process is likely to be a top-down approach.

Choreographic skills are normally taught to students at universities as a top-down approach, just as a professional choreographer normally works. They are required to formulate their own choreographic planning and implement it in their choreographic works. Most teachers of choreography place heavy emphasis on a holistic concept and the consistent structure of choreographic works at higher educational levels. Beyond that, the concepts that the teachers suggest tend to be expressionistic ones using narratives, emotions, or feelings to set up the choreography.

However, the authors believe that bottom-up and non-expressionistic approaches would also be vital and effective ways to master choreographic skills in contemporary dance. The students need to have the experience of composing dance movements without narrative, emotions, music, and all other audio-visual elements except for the dancers’ bodies. This is because the pursuit of novel movements with the intention of independence from concrete references in the world characterizes the contemporary dance scene of the day. Contemporary dance can be described as an artistic dance without any common or standard choreographic vocabulary. A number of legendary twentieth-century choreographers, such as Rudolf Laban (1879-1958), Merce Cunningham (1919-2009), and the early William Forsythe (1949-) sought to produce their original dance movements without narrative, emotions, and music. Such an abstract way of dance composition should be taught as part of learning choreographic skills at universities lest the students’ works be produced from only derivative material.

2.2 Analytic-synthetic Choreography

It is more difficult, but an exciting challenge, for choreographers to adopt the bottom-up and non-expressionistic approach than the top-down and expressionistic one. Computer technology sometimes helps them to pursue the abstract way. Cunningham famously pioneered the use of the choreographic software Life Forms in the late 1980s, while Forsythe used moving picture processing and hypertext technology to explain his unique algorithmic method of creating dance movements in the late 1990s (Forsythe, 1999).

The authors found that 3D animation made from MoCap data could be a powerful e-learning tool for learning choreographic skills in contemporary dance in the bottom-up approach. The basic idea of the method is to segmentalize dance movements performed by professional dancers into short elemental motions and then synthesize these segments as building blocks to create new movements. Both the elemental motions and the synthesized movements can be simulated easily and instantly as 3D animation. We call this method “analytic-synthetic choreography.”

The segmentalization of dance movements is transacted in a double way. First, the dance movements digitized by a motion capture system are separated into basic whole-body movements along the time axis, such as stamping forward, sliding aside, bending the knees, and toppling in an off-balanced way. Second, the whole-body movements are articulated to extract basic body-part motions, such as contraction of the breast region, rotating the head, shaking the left leg, and crossing the arms in front of the body. Single elemental motion of the whole body or a body-part lasts a few seconds.

Meanwhile, the synthesis of dance movements is transacted in a triple way. First, you can select several whole-body movements and combine them in a row on the time axis to create a short dance sequence. For example, if you select three movements which are denoted by A, B, and C, then you can create ABC, BAC, ACBA, CBCAAB, and so on. Second, you can blend one whole-body movement into another whole-body movement. For example, if you select the sliding aside movement, then you
can add the bending the knees movement to it at any timing you decide. The movements are overlapped on the time axis unlike in the first way. Third, you can replace part of a whole-body movement by a body-part motion. For example, if you select the stamping forward movement, then you can replace the head by rotating movement and the arms by crossing in front of the body. The movements are overlapped in this way as well.

The authors developed e-learning tools that actualized the first synthetic way for learning classical ballet (Soga, Umino, Yasuda and Yokoi, 2007; Umino, Longstaff and Soga, 2009) and hip-hop dance (Soga, Tsuda and Umino, 2014). In addition to these tools, the authors have developed an e-learning tool for contemporary dance that actualizes the second and third synthetic ways of creation, as described in Section 3.

The learning methodology based on analytic-synthetic choreography consists of three phases: (i) students create short dance motifs using the software and simulate them as 3D animation on the display of a computer; (ii) students try to perform the motifs by mimicking the 3D animation by operating their own bodies; and (iii) students create and perform their own short dance sequences by combining, arranging, and sophisticating the motifs in a studio. The second and third phases are essential for students to discover and develop their own creative process by themselves. Experiments were conducted according to the methodology, as described in Section 4.

3. Body-part Motion Synthesis System

The software BMSS has been developed to actualize analytic-synthetic choreography (Kohno, Soga and Shiba, 2010). In this research, 40 basic motions were selected meticulously as elemental motions so that dance students could use the system easily within a short span of time. Each motion’s potential for synthesis was analyzed, and the 40 motions were categorized into 3 main groups: Base motions, Blend motions, and Body-part motions. Base motions consist of whole-body movements. Blend motions consist of whole-body movements that are able to be blended together with a Base motion. This group mainly consists of hip movements like jumping and twisting motions. Body-part motions consist of movements that involve only specific body parts or limbs. This group is further categorized into five sub-groups: Body, Neck, L-Leg (left leg only), Shoulders, and Arms.

The system creates movements by the synthesis of a Base motion, Blend motions, and Body-part motions. It has two modes: Blend mode corresponds to the second synthetic way mentioned in 2.2; Replace mode corresponds to the third one. In the Blend mode, the selected Blend motion of the whole body is blended with a Base motion in a way that the vector of the Blend motion for each joint in every frame is added to that of the Base motion. For example, when a user selects sliding aside as a Base motion and bending the knees as a Blend motion, a sliding motion with bending knees is created. In the Replace mode, the system replaces motions of specific body parts with different Body-part motions.

There are currently two versions of BMSS. The old version runs on a notebook PC with keyboard input, and the latest version runs on a tablet with touch input. The sets of 40 motions are slightly different, and the old version does not implement the Blend mode. Despite the differences, they are underpinned by the same learning methodology explained above. Table 1 shows the number of motions and examples of motion codes in each category.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Notebook PC</td>
<td>Tablet</td>
</tr>
<tr>
<td>Base</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Blend</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Body-part</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Neck</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>L-Leg</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Shoulders</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Arms</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>
Figure 1 shows the GUI of the tablet version of BMSS. It employs only one window, which consists of a virtual environment and GUI components. The GUI components such as buttons are layered over the virtual world. The codes of all 40 motions are listed as buttons. First, you select a Base motion and the system displays it by 3D animation with a virtual dancer. Then, you select Blend motions or Body-part motions. The Base motion and the selected motions are synthesized, and the result will be displayed instantly. The system also has functions to support dance creation such as changing the viewpoint and saving the synthesized movements (Soga and Matsumoto, 2013).

4. Experiment

4.1 Method of Experiment

Experiments were conducted using both the notebook PC version and the tablet version of BMSS. The experiments aimed to evaluate the usability of the software. From the point of view of learning choreographic skills, usability is the most important aspect of the e-learning tool. Usability is defined in ISO 9241 as “The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments.” The users of the software are assumed to be students who study contemporary dance at universities. The goal of using BMSS is to learn skills in contemporary dance based on analytic-synthetic choreography. To evaluate the usability of BMSS, five questions were prepared preliminarily:

- Can dance students master the system to create dance motifs in a short span of time?
- Can dance students be satisfied with the system for learning dance movements?
- Can dance students be satisfied with the system for creating new dance movements?
- Can dance students discover new dance movements they did not know before?
- Can dance students discover new choreographic skills they did not know before?

The 26 examinees consisted of 18 students who majored in contemporary dance at University of Tsukuba in Japan and 8 students who belonged to the Department of Dance, University of California, Irvine, in the U.S. Here, 16 out of the 26 examinees were postgraduate students. They studied not only contemporary dance but also other genres of dance for 4 to 40 years. 8 out of the 18 Japanese students used the notebook PC version, and the remaining students used the tablet version.

The examinees gathered in a gymnastic studio and formed groups, each of which consisted of four or five students. After brief instructions on the software, the experiments were implemented in three phases: (i) the examinees tried to create short dance motifs on the display; (ii) they tried to perform the selected motifs by operating their own bodies; and (iii) they were requested to create their own dance pieces by selecting and connecting the short motifs. In the third phase, they were also requested not to mimic the motifs but to arrange and sophisticate them as their original choreographic works. After rehearsal, their short dance pieces were performed by themselves in front of a video camera one
by one. At the end of the experiments, they were requested to complete a questionnaire. The experiment took about 90 minutes for each group, including the instructions.

4.2 Results and Discussion

Although the examinees were given only short and simple instructions lasting about 10 minutes, every examinee could master the system readily and smoothly with both the notebook PC version and the tablet version. They all completed the creation of their original short dance pieces within 90 minutes. The duration of the pieces varied from 13 to 53 seconds, with an average of 25 seconds. The number of motifs they connected varied from 5 to 10, with an average of 7.

In the questionnaire, the examinees were asked to answer about the effectiveness of the system for “understanding of dance movements” and “creation of contemporary dance” (Umino, Soga and Hirayama, 2014). The examinees were requested to choose from four options, and Table 2 shows the number of replies for each option.

Table 2: Students’ ratings of BMSS.

<table>
<thead>
<tr>
<th></th>
<th>Understanding of movement</th>
<th>Creation of dance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Notebook PC</td>
<td>Tablet</td>
</tr>
<tr>
<td>effective enough</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>effective if modified</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>not so effective</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>don’t know</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

In terms of understanding movements, 23 out of the 26 examinees chose either “effective enough” or “effective if modified.” Three Japanese students with the tablet version chose “don’t know” and commented similarly that watching 3D animation without practice was insufficient to understand the movements. However, no one chose “not so effective.” The results suggest that the examinees were satisfied with the system as a useful tool for learning movements. In terms of contemporary dance creation, 20 examinees chose “effective enough.” Two Japanese students with the notebook PC version chose “don’t know,” but all of the students with the tablet version chose either “effective enough” or “effective if modified.” These results suggest that the examinees were satisfied with the system as a useful tool for creating new movements.

The free descriptions by the 26 examinees in the questionnaires were analyzed in detail. First, to the open question “Please describe in detail any choreography sequences that you made using BMSS that were unexpected and outside of your usual movement vocabulary,” all 26 examinees described what they found as new movements of contemporary dance for themselves. Several typical responses (JP denotes Japanese, US denotes American) were elicited: “When I created movements which looked interesting on the display, I noticed which body-part I usually tend to ignore” (JP); “Jumping from being in a deep lunge/one knee on the floor was unexpected” (US); “Having the foot shake at the end of the leg touch was way outside of my movement vocabulary” (US).

Second, to the open question “What did you learn about creating contemporary dance choreography through this experiment?”, all of the examinees described something they had learned. Furthermore, 22 out of the 26 examinees reported that they learned a novel choreographic method of contemporary dance. Several typical responses were gathered: “I could think of dance movements as combinations of simple movements” (JP); “I realized that combination and permutation of movements gave me original choreographies infinitely” (JP); “I learned that creating movements by layering different elements or body parts can be very effective” (US). The responses proved that the examinees learned the idea of analytic-synthetic choreography, although it had not been explained explicitly during the experiments. Although four examinees did not describe a new choreographic method expressly, they nevertheless pulled off creation using the analytic-synthetic way unconsciously.

After analyzing the free descriptions by the students in the questionnaires, it is reasonable to conclude that they could discover both new movements and new choreographic skills through the learning methodology based on analytic-synthetic choreography. Finally, we received positive answers to all five of the questions proposed in 4.1. A comparison between the notebook PC version and the tablet version was clarified in another paper (Umino, Soga and Hirayama, 2013).
5. Conclusion

Body-part Motion Synthesis System (BMSS) has been developed for learning choreographic skills in contemporary dance. The software is designed to actualize analytic-synthetic choreography. As a result of experiments, we verified that the system’s usability is acceptable in terms of easy operability, students’ satisfaction, discovery of new movements, and learning a new choreographic method.

At the beginning of this paper, the authors mentioned the difficulty of learning somatic and artistic skills with a computer. Regarding the somatic skills of dance, students will have learned new movements through the second and third phases of the proposed methodology. Regarding the artistic skills of dance, students will have learned analytic-synthetic choreography by themselves through this methodology. In conclusion, the methodology is effective for learning both somatic skills and artistic skills of contemporary dance.

Through the experiments, we received a lot of responses about how the examinees wanted to improve BMSS. In future work, we intend to improve it after reviewing these responses. For example, we plan to augment the user interface so that the system can promote learning more effectively.

Acknowledgements

We would like to thank Kanagawa Institute of Technology for permission to use a studio and a motion capture system. This work was partly supported by JSPS KAKENHI Grant Number 22300038.

References

Design of an Environment for Motor-skill Development based on Real-time Feedback

Keita YAMADA**, Kenji MATSUURA

**Graduate school of advanced technology and science, The University of Tokushima, Japan
bCenter for Administration of Information Technology, The University of Tokushima, Japan
*ma2@tokushima-u.ac.jp

Abstract: Advancements of information technology and sensing technology enables to support motor-skill development in real-time. The authors propose a supporting model, which improves the form of motion in real-time. Our proposal shows the difference between the present form and the ideal form. In addition, it offers the expected form in future and the result of the performance. It is a reason why the authors consider the process of human motor-skill. The target skill is a sort of closed skill. The retrieval in the form database is improved using the k-means algorithm. At last, the authors touch upon an experiment of our proposed model.

Keywords: skill development, motor skill, real-time, motion capture

1. Introduction

Advances in hardware and software technology make it possible to obtain digital data of human motion by video and sensors. In addition, there are several studies that support acquisition of motor skills using the digital data (Hamagami, et al., 2012) (Kosaka, et al., 2011). The field of these studies is called motor-skill development. In this research field, a motion of a human is called "motor-skill". A motor-skill is a physical-activity, which humans can master with a specific education or a training.

The supporting environment of motor-skill requires significant functionalities of "Monitoring", "Analysis" and "Feedback" (Schmidt, 1975). “Monitoring” function provides conversion of a human-motion to data. “Analysis” function is to calculate the difference between the monitored data as a learner and the model data as an instructor. “Feedback” function reports the straightforward information denoted by the difference to the learner using natural language and graphics. In addition, Zimmerman (2008) reported a model of the timing when learners acquire motor-skill in self-learning.

Moreover, motor-skill can be classified according to some criteria. We can classify the supporting-model using the timing of intervention. Intervention by the system is carried out either asynchronously or synchronously. In asynchronous supporting-model, we monitor and record full action of motion from beginning to the end using video and sensors at first. Secondly, we calculate the characteristic difference between the monitored motion and the other one for comparison. Finally, we advise the learner in an appropriate manner due to the result. Such an asynchronous supporting-model has an advantage of low-cost in terms of the system device and the development. Regarding synchronous supporting-model, we also monitor and record motor-action of a target skill using video and sensors at real-time. Secondly, we calculate the difference in parallel to monitoring while the learner performs continuously. At last, we advise the learner during the ongoing performance of the motor-skill. The synchronous supporting-model has a contradistinctive advantage, which the learner can obtain the advice at real-time. Therefore, the learner can correct the behavior using the advice on real-time.

In recent years, the improvement in the throughput of a computer enables high-speed information processing. Therefore, “synchronous supporting” becomes possible. In this research, the authors discuss the system design for "synchronous supporting".
2. Requirements for Motor-skill Development

Fitts et al. (1967) say that the motor-skill development consists of three processes; i.e. cognitive, union, and automatic ones. In a cognitive layer, a learner of motor-skill understands the goal of the target motion and its strategy for the goal. Nextly, in a union layer, the learner practices repeatedly so that s/he can perform the coordinated movement smoothly. In the overtimes practice, the learner needs the feedback in order to proceed effectively. Finally, the learner may get to the automatic layer. In the automatic layer, the learner can perform the skill smoothly and perform without consciousness.

Schmidt (1991) supposes that human performs a skill based on a process. The process consists of “stimulus identification”, “response selection”, and “response program”. In the “stimulus identification”, human recognizes an environment human exists and trajectory of limbs. The trajectory means a trace of own motion. In the “response selection”, human decides internal models within a brain and a physical manner. In the “response program”, human makes a program to perform an action. The action is a body representation of an internal model.

In motor-skill development, a learner in a union layer of Fitts needs to recognize a gap between an ideal motion and a selected internal model. The authors assume that real-time feedback makes easy to recognize the gap. Since the learner performs the skill based on the strategy, the action of a learner in a moment should attain the strategy. In order to attain the strategy, the learner needs to grasp the difference between an ideal motion and a present motion. Moreover, the learner needs to grasp the influence of the present motion on the future. That is, our real-time feedback should include a future’s motion predicted from the present motion.

Gentile (1972) classifies motor-skill with common criteria. Therefore, we can apply the supporting method according to the classification. For example, a motor-skill is classified as Open-skill or Closed-skill. In the Closed-skill, a performer should perform fixed motion. Therefore, the learner of Closed-skill needs feedback after the end of motion. The feedback should represent a difference between a target motion and the performer’s motion. This feedback enables the performer to obtain routinized and fixed motion. In the Open-skill, a performer should determine the contents of motion along with what the motion changes with time and situations. Therefore the learner should obtain a capability to perceive a situation and obtain a capability to judge contents of motion. We assume that real-time feedback should be considered of the skill’s classification.

In order to show predicted motion, it is necessary to calculate subsequence of future’s motions using present motion data. There are some researches to predict time series data. For example, Autoregressive analysis (AR) and Moving average (MA) are fundamental methods as a prediction with time series data. However, there are few related works about prediction of multi-dimensional data for a human-motion. Moreover, if the authors create the differential equation about the motion using the physical model, it may be possible to predict the next motion by solving the present state analytically. Since it is necessary to create a differential equation for every skill, the authors cannot use general-purpose supporting system. Then, the authors collect a learner’s data and calculate the similarity of the stored data and input data. The authors predict future’s motion using data with the highest similarity. Moreover, the authors predict the performance result using similar motion's data. The authors think similar motion has similar performance result. Since AR, or MA and a differential equation predict only motion, these methods cannot predict performance result.

Predicting future’s motion is a motion recognition problem. In other words we classify current data into the past data. There are some researches about motion recognition. For example, many techniques, such as a Fourier transform, discriminant analysis, principal component analysis, and a support vector machine, are proposed. Moreover, Yamada, et al. (2013) recognize a motion by HMM. However, this method recognizes the motion from all sequential data. Therefore, we cannot recognize the motion using sub-sequence of motion data. It means that we cannot predict the future's motion while a performer conducts a motor-skill. Then, the authors calculate similarity about all data of posture and presume the present state. If the present state can be specified, the remainder of the motion is a future motion. A problem is that there is much computational complexity in order to calculate similarity with all data of posture. In this research, the authors create a key to a dataset, and reduce computational complexity.
3. Supporting Scenario

3.1 Preparations

In our proposal, some preparations are necessary before learning. Figure 1 expresses the outline of the preparation that a learner should do until the learning. It also shows the flow of the preparation of the system side. In step (1)(on left side), it is checked whether a skill is "Closed-skill" or not. Otherwise, a learner divides into sub-skill to make "Closed-Skill". In step (2), a learner collects the data of motion and the result of performance about a skill. In process (I)(on right side), our system saves the data of motion and the result of performance into the database. Step (1), (2), and process(I) show preparations. Step (3) and process (Ⅱ) shows practices receiving actual feedback.

![Figure 1. Flow of preparations](image)

3.2 Contents of real-time feedback

Figure 2 shows the outline of supporting. At first, in (a), the system gets a learner's data of posture. In (b), the system finds the similar data of the posture from a database. In (c), the system shows the predicted performance result to the learner as a feedback. By this feedback, the learner can update selected motion. Furthermore, the system shows the sequence of the posture that may happen to the next of the present posture as a feedback. By this feedback, the learner can recognize a gap of own action and past action. In (d), the learner updates own selection. The learner corrects own motion by repeating (a)~ (d).

![Figure 2. Flow of supporting system.](image)
4. Development of Supporting System

Our system obtains data of the posture using a motion capture. The motion capture is the optical type in our system, while there are optical type, mechanical type, magnetic type, and so on. By using motion capture, posture’s data of time-series can be obtained by the three-dimensional data of limbs. Since it is related to performance, the authors don't obtain the information about a tool using motion capture. When a performance is related to the locus of a motion, the authors may obtain the information of a tool using motion capture. Our supporting system predicts motion using accumulated data. Furthermore, a data structure that enables high-speed recognition is required. In our system, an input is multi-dimensional data describing the posture. Moreover, the similar data is required as an output. A simple algorithm that fills these inputs and outputs is to calculate similarity with all posture’s data in a database. The similarity between postures is sum of Euclid distance about three-dimensional coordinate in each limbs. Therefore computational complexity is 3 x (number of limbs) x (number of postures) x (number of forms in database). However, depending on the number of the stored data, it is not a realistic method. Then, by segmenting the data using the k-means algorithm, the authors make other data structure, which can search faster than the simple algorithm. Segmenting a motion with the posture, or its acceleration, the authors create the average posture. When our system has posture data as an input, our system calculate similarity with this average posture.

The authors use the k-means algorithm for segmentation. A k-means algorithm is a kind of non-hierarchical clustering. A given dataset is classified into k clusters using the average of a cluster(hereinafter centroid). The k-means clustering consists of following procedure.

1. A cluster’s label is assigned at random to each data.
2. The centroids are created using an arithmetic average.
3. Calculating a distance between a data and each centroid of the new cluster. A cluster that has minimum distance is assigned to the data.
4. Procedure 2~3 are repeated. In “procedure 3”, when no cluster updates, a loop becomes an end. Furthermore, the loop is an end when the criteria of updating are cleared.

The reason of using k-means algorithm is that a motion of motor-skill doesn’t have clear hierarchy.

The authors describe an algorithm applying a k-means algorithm to segment the motion. Firstly, if a target skill is continuous skill, the learner saves a motion of one cycle to the database. The next procedure is following.

i. A data is divided into k pieces at equal intervals in order of a time series, and a cluster’s label 0~(k-1) is assigned to each data. The reason why the first cluster is not random is for the data to change according to time series.
ii. The centroid is calculated for every data. The centroid is an arithmetic average of the coordinates of each limb.
iii. Our system calculates the similarity between the centroid and each data. Our system assigns the cluster’s label using the minimum Euclid distance.
iv. “Procedure ii~iii” is repeated until updating is lost.

Thus, the centroid is created with a cluster. The learner or the instructor using this system determines the number of clusters. For example, they measure the acceleration of the limbs and determine the number of clusters on the basis of the number of peaks. In addition, if the number of typical postures is decided, they use it. Moreover, the reason for using the Euclid distance, the authors think that it is easy for the learner to understand an absolute distance between parts.

The authors show a flow that the system searches for a similar data. The searching procedure is as follows.

A) The posture’s data is input into the system.
B) The system calculates the Euclid distance with each centroid that exists in the database.
C) The system determines the cluster with the shortest distance.

The computational complexity is 3 x (limbs) x (number of centroids) x (number of forms in database) by using the k-means method. Compared with a simple method, it has succeeded in reducing the computational complexity. Since the centroid has the index set, the our system feed back the posture data with the next index as predicted data.
Figure 3 illustrates the flow of creating the keys with proposal algorithm. "Raw data" shows three-dimensional data of a motion and it is the form of the batting of baseball. Since this motion has "establishing", "backswing", "beginning to shake", "impact", and "follow-through", these five states are set to the keys. "Clustering" in Figure 3 describes "procedure2" and "procedure3". "Procedure2" in Figure 3 describes calculating the similarity for all data and updating the cluster. In "procedure3", the new centroid is created based on the updating a data. "The keys of searching" expresses the centroids in searching. "indexing" shows assignment of cluster’s label to each posture’s data.

5. Evaluation Method

The authors conduct an experiment for verifying the prototype system. The authors propose the system that performs real-time feedback for closed skill. By using this system, recognition of the gap with "response selection" and "response program" becomes easy. This system makes efficiently for a learner to acquire a closed skill. The authors think that the learner using the system can acquire the motion much earlier compared with no supporting learner. Then, the authors create a control group and an experimental group. Next, a learner practices respectively. The authors measure an effect without supporting of the system after one practice. Figure 4 express a flow of an experiment. In "Pre-test", the learner performs the target motion without supporting of the system. The authors record the form to verify the effect of the support. In "First learning", the learner looks at animation of an ideal motion to know what is an ideal motion. In "First learning", the learner doesn't perform the skill actually. In "Learning with support", the learner practices with an actual movement. In an experimental group, the learner practices based on the proposed supporting system. In the control group, the learner practices without the supporting system. In "Post-test", the learner performs the target motion without the supporting system. The authors record these forms and calculate a difference between the forms in "Post-test", and the motion in "Pre-test".
6. Concluding Remarks

The authors propose the environment for motor-skill development based on the real-time feedback using sensing technology, such as motion capture. From the information on the present form, the system predicts the next form and performance. Furthermore, the system feed back a predicted result to a learner. The authors think the learner who is in a union layer acquires the skill earlier. About prediction, the system calculates the similarity with the past learner's data. Furthermore, the system outputs the performance result with the largest similarity of forms. As a technique on the computer, our system segments the motion data using k-means algorithm. The computational complexity is reduced by the clustering. In order to verify this support model, the authors should apply the concrete skill.

References

Content Management System to Support Improvement in Quality of Fitness Testing of Athletes

Yuji KOBAYASHI\textsuperscript{a*} & Naka GOTODA\textsuperscript{b}
\textsuperscript{a}Graduate School of Instructional Systems, Kumamoto University, Japan
\textsuperscript{b}Department of Sports Sciences, Japan Institute of Sports Sciences, Japan
*yuji-k@kumamoto-u.ac.jp

Abstract: Fitness testing is conducted to evaluate athletes’ physical fitness and provide scientific evidence and data that will help improve their performances. The validity and reliability of the data need to be guaranteed, and this depends on the proficiency of staff in charge of testing. However, there are several problems in staff training. In this study, we propose a content management system to support staff training improvement for quality assurance of athletes’ fitness testing.

Keywords: Quality assurance, fitness testing, elite sports, skill proficiency, CMS, blended learning

1. Introduction

The Japan Institute of Sports Sciences (JISS) conducts surveys and measurements for several factors of physical fitness that help determine sports performance. Furthermore, JISS (2014) provides knowledge and data to help athletes improve their performances by indicating their fitness strengths and weaknesses. Thus, test results are used to set appropriate individual training intensity. Moreover, test results can help implement athletes’ training programs efficiently and effectively. Whether a current training program is working well can also be confirmed from these test results, and the athlete’s progress can be monitored. Additionally, data on elite athletes and averaged data on many athletes can become criteria for talent identification and transition. Therefore, the validity and reliability of the testing should be guaranteed.

The Australian Institute of Sport (AIS, 2014) conducts a quality assurance program for fitness testing, called the National Sport Science Quality Assurance Program. Since JISS was established in 2001, it has also standardized fitness testing by creating a unified manual. However, in implementing its staff development program, JISS is faced with various problems and constraints.

In this study, we present an overview and the problems of the JISS staff development program. Furthermore, we propose a content management system (CMS) to support the staff training program and solve its problems.

2. Staff Training for Proficiency at JISS

2.1 Overview of staff training for proficiency at JISS

At JISS, staff proficiency training comprises workshops and seminars on fitness testing, self-learning and self-practice, and proficiency checking (Figure 1).

2.2 Workshops and seminars on fitness testing
At JISS, workshops and seminars on fitness testing are held for new staff, called “rookie staff,” during the second week of April. In these workshops, the rookie staff attend lectures on basic knowledge and cultivate an appropriate attitude for fitness testing of athletes. For acquisition of skills related to fitness testing, first, the rookie staff observe demonstrations and then practice fitness testing using the actual measurement equipment.

2.3 Self-directed learning and self-practice

After these workshops and seminars, the rookie staff manage their own training through self-learning and self-practice. For self-learning, they study the manual created by expert JISS staff. Based on testing procedures in the manual, they practice fitness testing on each other to develop proficiency. For each fitness test, they use a checklist to confirm their proficiency (Table 1).

2.4 Skill proficiency check-up

After the rookie staff complete self-learning and self-practice, a “skill proficiency check-up” is administered to confirm their skill and knowledge. This check-up is conducted under the same conditions as actual testing of athletes. Its flow contains preparation of the test, the actual testing of the athlete, feedback to the athlete, and finally, storing the equipment and materials. Throughout this flow, several evaluators judge the individual rookies’ skill levels using a check-sheet especially designed for the evaluation and also associated with the self-learning and self-training checklist. During and after the check-up, individuals are questioned about their knowledge. Evaluators perform comprehensive evaluation of whether each rookie’s knowledge and skill achieves the evaluation criteria.

The rookie staff receive their individual evaluation results, and those who are successful are then qualified to perform fitness testing of athletes. On the basis of feedback, unsuccessful staff study and practice to improve their skills and then re-take the check-up.

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**Figure 1. Flow of measurement training.**

**Workshops and seminars about fitness testing**
- Checking and acquiring basic knowledge
- Observing and experiencing fitness testing of athletes

**Self-learning and self-practice**
- Acquisition of knowledge of fitness testing
- Mastery and proficiency of testing skills using the manual and check sheets

**Skill proficiency check-up**
- Confirmation of understanding of fitness testing of athlete
- Confirmation of skill proficiency

---

**Figure 2. Biodex System 4.**

**Figure 3. Scene of Measurement.**
Table 1: Example of checklist (example of equipment: Biodex System 4).

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Evaluation point</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC start-up</td>
<td>Following the manual’s instructions</td>
</tr>
<tr>
<td>Database connection</td>
<td>Selecting the correct database</td>
</tr>
<tr>
<td>Subject registration and selection</td>
<td>Following the manual’s instructions</td>
</tr>
<tr>
<td></td>
<td>Registering using the correct method</td>
</tr>
<tr>
<td>Protocol selection</td>
<td>Selecting the correct protocol</td>
</tr>
<tr>
<td>Explanation prior to measurement</td>
<td>Explaining clearly and correctly</td>
</tr>
<tr>
<td>Seating subject on Biodex System 4</td>
<td>Confirming the subject’s physical condition (e.g., confirming the subject’s injury)</td>
</tr>
<tr>
<td></td>
<td>Following the manual’s instructions</td>
</tr>
<tr>
<td>Setting center of rotation</td>
<td>Confirming and setting correct center of rotation</td>
</tr>
<tr>
<td>Setting range of motion</td>
<td>Following the manual’s instructions</td>
</tr>
<tr>
<td></td>
<td>(e.g., determining the position of maximal extension)</td>
</tr>
<tr>
<td>Warm-up instructions</td>
<td>Implementing warm-up adequately and sufficiently</td>
</tr>
<tr>
<td>Explanation of measurement flow</td>
<td>Explaining clearly and correctly</td>
</tr>
<tr>
<td>Consideration of subject</td>
<td>Conversing with subject appropriately</td>
</tr>
<tr>
<td>Confirmation of measurement completion</td>
<td>Checking continues, and completing data collection</td>
</tr>
<tr>
<td></td>
<td>Creating a measurement report in accordance with the manual’s procedure</td>
</tr>
<tr>
<td>Explanation of measurement result</td>
<td>Explaining results based on correct knowledge.</td>
</tr>
<tr>
<td>Total time for the procedure</td>
<td>Completing testing within 30 min from measurement preparation to explanation of result (Measurement time, approximately 20 min)</td>
</tr>
</tbody>
</table>

3. Problems in Improving Testing Skill

This section provides a description, along with some specific examples, of the problems in self-learning and self-practice. First, Figure 1 displays the conceptual flow of self-learning and self-practice in some detail. For “Acquisition of knowledge of fitness testing,” if practice has been inadequate, rookie staff are likely to remember only the fragmentary procedure shown in Table 1. In other words, although the rookie staff memorize each procedure, they do not understand the subtleties of the “evaluation point” and the linkages between procedures.

Furthermore, because the manual and checklist are intended to summarize the procedure, not for all athletes but only for the “standard” athlete, rookie staff must learn to adjust when testing individual athletes. Therefore, when the correct value is not obtained from the actual measurement, the staff must review and readjust the measurement procedure, and then re-measure. Of course, only one correct measurement is desirable. However, it is crucial that staff recognize an inaccurate or inadequate measurement, diagnose what is wrong with the procedure, make adjustments, and conduct re-measurement.

For example, during the measurement of thigh muscles’ isokinetic strength with a dynamometer (Biodex System 4, New York, USA) (Figures 2 and 3), the graph of measured force is displayed as Figure 4. The peak value is adopted as an individual record. However, this device displays the waveform of measured force and records its peak value as correct data even if correct measurement is not conducted. In Figure 5, the athlete could not perform as strongly as compared with the athlete in Figure 4. In other words, the staff’s explanation and the athlete’s practice and/or warm-up are insufficient. Additionally, compared with the athlete’s leg shown in Figure 6, that shown in Figure 7 is not fixed firmly. This may result in impulses or noise being measured in the waveform of force even if the measurement process itself is correct, as in Figure 8. Therefore, it is important for the staff to recognize these waveforms and incorrect points.
For acquisition of the ability to diagnose ‘what is wrong’, the rookie staff should practice on the actual equipment. Nevertheless the time and equipment for practice are limited in the current training program. In fact, even the practice equipment is occasionally used for actual fitness testing, further limiting practice opportunities.

Figure 4. Example of correct waveform of force  
Figure 5. Example of wrong waveform of force

Figure 6. Leg fixed firmly  
Figure 7. Leg not fixed firmly

Figure 8. Example of wrong waveform including noise or impulse
4. CMS to Support Improvement of Testing Skill

4.1 Proposal of blended learning program and CMS to support the program

As explained, the current rookie staff training program depends on self-learning and self-practice. However, limited time and equipment availability cause some program inefficiency.

Thus, we suggest a blended learning program and CMS for self-learning, as depicted in Figure 9. CMS services can compensate for the lack of face-to-face instruction in the program. Because JISS is the domestic representative of athletes’ fitness testing, this model can be expected to create a ripple effect on various relevant organizations.

4.2 Online Video Textbook: Delivery of practical instructional video materials

Because the checklist was created from the evaluators’ standpoint, rookie staff have often faced difficulty in understanding its content. Furthermore, opportunities to observe demonstrations by skilled staff are limited.

Therefore, we propose to create video teaching materials that contain explanations and demonstrations by skilled staff, and to deliver it in the CMS. These materials will help rookie staff efficiently understand the subtleties of the “evaluation point” and the linkages between the fragmentary procedures. Moreover, even without equipment, opportunities for improved self-learning are provided. During their limited free time, rookie staff can learn fitness testing.

4.3 Online Test Sheet: Introduction of practice and test materials for preparation and review

As mentioned, practice time with the testing equipment is limited. Delivery of practice and test materials for preparation and review in CMS will support the currently limited learning opportunities with actual equipment and face-to-face instruction by skilled staff. The new preparation materials will help rookie staff learn the basic knowledge required for fitness testing in advance. Additionally, preparation materials will enable rookie staff to review the required skill proficiencies objectively.

4.4 Applied Q & A: Problematic case collection system

In actual fitness testing, responding flexibly to various athletes is essential. Therefore, accumulating experience of incidental failures and problematic cases is very important. Problematic cases, insolvable through use of the manual alone, should be collected for consideration of solutions and for practice problems.

Accordingly, we propose the introduction of a support system based on problem-based learning (PBL) in CMS. PBL with CMS for practical staff training in several domains, for instance, in nursing, (Majima, So, & Seta, 2006) has been proposed; however, in our domain, it has not been proposed. If skilled staff participate assertively in the collection activity, this system will help educate rookie staff and support skilled staff in charge of actual fitness testing.
4.5 Flow of Support Scenario with CMS

Supportive CMS services for effectively and efficiently promoting skill proficiency are not independent, but mutual. In fact, Figure 10 illustrates an example of support by the services shown in Figure 9. In correcting the test in Figure 8 of section 3, in many cases, rookie staff cannot understand that the problem involves fixing the leg firmly from the beginning, in addition to the evaluation points and procedures. Therefore, before recognizing the problem, but after watching the video of the first step as an initial learning strategy, rookie staff can confirm the key point at the second step.

After that, the next learning step shifts to PBL. Input by expert staff triggers reflective learning activities, such as re-watching and re-testing. Repeated self-learning can help rookie staff deeply understand the relationship between the evaluation point and the procedures. Thus, applied Q & A provides linkages with the online video textbook and online test sheet. Throughout the flow of testing, rookie staff can enhance their understanding of the evaluation point and linkage of procedures, as in Table 1, to solve current problems.
5. System Configuration

5.1 Overview of server and client system through web interface

Figure 11 illustrates the overall system configuration between a CMS server and the client PCs. The server provides HTTP Service by Apache. All staffs can utilize CMS on the web interface through a browser. Essentially, however, the server is accessible on a closed network via private LAN or Internet with VPN. This is because, presumably, limited client PCs, permitted to handle personal data, can only connect to the server. CMS is developed with an open source named WordPress as the fundamental environment. WordPress is a typical and widespread CMS used for blogging in social network services. Therefore, many people, including rookie staff, are familiar with the front-end GUI, with the exception of the system control GUI such as administrator pages. Moreover, official or other developers have released various plug-ins and provide an extension method with a programmable plug-in that has several PHP frameworks. The following proposal functions are implemented as the module.
5.2 Primary function for rookie staff

From the viewpoint of information literacy and for user-friendliness, all action by rookie staff would be within the front-end GUI. The almost internal architecture of CMS services without relational linkages between services is based on the original function of CMS, similar to a blog post. Both video play and test services are also constructed and customized by distributed common plug-in. On this basis, the function enables rookie staff to concentrate on self-learning and self-practice.

5.3 Primary function for expert staff

In contrast, expert staff at JISS generally have a sufficient level of literacy, but are extremely busy at work. Therefore, expert staff members have a limited amount of time to produce learning materials, and they mainly use an exclusive front-end GUI, similar to the administrator page from short-term efficiency for one-to-many rookie staffs. We will develop the GUI based on the extension module and an additional relational database of MySQL. Using the GUI, expert staff can add reference linkages as reflective learning materials, in addition to answering posted questions. Expert staff will have indirect roles as “learning navigators” during the rookie staff’s reflective stage in self-learning, as illustrated in the lower part of Figure 9.

Moreover, these linkages are built effectively with a short code framework. Once a certain rule of short code is preliminarily defined, expert staff can easily create a flexible reference linkage in a text form like WYSIWYG. Speaking more concretely, the staff can create a simple, logical program with a placeholder and a conditional placeholder with a short code framework. For example, an expert staff member can control an automatic display of recommended linkages that enable deep learning, along with the individual results of online test sheets.
6. Summary

By introducing CMS to support the staff training program for athletes’ fitness testing, rookie staff can be expected to learn quickly and improve their proficiency effectively and efficiently. Furthermore, a problematic case collection system, based on PBL, can be helpful to both rookie and expert staff. Finally, this system can expand to support the solution of problems occurring in actual fitness testing.

Acknowledgements

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References

Development of a Learning Environment for Novices' Erhu Playings

Fumitaka KIKUKAWA*, Masato SOGA** & Hirokazu TAKI

*Graduate school of Systems Engineering, Wakayama University, Japan
**Faculty of Systems Engineering, Wakayama University, Japan
*s145062@gmail.com
**soga@sys.wakayama-u.ac.jp

Abstract: In this paper, we describe the development of a learning environment for novices' erhu playings. In case of self-learning, the novices who want to learn playing bowed string instruments give up because they get into a wrong habit and don't understand how to play. Therefore, our goal is to develop a learning environment for novices. We focus on the erhu in bowed string instruments. The system we developed diagnoses finger positions and bow strokes by using magnetic position sensors and gives awareness of errors by showing finger positions and bow strokes on virtual 3D space. In case of bow strokes, the system shows how to improve bow strokes by using arrows. Moreover, the system shows how and where the errors occur on score. Accordingly, the novices can recognize and improve their errors by using this system. In future works, we will conduct evaluation experiments to disclose learning effects by using this system.

Keywords: Bowed string instruments, skill, learning environment, learning support, electro-magnetic field sensing device

1. Introduction

In this paper, we describe the development of a learning environment for novices' erhu playings. Because of the following backgrounds, we aimed to develop a learning environment for playing instruments.

Usually, to learn skills for playing instruments is achieved by means of taking a lesson, practicing by self-learning, referring to a study-aid book, and so on. In case of self-learning, the novices give up learning playing instruments because they get into a wrong habit, don't understand how to play instruments and don't make progress. Recently, there are many studies about analyses of skills and learning environments because of progress of sensors and computers performances. In case of the piano, there is an analysis of finger movements of a pianist (Rahman et al., 2010). Moreover, there is a learning environment regarding the piano (Takegawa et al., 2012). In case of the guitar, there are visual methods for the retrieval of the guitarist fingering as well (Burns et al., 2006). Furthermore, there is a learning environment of guitarist fingering (Tobise et al., 2013). In case of the drums, there is a motion analysis for emotional performance of snare drums as well (Miura et al., 2012). In addition, there is a learning environment of playing the drums (Iwami et al., 2007).

Particularly, the bowed string instruments (e.g. the violin, the cello, and the erhu) have many parameters to be adjusted. The parameters are the finger positions, the pressures by pressing strings, the gesture, the speed, the acceleration, and the angle of bow strokes. Accordingly, it is difficult for the novices to play with accurate pitches. Therefore, if we develop a learning environment for playing the bowed string instruments, these problems will be solved. As related works, there are many studies about analysis of playing the violin. Rasamimanana et al. (2005) analyzed the gesture of bow strokes by using augmented violin bow. Moreover, they analyzed bow and arm movements and bow pressure on strings by using 3D optical motion capture system and a custom pressure sensor (Rasamimanana et al., 2007). Furthermore, Carrillo (2013) characterized bow strokes by using audio and a motion capture system. In addition, Maestre et al. (2007) analyzed bow strokes by using electro-magnetic field sensing device. On the other hand, there are studies about learning environment of playing the violin. Wang et al. (2012) developed a real-time pitch training system for violin learners. However,
this system does not diagnose learner's gesture parameters and pressure parameters, but diagnoses only sound pitches. Therefore, the novices cannot identify the cause of pitch errors. Thus, we aimed to develop learning environment for novices to understand why pitch errors were caused. Moreover, Ng (2009) developed 3D motion analysis and visualization system. This system visualize only bow strokes. Therefore, we aimed to develop learning environment for novices to understand bow strokes and finger position improvement simultaneously.

Although there are many studies about musical skills, there is no study about the erhu except for our studies. As our previous works, we describe following three studies. We have aimed to develop a learning environment for playing the bowed string instruments and have developed learning environment. Firstly, we have analyzed novices' parameters during playing a bowed string instrument (Soga et al., 2010). Specifically, we analyzed the erhu playing parameters by novices. As the results of the analyses, novices need supports of finger positions, bow motions, bow speeds, bow accelerations, and bow angles. The sounds depend on these parameters. A novice doesn't understand the reasons why the sounds aren't accurate because there are many parameters to be adjusted. Therefore, a novice needs a learning support environment for controlling each parameter. Secondly, we tried to assist novices' finger positions. We developed a learning environment regarding finger position on strings (Kikukawa et al., 2013). By conducting evaluation experiment, we found the system is useful for a novice to learn finger position on strings. Thirdly, we tried to assist novices' controls of bow strokes. We developed a gesture learning environment for novices' erhu bow strokes (Kikukawa et al., 2014). In this paper, we describe integration of previous two systems and improvement of the systems. By integrating previous two systems, the new system visualizes improvements of finger positions and bow strokes simultaneously and gives the novice learner feedback of diagnosed results of finger positions and bow strokes simultaneously for novices' understanding.

2. Instruments Choice

2.1 The Erhu

We have chosen the erhu in bowed string instruments. Figure 1 shows an erhu. There is a reason that we have chosen the erhu in bowed string instruments. It is a two-stringed instrument. Because of this feature, a learner only needs to judge which string s/he touches in those two strings with a bow. In case of the violin, a learner needs to judge which string s/he touches in four strings with a bow. Therefore, his/her hand and finger motions are very complicated when s/he learns the violin. It is comparatively easy for novices to learn how to play the erhu. Moreover, the erhu has the parameters that other bowed string instruments have (e.g. the finger positions, the gestures of bow strokes, the speed of bow strokes, the acceleration of bow strokes, the angle of bow strokes, and so on) in spite of only two strings. Therefore, to develop learning environment of playing the erhu is comparatively easy and can apply to other bowed string instruments.

![Figure 1. The erhu.](image)
2.2 How to Play

Figure 2 shows how to play the erhu. How to play the erhu is as follows. Left fingers press strings with pitches as Figure 2(a). Then, it needs to press accurate finger positions. A pitch error reflects a finger position error directly because the erhu has no border between pitches. On the other hand, right hand holds a bow from underneath as Figure 2(b). Then, right index finger is attached to the wood part and right middle finger and ring finger control hair tension of the bow. A learner plays sounds by moving the bow between right and left, by the frictions between the bow and the strings. Loudness and expression of sounds depend on pressures between the bow and the strings, moving speed of the bow, and how to move the bow.

![Figure 2. How to play the erhu.](image)

2.3 Bad Example of Erhu Bow Strokes

Figure 3 shows bad examples of erhu bow strokes. The bow strokes should not leave the resonator body as Figure 3(a). Moreover, the gesture of erhu bow strokes should be parallel to the ground and parallel to the surface of the body. Therefore, Figure 3(b) and Figure 3(c) are bad examples. Based on the above, we aim to develop the system that makes the novice learner being aware of these bad examples and learning accurate gesture of erhu bow strokes.

![Figure 3. Bad examples of erhu bow strokes.](image)

3. System Design

3.1 Electro-magnetic Field Sensing Device LIBERTY

LIBERTY is an electro-magnetic field sensing device developed by Polhemus Inc. A transmitter and up to 16 receivers are connected to a main unit for use. Figure 4(a) shows LIBERTY. Figure 4(b) shows transmitter of LIBERTY. Figure 4(c) shows receivers of LIBERTY. A transmitter generates electro-magnetic fields which have three directions by passing an electric current in turn through coils around three axes. Receivers also have coils around three axes. When the transmitter generates an electro-magnetic field, induced electric currents are generated on the coils in the receiver. Then, position and orientation of the receiver are calculated by this amperage. These measured data are transmitted to a connected PC with ASCII or binary data format. LIBERTY is connected with PC through USB ports or serial ports. The accuracies are 0.03 inch RMS for X, Y or Z position and 0.15 degrees RMS for sensor orientation. The reason why we choose LIBERTY as a motion tracking sensor is that we need to use real-time accurate 3D tracking data for real-time visualization and real-time diagnosis of finer positions and bow strokes.

![Image of LIBERTY](image)
3.2 System Composition

Figure 5 shows system composition. The system consists of a PC, an electro-magnetic field sensing device LIBERTY and an erhu. The erhu is equipped with a transmitter and receivers of LIBERTY. Figure 6(a) shows the erhu equipped with a transmitter and receivers of LIBERTY. Figure 6(b) shows left hand equipped with receivers. We equipped the erhu with a transmitter and receivers for measuring gesture of erhu bow strokes as Figure 6(a). Moreover, we equipped learner’s index finger, middle finger, and ring finger of left hand with receivers for measuring learner's finger position on string as Figure 6(b). The system diagnoses learner’s gesture of erhu bow strokes and finger positions by using data measured by the receivers. The learner learns playing skills about bow strokes and finger positions by using this information.

3.3 Visualization Window

Figure 7 shows visualization window. It shows bow strokes and finger positions with virtual erhu model in the virtual 3D space. These bow strokes and finger positions represent learner’s bow strokes and finger positions measured by electro-magnetic field sensing device on real-time. The learner's playing is diagnosed by the system. Viewpoint in the virtual 3D space is changeable freely. The default viewpoint is matched with the real learner's viewpoint while playing the erhu.

The results of diagnosis about bow strokes are represented as follows. During accurate bow strokes, they are colored green as Figure 7. Figure 9 shows visualization window while playing bad examples. If bow strokes leave the resonator body (over 0.5 inch), they are colored black as Figure 9(a). If bow strokes are not parallel to the ground (over 10 degrees), they are colored red or blue as Figure 9(b) and Figure 9(c). If bow strokes are not parallel to the surface of the body (over 10 degrees), they are colored pink or orange as Figure 9(d) and Figure 9(e). Viewpoint in the virtual 3D space is changeable freely. Each feedback shows 3D arrows for indicating how to improve bow strokes. The learner can recognize bow strokes errors by watching visualization window.

The window shows totally six colored small spheres on the virtual erhu model's strings as Figure 7. Three spheres of them represent learner's left finger positions. The positions of index finger, middle finger, and ring finger are colored light red, light green, and light blue, respectively. The other three spheres represent correct finger positions. The correct positions of index finger, middle finger, and ring finger are colored red, green, and blue, respectively. The correct positions can be switched to
display/non-display. If the learner's finger position is accurate, the light red sphere, the light green sphere, and the light blue sphere change the sky blue sphere. The learner can recognize finger positions errors by watching visualization window.

Figure 7. Visualization window. Figure 8. Score window.

3.4 Score Window

Figure 8 shows score window. It shows score of the music, current diagnosing point on the score, and results of diagnosing. The current diagnosing point is shown by a black vertical line, and it moves along the score. A learner must play the erhu by synchronizing the current playing note with the current note on the black line. The results of diagnosis are indicated under the notes. 'L' in Figure 8 is results of diagnosis left finger positions. The red triangles represent that learner's finger position is upper than correct finger position. The blue triangles represent that learner's finger position is lower than correct finger position. The number of red/blue triangle represents the size of difference between learner's finger position and correct finger position. The green squares represent that learner's finger position is accurate. Moreover, 'R' in Figure 8 is results of diagnosis right hand bow strokes. The green squares represent that learner's bow stroke is accurate. The other colored figures that correspond
to the representation of bow strokes in visualization window. The learner can recognize where s/he made errors of bow strokes and finger positions and how to improve his/her errors.

4. Conclusion and Future Works

In this paper, we designed and developed a learning environment for novices' erhu playings. The system diagnoses bow strokes and finger positions by using electro-magnetic field sensing device LIBERTY. The system has two windows, visualization window for visualization of bow strokes and finger positions on real-time, score window for showing the results of diagnosing bow strokes and finger positions along score. The novices can recognize and improve bow strokes and finger positions errors by using these functions. Therefore, we have achieved the aim.

In the future, we will conduct quantitative evaluation experiments for verifying learning effect during using the system by the data of electro-magnetic field sensing device.

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References


Analysis and Feedback of Baseball Pitching Form with use of Kinect

Yasuhisa TAMURA a*, Taro MARUYAMA a & Takeshi SHIMA b

a Department of Information and Communication Sciences, Sophia University, Japan
b Department of Health and Physical Education, Sophia University, Japan
*ytamura@sophia.ac.jp

Abstract: This paper introduces an automatic analysis and feedback system for amateur baseball pitching learners with use of Microsoft Kinect. Compared with conventional 3-D motion capture systems, Kinect has advantages of reasonable cost and easiness of application system development for physical exercises. The authors developed a similar system for flying disc throw, which is disclosed in Tamura, Yamaoka et al. (2013) and Tamura, Uehara et al. (2013). In this paper a target motion is moved to baseball pitching, so focused body parts and judgment criteria were changed, although utilizing the same Kinect platform. The proposing system acquires postures and motions of amateur baseball pitchers, and judges them in 2 criteria: (1) maximum angle of elbow, and (2) hand twist, which were decided by a training expert. It also displays feedback messages to improve their motions. As a result, novice testees of the target group showed significant improvement of their pitching motions.

Keywords: Baseball, pitching movement, Kinect, analysis, feedback

1. Introduction

In a field of sports science research, motion analysis of human body has become popular in the last decade. Barris and Button (2008) surveyed vision-based motion analysis researches for sports. Moeslund et al. (2006) surveyed vision-based human motion capture / analysis systems. Miles et al. (2012) surveyed applications of Virtual Reality environments for ball sports. There are wide variety of equipments adopted in these researches: GPS sensor, acceleration sensor, muscle sensor, HMD (Head Mound Display) etc. Among them, the major equipments are so called “motion capture systems”, that measure many points of human body in three-dimensional space in real time manner. However, the major commercial motion capture systems are extremely expensive, costing several hundreds of thousand dollars. Additionally, they require a dedicated equipped room, multiple cameras, special lighting facility and dedicated “tracking suits” to specify a tracking points of human body. Furthermore, myriad steps are necessary to set up and acquire data including the activity called “calibration”, which adjusts the 3-D points of marking sensors on the tracking suit. As a result, this kind of analysis is infrequently performed other than specialized researches or specific studies of limited top athletes.

Among them, Microsoft Corporation released a device called Kinect in 2010. It provides a simple and inexpensive way to perform 3-D analysis of a human body movement. First, the device itself costs only U.S.$110, which is far cheaper than conventional motion capture systems. Second, Kinect is capable of capturing data easily. It does not need any tracking suits, complex set-up, and troublesome operation procedure for data acquisition. Third, Microsoft has publicly released a software development kit (SDK) that includes necessary software libraries for data acquisition using Kinect. Application system developers are able to write customized Windows applications with use of this library in the C# or C++ languages. The proposed research in this paper has 3 major points below:

(1) Utilizes Kinect
(2) Captures 3-D motion and give feedback to sports learners
(3) Target motion: baseball pitching

There are many preceding researches to analyze human body motion with use of motion capture systems including Kinect. Also, there are some researches to give automatic feedback
messages to learners to refine their motion. The authors arranged these researches as shown in Table 1 in general.

Table 1: Preceding Researches

<table>
<thead>
<tr>
<th></th>
<th>Analysis</th>
<th>Feedback</th>
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<tbody>
<tr>
<td>Commercial/Orginal</td>
<td>Bideau et al. (2004)</td>
<td>Ishii et al. (2011)</td>
</tr>
<tr>
<td>3D Motion CaptureSystem</td>
<td>Brodie et al. (2008)</td>
<td>Kwon and Gross (2005)</td>
</tr>
<tr>
<td></td>
<td>Corazza et al. (2006)</td>
<td>Soga and Myojin (2008)</td>
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<td></td>
<td>Hachimura et al. (2004)</td>
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<td></td>
<td>Hsu (2011)</td>
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<td></td>
<td>Kato et al. (2012)</td>
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<td>Marquardt et al. (2012)</td>
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<td>Mitchell and Clarke (2011)</td>
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<td></td>
<td>Ogawa and Kambayashi (2012)</td>
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</table>

Papers at upper left side in Table 1 utilize commercial or original 3D motion capture systems to analyze 3-D motion. Bideau et al. (2004) utilized Vicon 370 system to analyze relationship of movement between throwers and a goalkeeper of handball. Brodie et al. (2008) synthesized a body model of a ski racer from GPS information and video motion graphics. Corazza et al. (2006) synthesized a body model with use of 8 motion cameras and replays it in a virtual environment. Hachimura et al. (2004) developed a dance training support system with use of magnetic sensor system Fastrak and HMD.

At upper right side, there are researches to give feedback messages to learners, based on 3-D captured data. Ishii et al. (2011) utilized a motion capture system IGS-190 for baseball batting movement. It also provided a comparing function between “goal motion” and learner’s one. Based on the comparison, the system showed messages to refine learner’s motion. Kwon and Gross (2005) developed an original motion capture system for Taekwondo training. It also displayed a visual feedback to adjust one’s movement. Soga and Myojin (2008) proposed a training support system for rhythmic gymnastics. It adopted an optical motion capture system, compared the captured data and ideal motion data, and displayed feedback messages in the screen.

At lower left side in Table 1, there are researches to analyze human motion with use of Kinect. Fujimoto et al. (2012) developed a dance training support system. It showed learner’s image and instructor’s ideal motion image in overlaying manner. Hsu (2011) discussed many possibilities of Kinect utilization in various sports learning activities. Kato et al. (2012) developed a system to compare a professional player and a novice learner of soccer. Marquardt et al. (2012) diagnosed a pose of ballet dancer with use of Kinect. It is called “Super Mirror”, because common ballet studios use a mirror to check and adjust one’s pose. Mitchell and Clarke (2011) developed a Kinect based system to diagnose hand movement for playground game. Ogawa and Kambayashi (2012) developed a distance learning system. An instructor and a learner share a common virtual space, and compare their body motions.

Finally, at the lower right side, there is one preceding research similar to the proposing method. Chye and Nakajima (2012) utilized Kinect to diagnose Karate pose. He compared 4 joint points of an instructor and a learner, calculates their Euclid distances, and gives feedback messages to the learner.

As mentioned above, this research focuses on the motion of baseball pitching. According to this topic, there are some related researches. Lin et al. (2003) used Qualisys motion analysis system by Qualisys AB. The goal is to analyze the movement and velocity of “center of mass” in the pitching cycle. They found different moving speeds in different pitching phases (lowest position and late cocking). Theobalt et al. (2004) used a proprietary, multiple video camera-based motion capturing system. Aguinaldo et al. (2007) used Real-Time Motion Capture System by Motion Analysis Corp (120 fps). They set 18 marker points for upper body, in order to analyze peak shoulder internal rotation torque. 38 pitchers are categorized into 4 groups (Pro, College, High School, Youth). The
Professional group showed a significant result of rotation timing. Lapinski et al. (2009) developed a proprietary wearable sensing device with use of Analog Devices iMEMS ADSXR300 and ADXL210E, that also provide a wireless communication function. For reference, they utilized a motion analysis system from XOS Technologies with 10 motion analysis cameras. They analyzed acceleration and G-Force of pitchers’ body points (hand, waist, forearm, chest and waist) and compared the results between their original system and optical motion analysis system. Ukita et al. (2014) developed a Kinect-based automatic rehabilitation system, and applied its motion as a baseball pitching in left tow and right hand velocity.

In above papers, most of them are utilizing commercial or dedicated motion capture systems. Only Ukita et al. (2014) utilized Kinect, but its focus is rehabilitation. In this sense, there is no preceding research to focus on baseball pitching training with use of Kinect device.

2. Proposed System

This paper proposes a system that will process data in three steps:
(a) acquisition of 2-D video images and 3-D position data for body points with use of Kinect,
(b) assessment of whether the baseball pitching movement is adequate or not, based on the position data acquired in (a), and
(c) display of feedback messages with 2-D motion image from (a) based on the results of the assessment in (b).

Details of these processes are given below.

2.1 Kinect and its Data Acquisition

Kinect is a device with a function to analyze the motion of human subjects in real time and 3-D manners. It was initially developed as a peripheral device to be connected to Microsoft’s Xbox gaming system. Kinect includes a CMOS camera, infrared projector, image depth sensor, microphone, and one USB port for connection to a Windows PC. Kinect projects patterned infrared rays that are analyzed by CMOS camera to recognize the distance between the target player and the device. Also, with use of a machine learning function called “human pose estimation” developed by Microsoft Research Cambridge, Kinect is able to recognize 20 positions of target human joints and body parts with reasonable accuracy. 3-D coordinates of these positions are transferred to a connected Windows PC in 30 fps (frames per second) through the libraries included in the device’s SDK.

2.2 Judgment of Pitching Form

This paper focuses on the assessment of baseball pitching movement. However, target skill levels of learners are totally diverse in beginner and professional learners. This study focused on absolute beginners and made assessments by comparing whether their pitching motions match a basic and standard one. The authors set two hypothetical criteria of the pitching motion: (a) maximum angle of elbow, and (b) hand twist. One of the authors (Shima) analyzed these aspects and tendencies during his coaching in college classes. They are shown in Figure 1.

The aspect (a) judges whether the right elbow (for a right-hand pitcher) is raised in enough height of not. An amateur pitcher tends not to raise his right elbow enough. In order to judge this point, the authors calculated the angle of hip center (#0) – shoulder center (#2) – right elbow (position #9) as \( \theta_1 \). These numbers of 0, 2 and 9 are specified in Kinect SDK to identify 20 human joints and body parts. Kinect is able to measure the absolute height of elbow position, but stature varies on individual. Then in this paper, this angle of \( \theta_1 \) was decided as a criterion. This \( \theta_1 \) is judged as below.

Points shown in parenthesis are used to evaluate performance at the time of experiment shown in Chapter 3.
- 125 <= \( \theta_1 \): too much (35 points)
- 115 <= \( \theta_1 \) < 125: a little much (40 points)
- 105 <= \( \theta_1 \) < 115: good (50 points)
- 90 <= \( \theta_1 \) < 105: a little few (40 points)
The aspect (b) is twist of the right hand (for a right-hand pitcher). In order to throw a fast ball, right elbow should go forward rather than his body. In other words, his elbow should be twisted, not straight. In order to measure it, the authors focus on the angle of pitching target – right elbow (#9) – right hand (#10) as $\theta_2$. In this paper, this angle of $\theta_2$ is judged as:

- $\theta_2 < 90$: too few (10 points)
- $110 \leq \theta_2 < 110$: good (50 points)
- $100 \leq \theta_2 < 110$: moderate (40 points)
- $\theta_2 < 100$: not enough (30 points)

In the previous studies (Tamura, Yamaoka et al. (2013) and Tamura, Uehara et al. (2013)), the target motion was flying disc throw. In this case, the main focus was height of right hand (#10). If this height changes widely, he is difficult to throw the disc to the intended target. However, in the baseball pitching, the main issues are the maximum angle of elbow and hand twist, as shown in Figure 1. This difference can be implemented after the judgment criteria is identified and quantified, but the criteria itself should be determined in discussion with a professional sports trainer.

As introduced in Chapter 1, there are some preceding researches to analyze baseball pitching forms. These researches focus on mainly speed, torque, acceleration and G-force of body points. However, they have little insights why and how the speed etc. come from. In other words, They do not show a “good” pitching form. In this paper, the authors set a hypothesis of a “good” form, and show judgment criteria as stated above.

2.3 Visual Feedback

In order to provide visual feedback to pitching learners, the authors also developed a visual feedback interface. It contains a real time 2-D video of pitching action and both quantitative numbers and qualitative feedback sentences of form judgment result described in section 2.2. Figure 2 shows a snapshot of the developed visual feedback interface. The proposing system is reset when a target person raises his left hand and then starts the analysis.

3. Experiment

In order to verify the effectiveness of the proposing system described above, the authors performed an experiment. The authors collected 40 testees in Sophia University. Some of them belong to athletic clubs in the college, but none of them have been trained as a baseball pitcher.
First, as a pre-test, all of the 40 testees were examined the precision of pitching forms 5 times. After that, the testees were divided into two groups of a target group (TG) of 20 and a control group (CG) of 20, whereas pitching performances of the two groups are to be statistically non significant. Next, as a test, the TG members were given feedback in 15 times of pitching movements with use of the proposing system. On the other hand, the CG members had no feedback from the proposing system in same 15 times of pitching. Last, as a post test, all members including TG and CG were assessed their pitching forms with use of the proposing system, without any feedback.

![Figure 2. Screen Shot of the Proposing System](image)

The authors compared the result of the post test, focusing on improvement of their performance. The result of t-test among all TG and CG testees, p value was p=0.227, which showed there was no significance between TG and CG in performance improvement. Then, in order to perform more detailed analysis, total testees were divided into six groups according to TG and CG, and also their performance groups; upper, intermediate, and lower. When TG and CG are compared in the same groups, p values were: Upper group: p=0.515, Intermediate group: p=0.706, and Lower group: p=0.061.

This result shows that the p value of lower groups shows a tendency of significance, while upper and intermediate groups are not significant totally. This phenomenon is similar to the experiment performed previously in Tamura, Yamaoka et al. (2013) and Tamura, Uehara et al. (2013).

4. Discussion & Conclusion

The result of experiment in Chapter 3 shows a tendency of significance only for relatively lower-graded learners. A possible reason of this point is that judgment points and their evaluations hypothesized in Section 2.2 fit exercises for novice learners of baseball pitching. In other words, there should be some other judgment points and evaluations for upper than intermediate learners. This point is thought as one of the future issues.

As a conclusion, this paper has presented a system with use of Kinect device for analysis of and feedback on the motion of baseball pitching. A result of experiment shows that this method is thought to be useful for relatively novice learners to improve their movement. Future research issues contain a work to refine the current system vis-à-vis the points noted in Chapter 3, and retry to validate the efficiency of the proposing system with improved methods and sequence.

Acknowledgements

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The Integration of Augmented Reality Mobile Learning and Self-Regulated Learning by using Concept Mapping - A Case Study of the Plants in Campus

Po-Han WU\textsuperscript{a*}, Gwo-Haur HWANG\textsuperscript{b}, Yu-Syuan WANG\textsuperscript{a} & Yen-Ru SHI\textsuperscript{c}

\textsuperscript{a} Department of Mathematics and Information Education, National Taipei University of Education, Taiwan
\textsuperscript{b} Department of Information Networking and System Administration, Ling Tung University, Taiwan
\textsuperscript{c} Department of Information and Learning Technology, National University of Tainan, Taiwan
\*cincowu@gmail.com

Abstract: With the rapid development of mobile devices, ubiquitous learning becomes the new trend of digital learning. In recent years, many scholars found that learning through augmented reality methods can improve students’ interest and motivation. Therefore, in this study, an integration system of augmented reality mobile learning and self-regulated learning by using concept mapping is proposed for conducting learning activities. Students can observe the plants in campus and draw the concept maps by augmented reality technology and self-regulated learning strategy. According to the drawn concept maps and the learning contents from real situations, the system can provide students the guidance and feedback to help their thinking. Students can set their learning goals and adjust their learning progress according to the nature of the learning tasks via self-regulated strategies. The experimental results were expected that the proposed approach is able to improve the students’ the cognition of the plants for students in campus and raise students’ learning motivation and effectiveness.

Keywords: Augmented reality, mobile navigation, self-regulated learning, concept mapping, campus plant

1. Introduction

In traditional teaching environment, it is difficult to express the abstract concept of knowledge. Thus, with the improvement of information technologies, many scholars tried to import some multimedia technologies into courses in the past. And some scholars found out that the multimedia learning systems can improve students’ learning motivation and effectiveness (Govaere Jan, de Kruif, & Valcke, 2012; Uluyol & Agca, 2012). But students think that multimedia learning systems are not in real environments. Because of the difference between virtual environments and real environments, students cannot associate learning contents with everyday life. (Barfield, Sheridan, Zeltzer, & Slater, 1995; Eysenck & Keane, 2005). However, augmented reality (AR) is a technology combined with virtual and reality images (Azuma, 1997). Thus, students can directly scan learning objects in real environments and get the relational teaching contents immediately. In the past, many scholars applied AR technologies in classes. For example, Martin-Gutiérrez et al. (2010) used AR technologies in learning the spatial integration ability in geography, history, arts and humanities. The results of their study showed that AR technologies can raise the attraction of students and have the easy manipulation characteristics, and it can improve their space ability. Wernhauer and Ou (2012) developed a smartphone butterfly ecological system in virtual environments by AR technologies. The results of their study showed that AR technologies for learning can improve students’ learning effectiveness. Hwang et al. (2013) developed a multi-language learning system by AR technologies. This system can appeared correspondence learning contents when students scan the objects in real environments. In addition, it can also provide multi-language spelling and voice teaching by the objects. The purpose of this system is to let students study languages. At the same time, it can also let students practice pronunciation.
In traditional teaching environments, teachers faced too many students and cannot consider the individual learning situation for students. Thus, the learning effectiveness is not very good (Hwang, Tsai, & Yang, 2008; Wu, Hwang, Milrad, Ke, & Huang, 2012). In the past, some scholars indicated that students can use mobile electronic devices in real situations. For students, those methods cannot only solve the problems in one-to-many teaching environment (Wu, Hwang, Su, & Huang, 2012), but also can let students study according to their own learning pace. For teachers, they can act the leader roles and understand the students’ learning situations from the systems.

Bandura (1986) indicated that self-regulated learning is defined as “personalization means perception, motivated willingness, and active behaviors in the learning process”. And self-regulated learning is built learning goal by students. The process of setting goal contains self-monitoring, standard setting, evaluative judgment, self-appraisal, and affective self-reaction (Schunk, 2001). In real environments, learning activities are very complex and difficult. If teachers use unsuitable teaching tools, they need to take attention to individual students and provide guidance and assistance, and it is a difficult thing. In the past, many researches showed that concept mapping was thought an effective learning strategy, and it is a visual method. Concept mapping expresses the cognitive structure between “Concept” and “Relationship”. The purpose is to let students understand learning contents (Hwang, Panjaburee, Triampo, & Shih, 2013; Panjaburee, Triampo, Hwang, Chuedoung, & Triampo, 2013).

Therefore, in this study, we developed an integration of augmented reality mobile learning and self-regulated learning by using concept mapping. This system is different from traditional paper textbooks and traditional media materials, which appeared text or images only. Thus, this system use augmented reality methods to improve students’ learning willing. At the same time, it uses self-regulated methods to complete students’ goals. And it uses the concept mapping method, so that students may conduct reflection to finish their learning goals.

2. Development of System

2.1 System Architecture

The system architecture (includes three learning modules) which is composed of self-regulated learning, AR learning navigation, and concept mapping (see Figure 1). The self-regulated learning module function includes setting the observed goals and getting the learning feedback. When students use the AR learning navigation, they can collect data such as photos, videos and audio, so that more supplementary materials can display on the screen. The concept mapping module provides a way to improve the learning effectiveness of students. It allows students to create their own concept maps and gives them a rank with appropriate materials. The system is built by HTML5 and converted into the mobile platform through Phone Gap. All of the learning data is stored in the machine in JSON format, and upload to the server when the internet is connected.

2.2 Interfaces for Users

![Figure 1. The system architecture.](image-url)
At first, students may login the homepage of the system by usernames and passwords. In self-regulated mode, this system provided learning goal contents for students. Students can use the dropdown menu to select their learning objects, and the system will provide the learning contents according to their learning goals. Then students can select their learning goals for the learning object. Students also can choose the confirm button to learning, as shown in Figure 2. After setting goal, the system will appear the main screen. The main screen contains four bottoms: data collection, concept mapping, operating instructions and log out, as shown in Figure 3. The four buttons are described in detail as follows.

In the AR learning navigation module, students click data collection button that they enter data collection interface according to system tasks guidance. In the AR learning navigation module, students can click data collection button, so that they can enter the data collection interface and record the data by photo, video, or audio format. According to their collection, they also can record the names, the found locations and the number of the found plants, as shown in Figure 4. In the concept mapping module, students can draw relationships by using image methods according to the learned content. In the concept mapping module, there exists a learning diagnostic mechanism. In the learning diagnostic mechanism, when students click the edit-finished button, the system will evaluate the concept maps draw by students and produce summary reports, as shown in Figure 5. The completion rates of learning goal and self-learning goal will appear in the summary report. The concept maps drawn by students will appear at the bottom of the summary report, as shown in Figure 6. When an error happened in the concept map drawn by a student, an error-list button will appear at the bottom of the summary report. In the error list, the system will provide some information for the concept map drawn by a student and correct his/her misconception. According to the unfinished learning tasks, students can adjust the goal to learning, as shown in Figure 7. In addition, when a student clicks the operating-instructions button, the system can appear operating instructions interface, as shown in Figure 8. The system can provide guide and learning-goal materials for students, and they can learn the materials via the AR technologies, as shown in Figure 9.
3. Conclusion and Future Works

3.1 Conclusion

In this study, an integration system of augmented reality mobile learning and self-regulated learning by using concept mapping is developed. Students can use AR technologies to learn in a real environment. At the same time, students can also learn according to their own learning pace. And students can understand the learning contents and the cognitive structure between the concept and the relationship through concept mapping strategies. In the other hand, the system provides the guide and the learning diagnostic mechanisms, which can correct the misconceptions of students and provide the feedback to students. The experimental results were expected that the proposed approach is able to improve students' learning motivation and effectiveness.

3.2 Future Works

In future works, we will continue the experiment of this study. We will conduct teaching experiment at a certain school in the Northern region of Taiwan. The participants are about 60 students in two classes. One class is the experimental group, which is using our system. The other class is the control group, which is using AR mobile navigation learning strategy only. All students will conduct pretest, posttest and questionnaire, which contain learning effectiveness, learning motivation, learning attitude, learning satisfaction and cognitive load. After the experiment, we will analyze whether the learning motivation and the effectiveness between the experimental group and the control group exist significant difference. In addition, we will analyze the log data of students to find what behavior may influence students' learning effectiveness, as shown in Figure 10.
Course teaching in campus plant

Pretest

Experimental group (N=30)  Control group (N=30)

Operation teaching of mobile carrier and Learning task description

The integration of augmented reality mobile learning and self-regulated learning by using concept mapping

Augmented reality mobile navigation learning strategies

Posttest and Questionnaire

Figure 10. The flowchart of the experiment.

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References


Application of Teams-Games-Tournament Strategy to Investigate Learning Effectiveness in Primary Schools

Shu-Hsien Huang*, Ting-Ting Wu, Yueh-Min Huang*

*Department of Engineering Science, National Cheng Kung University, Tainan, Taiwan
bGraduate School of Technological and Vocational Education, National Yunlin University of Science and Technology, Yunlin, Taiwan
*huang@mail.ncku.edu.tw

Abstract: Mathematics is the foundation course in many fields, but many students are afraid of it. Determining a method by which to promote the student interest and enthusiasm is still a problem many researchers are trying to solve. However, a lot of studies have found that a combination of mathematics and everyday life things can improve student interest, and the math learning process, combined with appropriate teaching strategies, can enhance learning achievement. Therefore, in this study, addition and subtraction, which are the basis for mathematics and a beginning course, are chosen as the learning content, and Teams-Games-Tournament (TGT) learning strategy is used in the entire learning process. It is expected that students' motivation and interest would be aroused by using game-based learning and that learning performance would be improved as a result of competition in a peer tournament. All of the participants in this study were second grade primary students who used an interactive game-based learning system constructed as a virtual grocery store and combined with TGT learning strategy for the purpose of learning addition and subtraction. The results of the experiment indicated that the students who used the proposed learning system with the TGT learning strategy had higher performance during the learning process and that interactive game-based learning can effectively promote motivation and attitude toward a math course.

Keywords: Addition and Subtraction, cooperative, Teams-Games-Tournament, game-based learning, learning performance

1. Introduction

Previous studies have indicated that motivation will enhance the enjoyment of learning (Johnson & Johnson, 1990; Jacob, 1999; Huang, Huang, & Wu, 2014) and that this in turn will improve learning achievement. The characteristics of game-based learning include interactivity, enjoyment and liveliness (Mayer, 2003; Lisi & Wolford, 2002), among others. If these characteristics along with instruction are combined and implemented into a pedagogy, this will result in a learning environment with little pressure that is enjoyable as well.

In the area of multiculturalism, cooperative learning strategy became a popular learning method starting in 1970 (Johnson & Johnson, 1990). Cooperative learning was connected with the peer cooperative relationship and sharing in order to achieve shared personal and group learning goals (Mentz, Walt, & Goosen, 2008). In cooperative learning strategies, Teams-Games-Tournaments (TGTs, as presented by David Devries and Keith Edwards in 1970, have been used to promote learning performance among peers. Slavin (1995) also indicated that TGT strategy has a structured pedagogy that is independent of the learning context, e.g. mathematical computation and applications, sentence patterns, geography and graphical skill, and science concepts.

The TGT strategy has been implemented in kingdom and at the first grade level. The results indicated that TGT positively affects mathematics learning (Jacob, 1999).

Two effects of game-based learning (GBL) are the provision of interaction and the development of intrinsic motivation. Learners either work alone or in group activities in the interactive learning...
environment, and learning performance is enhanced through their operative experience and interactive communication with each other (Mayer, Mautone, & Prothero, 2002). Thus, learning achievement of game-based learning strategy comes from experience in games and is a result of immediate feedback. Learning through games initiates tournaments and cooperative as well as fun, entitlement, and overwhelming (Prensky, 2001). Moreover, interdependence and personal responsibility for individual performance exist between members in the group learning and competition process (Johnson & Johnson, 1994; Slavin, 1981). Group learning can consist of both active participation in learning activities and interaction with situations. Cognitive structures and fundamental models are constructed based on situations. In addition, learning in situations also stimulates reflection and problem-solving skills (Brown, Collins & Duguid, 1989; Huang & Wu, 2010; Huang, Huang, Huang, & Lin, 2011).

When situations are integrated into in-class learning environments, interactive game-based learning not only enhances learning motivation but also helps learners immerse into the interactive learning environment. Interactive learning includes good instruction and a multimedia environment, and some design concepts, like “learning by doing,” “interaction,” and “cooperative.” In such a learning environment, learners will find it easier to enhance both their learning performance and motivation. Instructional activities based on a game-based learning environment involve structuring the learning content and integrating the knowledge structure instead of attempting to obtain a pure recreational effect (Druckman, 1995; Eskelinen, 2001).

This study combined digital games, situational learning, and mathematics instruction as well as the design of a life-oriented virtual shop. In the game-based learning environment, learners simulate trading activities in order to learn addition and subtraction skills. Moreover, the learning environment integrates the TGT strategy into the game. Learners will use the TGT learning environment to promote constructive competition with their peers and to promote learning aspirations. The TGT strategy has funny and interactive characteristics that will attract active learning, promote learning motivation, and enhance learning performance. In this study, the experiment participates are the second grade students. This study investigates the learning effect between general game-based learning and life-oriented virtual shop game-based learning.

2. The TGT Strategy Method for Addition and Subtraction

2.1 Teams-Games-Tournament, TGT

The main characteristic of TGT strategy is a focus on team-game tournaments after the learning instruction. Before the games, learners are divided according to ability, gender, and so on. Each group includes three to six persons. All of the groups initially do interclass learning by themselves. The team game tournaments are implemented after the interclass learning. They have to invent a game to get 20 points in the tournament process. Five games lead to a total score of 100 points. Each game scores student performance in lieu of a paper-based test. In the final step of the TGT process, the total score for each group is recorded. Moreover, the teacher praises the winning groups in order to motivate the students. This process consists of both personal learning and group performance as well as increasing the interaction among peer groups. The TGT process is shown in Figure 1.

![Figure 1. The TGT strategy learning process](image-url)
2.2 TGT Platform - Addition and Subtraction

The aim of this study is designing a game-based TGT learning system for addition and subtraction. The learning system can assist primary students with learning addition and subtraction. Group ranking of is one function in this learning system. This function will help the tournaments held among the students promote group motivation. In this system, a virtual shop function is designed for real grocery store situational learning. Learners can use the system, which resembles a real-life experience, to learn addition and subtraction skills. Figure 2. shows the platform for the game-based TGT learning system for addition and subtraction.

![Platform Illustration]

a.) The virtual store interface

![Ranking Interface]

b.) Ranking interface

Figure 2. Illustration of the TGT learning platform

3. Experimental Environment

3.1 Participants

The participants in this study are second grade primary students. They are randomly divided into two groups. One group is the control group (n=27), and the other one is the experimental group (n=28). The control group is learning with general game-based learning. The experimental group is learning with game-based TGT learning. Both groups are learning addition and subtraction with the same teacher.
3.2 Experimental Procedure

This study experiment was conducted for 240 minutes in order to investigate the experimental activities with the experimental group and the control group and to evaluate their learning performance. A teacher with five years teaching experience was invited to conduct the teaching of addition and subtraction. Before the experiment, in order to determine the changes in the comprehension level in the two classes regarding addition and subtraction through the experimental design, prior to the teaching of addition and subtraction, a mathematics addition and subtraction pre-test was conducted. Before the experimental process, the two groups were instructed in mathematics addition and subtraction and in system operations. There were two classes 40 minutes long each week. In the experimental process, the experimental group used a game-based learning system with the TGT strategy. The control group used the traditional game-based learning system. At the end of the experiment activities in the last week, a post-test and attitude questionnaire related to addition and subtraction was given to the students to determine their learning performance and their attitude after implementing the experimental activities (as shown in Figure 3).

Attitude toward mathematics affects learning performance. A positive attitude toward mathematics causes students to spend more time and effort on learning mathematics as well as helping them become effective learners, and vice versa in the case of students who have negative attitudes toward math (Ma & Kishor, 1997). Aiken (1970) indicated that attitude and achievement mutually influence the learning of mathematics. Corbo (1992) also indicated that attitude toward math is significantly different in the case of learners at different levels. Some researchers have pointed out that mathematics performance is related to achievement. For the purposes of this study, an existing mathematic attitude questionnaire was modified. The questionnaire had 24 items and was scored with a five point Likert scale. This questionnaire is used to investigate the relationship between attitude toward mathematics and achievement.

![Figure 3. The experimental procedure](image)

4. Results and Analysis

4.1 Learning Achievement

In order to investigate the differences between the two groups, a learning achievement pre-test was essential. The pre-test was used to ensure the ability to measure learner achievement differences. A t-test was used to evaluate the results of the pre-test. The experimental group’s mean and standard deviation were 75.11 and 9.07, respectively. The control group’s mean and standard deviation were 73.69 and 9.73, respectively. The variance in the t-test was .548 (p>.05). The results of the pre-test
indicated that there were no significant differences between the two groups. Their learning achievement was at the same level before the learning activity. Therefore, the learning activity could be implemented.

After the learning activity, a post-test was scored and an analysis of covariance (ANCOVA) was used for analysis in order to investigate the effects of the activity on learning achievement. In the analysis process, the pre-test score was the covariance variable and the learning method was the independent variable. The analysis results are shown in Table 1. In the post test ANCOVA analysis, the mean, standard deviation and adjustment average for the experimental group were 85.33, 7.63 and 85.17,. The mean, standard deviation and adjustment average for the control group were 76.65, 8.72 and 76.81, respectively. These results indicated that there were significant differences between the experimental group and the control group (F=7.284, p<.05, as shown in Table 1). The results indicated that the experimental group and control group were significantly different in the post test. The mean for the experimental group was higher than that of the control group. This result also can be interpreted to mean that game-based TGT learning was superior to general game-based learning with regard to learning achievement. On the other hand, the standard deviation for the experimental group was lower than that of the control group. This means that the learning difference in the experimental group was smaller than that of the control group. Therefore, game-based TGT learning promoted learning achievement and lower learning differences among peers.

<table>
<thead>
<tr>
<th>Table 1. The post-test ANCOVA analysis</th>
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</tr>
<tr>
<td>Exp</td>
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<td>Ctrl</td>
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</table>

* *p<.05

4.2 Mathematics Attitude Questionnaire

From the mathematics attitude questionnaire shown in Table 2, a t-test was used to ensure differences between the two groups. The results indicated that the two groups were not significantly different. The possibly reason for this result was that both two groups used a game-based learning system and the participants were primary students. Aikden (1970) reported that mathematics attitude and achievement have a relationship at the primary school level, but the relationship is not significant. This result also echoed Wenger’s (1992) report. The results of Wenger’s study indicated that learners with high levels of positive attitude toward mathematics have better ability than those with low levels of positive attitude. The results also indicated that mathematics attitude was not positively related to mathematics achievement. Therefore, both groups’ attitudes toward mathematics were not significantly different.

<table>
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<th>Table 2. Descriptive statistics for mathematics attitude questionnaire</th>
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<td>Group</td>
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<tr>
<td>Exp</td>
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<td>Ctrl</td>
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</table>

5. Conclusions

This study investigated game-based TGT learning of addition and subtraction. The learning environment was a combination of game-based learning, team tournaments and virtual shop trading. The teams invented games in the learning environment. Mutual survival and personal responsibility were learned by inter-group relations. The results indicated that TGT game-based learning achievement was higher than general game-based learning. Thus, constructive competition promotes peer learning and learning achievement. Hence, the two groups were not significant different in terms of attitude toward mathematics. Related work is in progress, and qualitative research will be used to collect interview data. Participant information (e.g. learning motivation, math anxiety, etc.) will be collected in the future in order to investigate the mathematics learning status of students.
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Education 3.0 and beyond: A learner-led experience of Education

Pranav KOTHARI\textsuperscript{a}, Anurima CHATTERJEE\textsuperscript{b}
\textsuperscript{a}Educational Initiatives Pvt. Ltd., India
\textsuperscript{b}Educational Initiatives Pvt. Ltd., India
\*pranav.kothari@ei-india.com

Abstract: The last decade has seen technology entering the education space in multiple ways – through digitised learning content, adaptive online tests, pre-recorded or real-time videos of teachers, social networking, MOOCs, etc all that have been classified as Education 1.0, 2.0 and 3.0. The predominant reference of these terms has been for higher education (college level and beyond). It assumes that the student is a mature and motivated adult who is able to take in discrete pieces of information and assimilate it coherently to learn. This paper explores how Education 3.0 concepts are implemented in the realm of elementary education with a focus towards increasing students’ learning outcomes. This paper combines our research in heutagogy by drawing on data from an intelligent tutoring system called Mindspark that has been used by over 80,000 students in 150 private schools over the past five years as well as in 5 after-school remedial centres in urban slums of Delhi. There is a shift in educational processes - characterized by the transformation from a teacher-led delivery model to a student-led learning experience. In this Education 3.0 model, the learner is no longer a passive recipient but rather becomes an active player in defining their learning environment, the teacher-learner interaction, affective factors of learning, evaluation, interventions and finally achievement – all towards achieving higher outcomes on students’ learning.

Keywords: Education 2.0, Education 3.0, intelligent tutoring system, elementary schooling, technology in education

1. Education 3.0 – Newer trends in elementary education

Education technology has seen varied changes resonating users’ social experience and interaction with the Web. In line with the various versions of the Web there is an evolution of educational processes as Education 1.0, Education 2.0, Education 3.0 and finally Education 4.0. This evolution draws in from the ideas like progressivism and social constructivism. The ideas of progressivism in education (as purported by thinkers like John Dewey) talk about how “learning by doing” allows for a more active environment for learning where the learner is able to develop problem-solving and decision-making skills. Social constructivism recognises that culture plays a large role in cognitive processes and learning (Vygotsky) and student dialogue and discussion and collaborative learning processes are emphasised. Technology has been a catalyst for these ideas in education, wherein content can be made more meaningful and interactive for the learner and executed even in operational constraints like low availability (in quantum or quality) of teachers and teaching resources.

Education 3.0 is a shift in user-driven motivation, teacher facilitation and in pedagogic styles. According to Jackie Gerstein, use patterns of students should drive the type of mobile learning activities so that the transfer outside the learning setting can occur. The role of the educator in this new environment transforms from being gatekeepers of knowledge to becoming model learners who can demonstrate self-directed learning (Gerstein). While Education 3.0 and 4.0 suggests ubiquitous learning is possible with freely available resources and user-generated content and processes, one needs to interrogate how effective this process is for elementary school students. Can such large amounts of learning content be moderated intelligently by students? Can a 5\textsuperscript{th} grader be expected to read large volumes of data on historic wars and discern reliable sources from non-reliable sources? Can a 2\textsuperscript{nd} grader have the requisite knowledge to decide what she/he needs to learn after finishing addition of fractions? To make it effective, Education 3.0 for elementary education will need to adapt to some of the things that are taken for granted in adult education in Education 3.0.
In this light, we will look at how the learning process in elementary education is aligned to the principles of Education 3.0 in three aspects. The first aspect of analysis will be the learning environment which will describe the online interface with its various features for students to engage with their teaching learning content, understanding their own learning achievement and progress, communicate their emotional states on specific content, receive rewards based on achievement for motivation to continue further and many others. The second aspect studies the role of the teacher in this new learning environment. The third aspect is the dynamic nature of the learning content that is served in real time driven by user response. This section will describe the logic of learning content sequencing through data driven misconception identification and remediation, recognition of prior learning, variable learning path and students’ learning while being in flow. Table 1 below is a brief understanding of the shifts in the various generations of education as explained by John Moravec and Arthur M. Harkins (Moravec, 2008 and Harkins 2008) and the next section will describe how the above concepts of Education 3.0 have been implemented utilizing Mindspark.

Table 1: The various generations of educational technology

<table>
<thead>
<tr>
<th></th>
<th>“Download” Education 1.0</th>
<th>“Open Access” Education 2.0</th>
<th>“Knowledge Producing” Education 3.0</th>
<th>“Innovation Producing” Education 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning is..</td>
<td>Dictated</td>
<td>Socially constructed, with aid of Internet access</td>
<td>Socially constructed and contextually reinvented knowledge</td>
<td>Build through selective individual and team-driven embodiments in practice</td>
</tr>
<tr>
<td>Technology is...</td>
<td>Confiscated at the classroom door</td>
<td>Cautiously adopted open access</td>
<td>Everywhere</td>
<td>Always changing with learners as a source of innovation production</td>
</tr>
<tr>
<td>Teaching is done...</td>
<td>Teacher to student</td>
<td>Teacher to student and student to student</td>
<td>Teacher to student, student to student, student to teacher, people-technology-people</td>
<td>Amplified by positive innovation feedback loops; ubiquitously and creatively 24/7 in all phases of living, learning and working</td>
</tr>
<tr>
<td>Schools are located...</td>
<td>In a building (brick)</td>
<td>In a building or online but increasingly on the Web</td>
<td>Everywhere in the “creative society”</td>
<td>In the globally networked human body, a continuously evolving instrument innovatively supplementing and replacing classrooms</td>
</tr>
<tr>
<td>Parents view schools as...</td>
<td>Daycare</td>
<td>Daycare with a laboratory</td>
<td>Places for students to create knowledge</td>
<td>Schools are viewed as one of many innovation venues</td>
</tr>
<tr>
<td>Teachers are...</td>
<td>Licensed professionals</td>
<td>Licensed professionals who team with students and parents</td>
<td>Everybody, everywhere backed by wireless devices for knowledge production</td>
<td>Everybody, everywhere is an innovation production source backed up intuitive software “partners” and human collaborators.</td>
</tr>
</tbody>
</table>

2. Mindspark – Intelligent Tutoring System

Educational Initiatives, India developed an intelligent tutoring system (ITS) called Mindspark in 2008 which is used for teaching Mathematics and Language to elementary school students. In 2014, the Mathematics program is used by over 80,000 children in private and government schools and the
Language program is used by 5,000 children in government schools and after school remedial centers. An Intelligent Tutoring System (ITS) is a computer based tutoring program that provides personalized learning content to students based on factors like student performance and prior knowledge (Corbett, Koedinger and Anderson, 1997). The sequencing of learning content is done in a manner to avoid cognitive mismatch such as cognitive overload for low performers and boredom for high performers (Brusilovsky and Milln, 2007) to ensure that child is engaged and is performing at the optimum level (Csikszentmihalyi, 1998). In Mindspark, the questions are ‘finely-graded’, meaning that there are a very large number of questions of gradually increasing levels of difficulty. In a way, Mindspark adapts to the needs of every individual student. Questions are specially designed to test understanding and to help students clear their misconceptions. When a student answers a question or combination of questions incorrectly, the intelligent system diagnoses the child’s misconceptions/weak areas. The child may be further provided with a simple or detailed explanation, or be redirected to questions that strengthen the basic understanding. These decisions are taken by an adaptive logic which is expected to get better and better with increased student usage (Rajendran and Muralidharan, 2013). There is very little emphasis on instruction due to the belief that students learn when they have to think – either by answering a question, or by doing an activity on the computer (Prince, 2004).

An independent third party evaluation of Mindspark shows an effect size of 0.40 against a comparison group with usage as low as 1 hour per week (50 hrs per year). This study finds a favorable outcome despite the teacher effects and school effects that may occur. This study was done across more than 4,400 students from 18 different schools that used Mindspark comparing with more than 15,000 students across 150 schools that did not (IDInsight, 2014).

3. Technology in Education 3.0 is…

3.1 Providing student intelligent and limited choice

The Mindspark portal hosts the interface for every student, where the content is available to students depending on their learning levels. This becomes a dynamic classroom for every child where they have a certain choice of topics to choose from based on extent of completion, performance on the pre-requisite topics, teacher intervention and the adaptive algorithm. Intentionally the entire content is not left open at the discretion of the student. These are shown on the left side in Figure 1. This session is bookmarked to the place where the student left the previous session and allows the student to continue from the same place.

Figure 1. Dashboard for Mindspark
3.2. Providing the encouragement and incentives customized to each child’s needs

While technology has allowed for systematic archiving of content and assessing student performance, it is often felt that affective factors like boredom, motivation, and sensing emotional states of the learner are outside the purview of technology. Although intrinsic motivation to learn often helps students approach technology based learning tools, at times, they need a little push to persist at it, with minimal human interaction. Skinner’s work on rewards and reinforcements (Skinner, 1938) has been applied extensively by teachers and educationists in working with student behaviour and motivation. These are replicated by Mindspark through creating extrinsic rewards called “Sparkies” to promote positive learning habits like grit and persistence required to help students learn and progress from the mistakes they might make; and to cope with the increasing difficulty levels of questions. Sparkies are shown by the number 364 in Figure 1 above.

3.3. Capturing students’ emotions

In addition to this, the tutoring system tries to gauge the student’s emotional state through an Emote Toolbar shown on the right side of Figure 2 (to share feedback on moods and emotions related to content). This also provides data to analyze questions that have been repeatedly marked by students as “Boring”, “Exciting” or “Confusing”. While this data is currently used to review and modify the learning content and its sequencing for greater student engagement, research on affective states of learners indicates that there in future there is a possibility to predict frustration and also address it in real-time through the program’s learning environment (Rajendran, Iyer, Murthy, Wilson and Sheard, 2013).

3.4. Providing students transparency and visibility into their learning

Mindspark helps children keep track of their goals through a tabulated Cluster chart shown in Figure 3 to track their levels of completion as well as success. Mindspark believes that keeping students well-informed about their learning process will help them be more aware of themselves as learners and therefore, understanding the value of what is being presented, do better. This is why students are also given prompts telling them when they have finished a learning unit successfully and when they are being made to repeat a learning unit or attempt more basic learning units, as is the case when they get a number of questions incorrect.

![Emote toolbar where the child can express like / dislike, boredom, excitement, confusion and even share comments with the interface](image)

![Cluster charts that show extent of completion and accuracy](image)
3.5. Providing encouragement to those who have done well, and support to those who need it

Encouragement is provided to students when they achieve certain milestones (Figure 4: “Great going, Anita”) so that their energy and enthusiasm is renewed for the next topic. In addition to this, the reward system (Figure 5) applauds diverse qualities like being consistent and perseverant, academic achievement etc. There is a monthly competition among students to become champions in their classroom based on the speed, accuracy, complexity of questions as well as reading explanations to encourage higher usage.

Figure 4. The student interface showing various interactive elements like Sparkies (rewards), encouragement statements, and emotional sensors

Figure 5. Reward system at the classroom level

3.6. Personalization based on the student, time of year, geographic location, festivals, etc

Mindspark allows for personalization of celebrations like an animated “Happy Birthday” greeting card on the student’s birthday that opens up on the first login of that day. It also allows for localization of content through interface themes related to upcoming festivals as shown below on the left hand side of the login page during an Indian festival (Figure 6). This space is also used to profile accomplished mathematicians thereby providing the inspiration to become one.

Figure 6. Mindspark login page showing public announcements for Sparkie Champs and greetings
3.7. Providing specific step by step intelligent responses
Technology in Education 3.0 is used more for ensuring that children are learning by providing intelligent responses instead of simply marking students right or wrong (which can be discouraging). Here feedback provided is customized to the type of error that a student is making as shown in an example leading to solving a linear equation with popular mistakes that students make.

![Figure 7. Intelligent responses to errors made by students while solving linear equations](image)

4. In Education 3.0 Teaching is done…

4.1 By reading accurate and instantaneously generated reports of classrooms
Teachers are able to gauge performance, students’ needing attention, level of comprehension through system generated reports to aid in teaching.

![Figure 8. Class level reports showing topic progress across various students](image)

4.2 Using real time data for effective monitoring
In this model, the teacher is provided by system driven prompts to help facilitate their teaching in a Mindspark class. Through the dashboard (shown below in Figure 9), a teacher is able to ascertain the child’s comfort with the learning content and provide support to students struggling with concepts. This is done by a combination of the pace at which questions are done (system flags if some student is really slow), the accuracy with which it is done and shows relevant parameters (such as class grade level vs. actual level, etc)

![Figure 9. Teacher dashboard for monitoring students’ performance](image)
4.3 Better communication with parents
Through system generated reports, the teacher is able to accurately gauge the learning levels of each child and communicate the learning gains and the challenges with parents and to set goals for their students for subsequent months. Also through the teacher interface, the teacher is directly able to email students’ parents who can also monitor the progress via the parent portal.

![Student Report - Poonam Barik(1041)](image)

Figure 10. Monthly report on student usage and accuracy shared with parents

4.4 Data driven instruction
Through data on student performance across levels, topics and questions, teachers are able to identify learning misconceptions and plan their offline instruction to help kids through these. For eg. in image below the question shows the “Most common wrong answer” that children have picked as a result of a popular misconception as well as kids who never got the concept right even after being given multiple times. This allows the human teacher to intervene and teach the particular concept. Also the Common Wrong Answer report can be downloaded as a worksheet – printed copies of which can be given to children for practice.

![Find the value of 9025 + 2999](image)

Figure 11. Common Wrong Answer reports

4.5 Teacher-led customization of learning content
While Mindspark provides the learning path for every child, flexibility and autonomy is given to the teachers to allow students to focus on a particular concept determined important by teacher or school. This can be done at the individual student level or at the entire class level.

![Topic customization by teacher – for individual level or class level](image)
5. In education 3.0 the learning content is…

5.1 Integration of online content with school curriculum
Teachers using this program integrate Mindspark into their curriculum plan whereby they ‘activate’ topics for students based on content taught in class and use the performance results of students to identify degree of comprehension, common misconceptions, and low performing students. It thus aims to use not just the interactivity of the computer, but its intelligence; and to mimic the diagnostic capabilities of a good teacher. In addition it also serves as a powerful teaching tool in these cases allowing teachers exposure to good learning materials.

Figure 13. Integration of Mindspark in the school curricula

5.2 Informed through data on student performance and misconceptions
Similar to the discussion on Common Wrong Answer reports, the program captures data on student performance across topics to identify misconceptions. The learning content recognises these misconceptions and attempt to address these through its content flow. Examples of student misconceptions diagnosed and addressed by Mindspark are

- 20 = 5x4 is considered wrong by many students (most students think that 5x4=20 is the only correct notation)
- Confusion between terms like k + 3, 3k, k^3, etc

5.3 Appropriate to the learner’s abilities and learning levels

The learner’s journey begins with a baseline diagnostic test that assesses the actual understanding level (i.e. “current level”) of each child for their Language and Mathematical competencies. In cases where the current level is lower than the grade level of school, the program adapts to the child’s learning level and through performance at each learning unit, the child progresses to the next unit or moves to a lower level learning unit or a remediation plan. In Figure 11, this child is successfully completing learning units (downwards) but needs to move to previous units at various junctures.

Figure 11. Learning path of learner

6. Concluding remarks

The best use of technology in elementary education is not for putting up fancy smartboards and projectors in classroom which typically deal with the delivery of material to students; but instead employing it towards a personalized and adaptive learning program with the right support system. Student attendance tracking, greater tracking of attendance and accountability of teachers by monitoring their login behaviour, involving parents in student behaviour through system-driven phone calls or texts, measuring
metrics like retention, usage, and performance in real-time are some ways that would allow for greater facilitation and efficiency of learning for children under the Education 3.0 generation.

Applying the principles of Education 3.0 in the context of elementary education is a complex one due to the nature of the target group. Catering to learners of different learning abilities, varying levels of reading, and requiring diverse skill sets to achieve the goals of the curriculum requires us to think beyond the framework of Education 3.0. While knowledge must be freely accessed and produced by the learner, the learner can’t be left to moderate that knowledge on their own. Hence, the learning platform needs to be responsive to the access and creation of that knowledge to provide appropriate learning support and avoid a ‘knowledge deluge’. In addition to this, one can’t ignore the importance of a human intervention required with young learners. While advocating for technology-led learning, the changing role of the teacher and parent must be understood to allow for effective learning for every child. Through adaptive learning platforms like Mindspark, it is possible to provide young learners with the new learning experience synonymous with Education 3.0 that creates the incentives for a child to learn and for teachers to monitor and ensure that each child is performing at his/her best potential.

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References
The Impact of Affective Tutoring System and Information Literacy on Elementary School Students’ Cognitive Load and Learning Outcomes

Ching-Ju CHAO\textsuperscript{ab*}, Shang-Chin TSAI\textsuperscript{ac}, Chia-Hsun LEE\textsuperscript{a}, Tao-Hua WANG\textsuperscript{d}, Hao-Chiang Koong LIN\textsuperscript{a}

\textsuperscript{a}Dept. of Information and Learning Technology, National University of Tainan, Taiwan
\textsuperscript{b}Dept. of Applied Foreign Languages, Tung Fang Design Institute, Taiwan
\textsuperscript{c}Dept. of Motion Picture, Tung Fang Design Institute, Taiwan
\textsuperscript{d}Degree Program of Fashion and Performance, Kun Shan University, Taiwan
*chingju@mail.tf.edu.tw

Abstract: In this study, an affective tutoring system (ATS) is developed by integrating dengue fever prevention courses with an intelligent tutoring system (ITS) under a semantic identification module for a teaching experiment. A one-group pretest-posttest research design is adopted for this teaching experiment, which involves 66 research participants and lasts for two weeks. Further, students are divided into a high score group and a low score group based on students’ information literacy and cognitive load, and nine students are selected to participate in a focus group interview. Our research team uses a “primary school information literacy questionnaire” and a “primary school student’s cognitive load scale”, qualitative research methods, and auxiliary quantitative research methods to cross-verify the effect of the dengue fever prevention affective tutoring system on the cognitive load and learning outcomes of primary school students with different level of information literacy.

According to results of this study, both qualitative and quantitative analysis endorse the hypothesis that the dengue fever prevention affective tutoring system enhances students’ learning outcomes. Students with varied information literacy show significantly different cognitive load, yet there is no significant difference in students’ overall cognitive load, content of cognitive load, and learning outcomes. Quantitative analysis shows partially significantly negative correlation between students’ information literacy and cognitive load, yet the correlation between students’ information literacy, cognitive load, and learning outcomes is not endorsed by quantitative analysis.

Keywords: Affection Tutoring System, Intelligence Tutoring Systems, dengue fever, information literacy, cognitive load

1. Introduction
Dengue fever, which is rampant in southern Taiwan every summer, is an acute infection transmitted by the bite of a mosquito infected with dengue viruses. Due to the general public’s inadequate knowledge of mosquito species that transmits dengue fever, the time when these mosquitoes are active, and how dengue transmission happens, people tend to pay little attention to environmental hygiene and end up aggravating the severity of dengue fever outbreaks in metropolitan areas. To reinforce the promulgation of dengue fever prevention knowledge, the government is devoted to advocating the importance of dengue fever prevention in schools at all levels. In this study, our research team observed that in the course of receiving traditional indoctrination, students may be subject to various influencing factors, develop negative emotions in the process of learning, and end up having learning outcomes that are below expectation.

Given that a growing number of recent studies have pointed out the important impact of emotions on learning, we suggest integrating an affective tutoring system (ATS) with courses of dengue fever prevention, which involves discerning students’ emotional state in the process of interacting with students, giving timely feedback, and adjusting the pace of teaching. Such teaching mode can only be performed through students’ human-computer interaction. At present, students are accustomed to being surrounded by abundant information. Nevertheless, whether students are equipped with better information literacy to minimize cognitive load caused by an overall curriculum in the process of learning, sources of such cognitive load,
along with the interplay between students’ cognitive load and learning outcomes are still what researchers are curious about. As such, with the aid of the innovative teaching mode, we propose to examine the interplay of cognitive load and learning outcomes of students with dissimilar information literacy in students’ learning process. Through this study, we also aspire to suggest more diverse promotion approaches of dengue fever prevention to teachers in the field of education.

2. Literature Review

2.1 ITS & ATS

An intelligent tutoring system (ITS) is a system which provides students with personalized guidance or direct feedback through computer analysis (Sarrafzadeh, 2002). Knowledge of an intelligent tutoring system is constructed by three modules: a student module made up of students’ knowledge, a tutoring module made up of teaching-related knowledge, and an expert module made up of knowledge in specific fields. Further, knowledge of an intelligent tutoring system and the user interface module are integrated to make a comprehensive intelligent tutoring system structure (Koedinger & Corbett, 2006). Also, an intelligent tutoring system, which determines the content and methods of teaching based on individual students’ characteristics, is like a real tutor. As such, an intelligent tutoring system enjoys more advantages as it provides useful, uncritical, and tailor-made feedback (Anderson, Corbett, Koedinger, & Pelletier, 1995; Johnson, Rickel & Lester, 2000).

Affective tutoring systems, which are developed from intelligent tutoring systems, are expected to improve intelligent tutoring system and further make intelligent tutoring systems like a real tutor, adapt to learners’ emotional state, and help learners learn effectively (Sarrafzadeh et. al., 2003; Alexander, Sarrafzadeh & Hill, 2006). A tutoring research group at the University of Memphis attempted to add emotional components into the AutoTutor of an intelligent tutoring system and used this system to conduct a test on approximately 1,000 learners with physics or computer background knowledge. The result was that learners had achieved remarkable learning outcomes in both surface-level knowledge and deeper learning (Craig, Graesser, Sullins & Gholson, 2004). Moreover, in the course of real teaching and teaching through an intelligent tutoring system, learners’ common emotions such as joy, frustration, surprise, curiosity, wonder, etc. had stronger correlation with and made great impact on learners’ learning experiences (Burleson & Picard, 2004; Craig et al., 2004; D’Mello et al., 2008; Graesser et al., 2006). On the other hand, Picard’s research put forward a conceptual module which could affect learners’ emotions while learning, identify learners’ emotional state, give timely feedback, and improve learners’ learning (Picard, Kort & Reilly, 2001).

2.2 Identifying semantics and emotions in Chinese language

Through natural language processing and semantic analysis, we could effectively understand the semantic content, acquire correct information from the semantic content, and assist to identify emotions (Yan, Bracewell, Ren & Kuroiwa, 2008; Quan & Ren, 2009). This is because subsequent actions such as emotion recognition and feedback could only be performed after the acquisition of correct information. However, in practice, semantic and emotion recognition methods would vary according to a sentence or an article’s hierarchical structure (Kao et al., 2009; Quan & Ren, 2010; Xu, Meng & Wang, 2010).

Calix (2012) extracted descriptive texts from fairy tales and incorporated these texts into the Support Vector Machines (SVM) training corpus, determined learners’ emotions based on learners’ textual inputs of learners after training, and let a specially-designed 3D character model show corresponding emotional responses based on learners’ emotions. In 2009, Goh & Huang mentioned about using text mining algorithms to search for wordings which convey negative emotions on blogs as a way to prevent teenage depression and suicide incidents.
Sun, Chen, Liu, Liu & Soo (2010) used the Chinese word segmentation system developed by Academia Sinica Institute of Information Science to segment words and phrases. Also, the popular social networking site “Plurk” was used as the source where words and phrases were gathered from. Further, the collected short Chinese phrases were categorized based on these phrases’ emotions and the characteristic lexicons were converted to vectors and joined with a probability model, which was from the semantic dictionary developed by the Natural Language Processing Laboratory at National Taiwan University, to form a hybrid model to analyze emotions of short Chinese phrases. As indicated by studies in recent years, results of research on Chinese semantic identification technology have been good. Marvelous progress in Chinese semantic identification technology has strengthened its potential of enhancing the effectiveness of emotion recognition research.

3. Research Method

3.1 Research Architecture

With the one-group pretest-posttest design as the research design and the research framework in Figure 1, this study proposes the following three hypotheses:

H1: Teaching by means of an affective tutoring system can enhance students’ learning outcomes.

H2: Students with varied information literacy would experience significantly different cognitive load while receiving teaching through an affective tutoring system.

H3: Students with varied information literacy would have significantly different learning outcomes after receiving teaching through an affective tutoring system.

![Figure 1 Research Architecture](image)

3.2 Participants and Instrument

77 students in grades 5-6 from a public primary school in Kaohsiung were chosen as research participants in this study. 77 questionnaire copies were distributed and 70 questionnaire copies were collected, a response rate of 91%. After four invalid questionnaire copies with incomplete data or answers were removed, 66 valid questionnaire copies were left, an effective response rate of 94%.

Research instruments of this study include: an affective tutoring system about dengue fever prevention, a primary school students’ information literacy questionnaire, a primary school students’ cognitive load scale, and a quiz of students’ dengue fever prevention knowledge.

3.2.1 Affective Tutoring System about dengue fever prevention

Other than using dengue prevention courses designed and distributed by the environmental protection administration as teaching materials, our research team also added the module of semantic and emotion recognition and relevant modules to this teaching mode. This system,
which can be divided into affective computing and course teaching, consists of four modules: a semantic identification module, a pedagogical assistant agent module, a dengue fever prevention teaching materials module, and a teaching strategies module.

(1) semantic identification module

The procedures of building a semantic identification module under the category of affective computing include compiling a dictionary of emotions, processing semantic structures, and using Semantic Clues Emotion Voting Algorithm (SeCeVa) to identify emotions. Methods of how the semantic identification module was constructed and the operating procedures are shown in Figure 2:

Figure 2 methods of how the semantic identification module was constructed and the operating procedures

Considering the similarity of categories of emotions and the system’s promptness in perceiving learners’ emotions and giving feedback, the six basic emotions proposed by Ekman (1972) and eight academic emotions proposed by Pekrun et al. (2009) were consolidated and classified to become this system’s eight emotion categories derived from semantic identification. After giving definitions to each emotion, the collected emotion keywords were classified and the
A characteristic or property of a certain word was marked next to the word. How the emotion keywords were consolidated is shown in Figure 3.

![Figure 3](image)

**Figure 3** A flowchart of the integration of emotion keywords

(2) A pedagogical assistant agent module
A pedagogical agent, who acts as an intermediary between learners and messages from the system, could provide learners with opportune feedback through a two-way interactive mechanism which involves informing learners the system’s current actions and understanding learners’ needs. A screen shot showing the interaction between a learner and a pedagogical agent is shown in Figure 4.

![Figure 4](image)

**Figure 4** The interaction between a learner and a pedagogical agent

3.3 Experimental procedures
The one-group pretest-posttest research design is adopted for this study’s experiment. Prior to using the affective tutoring system, students are instructed to fill out an information literacy questionnaire, take the dengue fever prevention knowledge pre-test, and receive a score from the pre-test. The same procedures are performed in each class for a total of four times. The next week, students are instructed to fill out a cognitive load assessment questionnaire, take the dengue fever prevention knowledge post-test in a computer classroom immediately after using the affective tutoring system, and receive a score from the post-test. The same procedures are also performed in each class for a total of four times, and the experiment lasts for two weeks in
Following the affective tutoring system-based course and questionnaires, students are divided into groups based on their information literacy. The top 27% of students are allocated to the higher score group, the bottom 27% are allocated to the lower score group, and the remaining 46% are allocated to a new group. Further, three students are selected from each group and a total of nine students are selected to participate in a focus group interview. Also, the whole interview is recorded with a digital video camera instead of a sound recording device for better accuracy of recording. The experimental procedures are shown in Figure 5.

### 4. Experimental results

This study aims to explore: 1. whether an affective tutoring system enhances students’ learning outcomes; 2. difference in students’ cognitive load in the process of using an affective tutoring system and students’ learning outcomes afterwards due to students’ varied information literacy; 3. the correlation between students’ information literacy, cognitive load, and learning outcomes. T-test is employed to analyze students’ scores at the pre-test and the post-test to compare students’ learning outcomes before and after using the affective tutoring system and to test H1. Mean scores, standard deviation, and t-test results, which show students’ learning outcomes before and after using the affective tutoring system, are shown in Table 1.

**Table 1: Summarized statistics of students’ learning outcomes**

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>Test</th>
<th>Number of students</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>66</td>
<td>76.73</td>
<td>14.50</td>
<td>-4.357***</td>
</tr>
<tr>
<td></td>
<td>Post-test</td>
<td>66</td>
<td>84.73</td>
<td>11.38</td>
<td></td>
</tr>
</tbody>
</table>

***p<.001

As shown in Table 1, “H1: teaching by means of an affective tutoring system can enhance students’ learning outcomes” is supported as students’ mean score on the post-test is higher than the mean score on the pre-test. Also, the quantitative data and results of qualitative data analysis validate each other as all students in the interview unanimously speak highly of the effectiveness of teaching by means of an affective tutoring system. Independent sample t-test is employed to analyze the completed primary school students’ information literacy questionnaire copies to find out difference in students’ cognitive load and learning outcomes as well as to test “H1: teaching by means of an affective tutoring system can enhance students’ learning outcomes” and “H2: students with varied information literacy would experience significantly different cognitive load while receiving teaching through an affective tutoring system.” Mean scores, standard deviation, and t test results in relation to the two aspects of cognitive load and the overall cognitive load of students with varied information literacy are shown in Table 2.

As shown in Table 2, primary school students in the higher information literacy group and the lower information literacy group demonstrate significant difference of .05 on the interface operation aspect of cognitive load. The t-value is -2.20, indicating that in comparison with students in the lower information literacy group, students in the higher information literacy group demonstrate significantly lower cognitive load on the interface operation aspect.
Nevertheless, the difference on content and overall cognitive load does not reach a level of significance, indicating primary school students’ varied information literacy makes no significant difference on overall cognitive load and cognitive load on the content aspect. Further, mean scores, standard deviation, and t test results of learning outcomes of primary school students with varied information literacy are presented in Table 3. According to Table 13, difference on learning outcomes of students in the higher information literacy group and students in the lower information literacy group does not reach a level of significance, meaning that primary school students’ varied information literacy does not make a significant difference on students’ learning outcomes.

**Table 2 Summarized statistics of the interplay between students’ varied information literacy and students’ cognitive load**

<table>
<thead>
<tr>
<th>Aspects in Relation to Cognitive Load</th>
<th>Information Literacy Group</th>
<th>Number of Students</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>higher information literacy group</td>
<td>18</td>
<td>12.94</td>
<td>3.50</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>lower information literacy group</td>
<td>19</td>
<td>11.11</td>
<td>4.29</td>
<td></td>
</tr>
<tr>
<td>Interface Operation</td>
<td>higher information literacy group</td>
<td>18</td>
<td>15.06</td>
<td>6.88</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>lower information literacy group</td>
<td>19</td>
<td>20.16</td>
<td>7.21</td>
<td></td>
</tr>
<tr>
<td>Overall Cognitive Load</td>
<td>higher information literacy group</td>
<td>18</td>
<td>28.00</td>
<td>8.04</td>
<td>-1.25</td>
</tr>
<tr>
<td></td>
<td>lower information literacy group</td>
<td>19</td>
<td>31.26</td>
<td>7.91</td>
<td></td>
</tr>
</tbody>
</table>

* p<.05

**Table 3 Summarized statistics of the interplay between students’ varied information literacy and students’ learning outcomes**

<table>
<thead>
<tr>
<th>Learning Outcomes</th>
<th>Information Literacy Group</th>
<th>Number of Students</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>higher information literacy group</td>
<td>18</td>
<td>90.22</td>
<td>9.33</td>
<td>1.78</td>
</tr>
<tr>
<td></td>
<td>lower information literacy group</td>
<td>19</td>
<td>82.74</td>
<td>15.38</td>
<td></td>
</tr>
</tbody>
</table>

**5. Conclusions and implications**

This study aims to explore the correlation between cognitive load and learning outcomes of primary school students with varied information literacy when an affective teaching system is used. According to results of this study, the current status of students’ overall information literacy is relatively good and is at an upper-intermediate level. As for each aspect of students’ information literacy, students receive the highest score in the “retrieving information” aspect and the lowest score in the “assessing and sharing information” aspect, indicating students’ relative strength in retrieving information yet relative weakness in assessing and sharing information. While students are using the affective teaching system, the “content” aspect of students’ perceived cognitive load receives a higher score while the “interface operation” aspect receives a lower score, indicating that content causes more cognitive load for students than interface operation does. With respect to whether teaching with an affective tutoring system could enhance students’ learning outcomes, statistical analysis by means of t-tests is performed on students’ scores before and after receiving the affective tutoring system-assisted teaching. Results of the analysis show that students’ mean scores at the pre-test and the post-test have reached a level of significance, indicating that teaching by means of an affective tutoring system could effectively enhance students’ learning outcomes. However, students with varied information literacy are only different in the interface operation aspect of cognitive load yet show no significant difference in overall cognitive load and the content aspect of cognitive load. Nevertheless, a multitude of factors, which include students’ intelligence, motivation to learn, learning styles, leaning attitudes, learning anxiety, parents’ attitudes, and many more, may affect outcomes of teaching by means of an affective tutoring system.
Therefore, these factors may be counted as research variables in future research which explores the influence or correlation between other variables and different aspects of learning outcomes. In this way, researchers may better understand the importance of different variables on different aspects of students’ learning outcomes as well as provide a reference for teachers who use an affective tutoring system to teach.

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Development of Digital Game-based Biology Learning Experience on Cell Cycle through DSLM Instructional Approach

Porntip KANYAPASIT\textsuperscript{a} & Niwat SRISAWASDI\textsuperscript{b*}
\textsuperscript{a}Science and Technology Education Program, Faculty of Education, Khon Kaen University, Khon Kaen, Thailand
\textsuperscript{b}Division of Science, Mathematics, and Technology Education, Faculty of Education, Khon Kaen University, Khon Kaen, Thailand
*niwsri@kku.ac.th

Abstract: Digital games were several used as instructional tool in science education in several countries. Using games could increase students' motivation and interest to learn in regular class. The purposes of this study were to design and develop digital game-based learning by inquiry regarding biology of cell cycle based on dual-situated learning model (DSLM) approach, and evaluate effectiveness of the digital game-based learning on improvement of students' conceptual understanding of cell cycle. In this paper, the researchers report results of an investigation of students' existing ideas on biological concepts about cell cycle. 36 twelfth-grade students were recruited into the investigation by undertaking a series of open-ended conceptual questions covering five main concepts i.e. cell cycle, interphase, mitosis, meiosis and cytokinesis. The results indicated that they hold different patterns of alternative- and misconceptions about cell cycle, and some had no conception on the concepts. Then, these findings on specific mental set students lack were used to particularly design dual-situated learning events for the cell cycle concepts. Purposively, a digital game was created by the researchers in order to use for eliminating or decreasing students' alternative- and misconceptions about cell cycle. Besides, the digital game was designing to use as inquiry-based tool to support constructing scientific understanding on the concepts and it is illustrated in this paper. An implication of this paper is to provide pedagogical guidance for developing digital game-based biology learning environment with regarding effective strategy for science learning, open-inquiry learning process.

Keywords: digital game, open inquiry, dual-situated learning model (DSLM), biology education, cell cycle

1. Introduction

In recent years, there are several studies with purpose to promote students’ scientific conceptual understanding and conceptual change in biology education. Several researchers developed instructional models and teaching techniques for enhancing the leaning of biological concepts such as cellular respiration (Songer and Mintzes, 2006), genetics (Termtachatipongsa, 2014; Opfer and Siegler, 2004). The results from previous studies reported that students often hold alternative conceptions about cell cycle, especially interphase, mitotic and meiotic cell division, and cytokinesis, due to its abstraction and invisible by nature (Termtachatipongsa, 2014). Also, researcher mentioned that teaching method used in biology class might be a major factor which causes students alternative- and misconceptions (Obaidat and Malkawi, 2009). Moreover, lack of prior knowledge and appropriate ideas could affect ineffective conceptual learning in science (Obaidat and Malkawi, 2009; She, 2004). As such, to promote students’ scientific understanding and conceptual development in science, several researchers have attempted to develop instructional materials and models for teaching and learning of science concepts. The dual-situated learning model (DSLM) was proposed by She (2004) and it is one of the instructional models which considers students’ alternative conceptions to be a very important consideration in process of learning, and many researchers reported successful on the use of DSLM for enhancing
students’ conceptual understanding in science (Lee and She 2010; Liao and She 2009; She and Liao 2010; Srisawasdi and Kroothkeaw, 2014; Srisawasdi and Sornkhatha, 2014). However, no study has utilized digital game into this learning model.

In recent years, several researchers have paid attention to a new research trend that focused on using digital game for teaching biological concepts and other science concepts. With technological features, development of interactive computer-based learning materials for science teaching and learning provide opportunities to help students understand the concepts better by visualizing abstract science concepts into concrete experience to change students’ alternative conceptions to scientific conceptual understanding (Srisawasdi, Kerdcharoen, and Suits, 2008; Suits and Srisawasdi, 2013). Moreover, teaching-learning process by using computer technology such as digital game could be a novel pedagogy to promote meaningful learning and students’ motivation better than traditional teaching-learning process. Therefore, with the abovementioned reasons, importance of using digital game cooperated with DSLM for conceptual change in science learning, the researchers interested to develop digital game-based inquiry learning in biological concepts about cell cycle through DSLM approach for facilitating students’ scientific conceptual understanding and cognitive process of conceptual change.

2. Literature review

2.1 Dual-situated Learning Model (DSLM)

Dual-situated learning model (DSLM) (Lee and She 2010; Liao and She 2009; She and Liao 2010). is one of instructional model that considered prior knowledge, alternative conceptions of students and use these data for generating instructional tools for helping students to have correct science concepts through process of conceptual change. The DSLM comprised of six major stages: (1) examining the attributes of the science concept to provide information in which essential mental sets are needed to construct a scientific view of the concepts; (2) probing students’ misconception on the concept; (3) analyzing for mental sets in which the students lack to pinpoint which and how many particular mental sets students lack for restructuring the science concepts based upon the first pair of DSLM theory; (4) designing dual-situated learning events including the ideas of second and third duals of DSLM; (5) instructing with dual-situated learning events to provide students an opportunity to make predictions and provide explanations before and after the event, and to further explain why they changed their conceptions or retained their original conceptions and (6) instructing with challenging situated learning event to provide an opportunity for the students to apply the mental sets they have acquired to a new situation, ensuring that successful conceptual change to occur (She and Liao 2010).

According to several previous studies, DSLM had been used in learning of physics and chemistry, and the results showed that students had meaningful learning in science concept through process of conceptual change (Srisawasdi and Kroothkeaw, 2014; Srisawasdi and Sornkhatha, 2014). However, there was no study on application of DSLM in biology class before.

2.2 Games-based Learning in Science

A game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” (Salen and Zimmerman, 2004). General characteristics of game are fun and challenge (e.g. leader board). Effective educational computer game should have five characteristics: (i) built on learning principle; (ii) provide personalized learning opportunities; (iii) provide more engagement for learner; (iv) teach 21th century skills; and (v) provide an environment for authentic and relevant assessment (McClarty et al., 2012).

Currently, digital game or computer game plays common role to provide fun and relax because the game can challenges the player to a digital control of the game on their own. As a result, educators are interesting into how to use the game to facilitate and enhance teaching and learning in subject matters. Kumar (2000) suggested utilization of computer games as instructional tools to stimulate intrinsic motivational factors that encourages curiosity and creates the impression to the students by self-controlled learning. In additions, there were several researches showed that digital games can
promote students’ learning and their positive attitudes (Sung and Hwang, 2013), support development of critical thinking (Squire, 2006), and creativity (Annetta, Cheng, and Holmes, 2010). Compared to traditional class, digital game can increase motivation that make students interested to learning better than the traditional (Bergin and Reilly, 2005; U.S. Department of Education, 2010). Moreover, learning with digital games promote collaborative process for learning (Gee, 2005; Sung and Hwang, 2013; Wu, Chiou, Kao, Hu, and Huang, 2012).

3. Methods

3.1 Participants

The participants in this study were 36 twelfth-grade students, age ranging from 17 to 18 years old in a public school in Northeast of Thailand. They are attending a biology course for basic education level and they study in special science program for gifted students. Based on background knowledge of twelfth grade students were learned contents about cell cycle before, in tenth grade.

3.2 Instrument

The instrument in this study is ten open-ended conceptual question items regarding five major concepts about biology of cell cycle, i.e. cell cycle, interphase, mitosis, meiosis and cytokinesis. Before employ the instrument to elicit students’ understanding of these concepts, it was processed construct and communication validity by four independent experts, including two biologists and two biology teachers, and two of ten items were revised following the experts suggestions.

3.3 Procedures and Data Analysis

All students took 60 minutes to complete the series of open-ended conceptual question items. Following this, content analysis was the primary method for analysis of students’ written responses to the open-ended question items, represented their conceptual understanding about biology of cell cycle. The researchers began with repeatedly read the students’ written responses and then development of a general conceptual understanding category. The researchers have analyzed, interpreted, and classified their responses into five categories i.e. scientific conception (SC), incomplete scientific conception (IC), alternative conception (AC), misconception (MC), and no conception (NC). Then the researchers have designed a series of dual-situated learning events for facilitating mechanism of change and revise of their alternative and misconceptions of cell cycle into scientific conception. The dual-situated learning events were emphasizing into the design of a digital game of cell cycle.

4. Results and Discussion

Based on the five categories (SC, IC, AC, MC and NC) interpreted students’ unscientific conceptions, the percentages of quantity of a combination between students’ alternative- and misconceptions and their no conceptions on the interphase concept was displayed in Figure 1.
According to Figure 1, the percentages for combination of alternative- and misconceptions for incident of interphase and importance of interphase were 11.1% and 8.3%, respectively. The percentages of no conception for incident of interphase and importance of interphase were 0% and 8.3% respectively. The result of students’ alternative-, mis-, no conceptions on meiosis concept was illustrated in Figure 2.

As seen in Figure 2, the highest percentages for combination of alternative- and misconceptions on the concept of meiosis were (i) type of cells and properties of organism, (ii) important incident in anaphase I, (iii) important incident in prophase I, and (iv) products, and there were 58%, 47.3%, 25%, and 13.9% respectively. The percentage of no conception was highest on the products concept (75%), and there was none of the students who had no conception on the important incident in prophase I. This means the researchers should focus to design learning event for the process of conceptual change for this sub-concept, but it need to be ground the students’ conceptual understanding in the learning events for another three meiosis sub-concepts. In the next, Figure 3, the results of students’ conceptions of process and products within mitosis concept were presented.
As shown in Figure 3, there was a small number of the students who hold alternative- and misconception on process and products sub-concept (8.4%). However, more than a half of them showed no conception on the concept (61%). This means there need help for facilitating construction of conceptual understanding regarding the concept of process and products. The result of students’ alternative-, mis-, no conceptions on cytokinesis concept was depicted in Figure 4.

Figure 4 shows the percentage for combination of alternative- and misconception for comparison between animal and plant cell was about the half of them (47.2%), and for no conception was 13.9%. This revealed that this concept need a couple for student learning, both grounding scientific concept and changing unscientific concept. For the main concept of cell cycle, Figure 5 displayed students’ conceptions on the sub-concept of important of cell cycle and types of cell.
In Figure 5, none of students’ unscientific conceptions on importance of cell cycle were found and only 22.2% of them showed incomplete conceptions in this sub-concept. This means most of them were able to comprehend the sub-concept from the regular class. Nevertheless, a half of them (50%) hold unscientific conceptions on type of cells sub-concept, and there was 44% who had no conception about the concept.

The findings of this study consistent with the previous finding that many students hold alternative conceptions in mitotic and meiotic division (Ozcan, Yildirim, and Ozgur, 2012). Moreover, the results also confirm to a research carried out by Lewis and Robinson (2000) that high school students hold unscientific understanding, and encounter learning difficulty and they cannot understood on biological concepts of DNA, gene, chromosome, mitotic and meiotic division.

According to the DSLM approach the researcher used, Table 1 shown examples of students’ alternative conceptions in cell cycle concepts and the design of learning events to address and facilitate conceptual change. Moreover, the next section illustrates the design of digital game-based inquiry learning in biology of cell cycle.

**Table 1: Designing dual-situated learning events regarded students’ alternative conceptions on cell cycle.**

<table>
<thead>
<tr>
<th>Concept</th>
<th>Sub-concept (item)</th>
<th>Example of students’ alternative conceptions</th>
<th>Design of learning event to address the alternative conceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interphase</td>
<td>Incident of Interphase (1)</td>
<td>DNA synthesis occurs in G1 phase.</td>
<td>Comparison of necessary compounds for biological process occurred in G1, S, and G2 stage (Learning Event#1)</td>
</tr>
<tr>
<td></td>
<td>Importance of Interphase (2)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Meiosis</td>
<td>Type of cells &amp; properties of organism (3)</td>
<td>Meiosis occurs in reproductive organs, for example, testes and ovaries.</td>
<td>Comparison between the origin of somatic cell and reproductive cell (spermatogenesis and oogenesis) (Learning Event#2)</td>
</tr>
<tr>
<td></td>
<td>Important incident in prophase I (5)</td>
<td>Crossing over occurs in prophase II of meiosis process.</td>
<td>Identification of key characteristics of “crossing over” (Learning Event#3)</td>
</tr>
<tr>
<td></td>
<td>Important incident in anaphase I (6)</td>
<td>Segregation of homologous chromosomes occurs in telophase I.</td>
<td>Comparisons among meiosis I, meiosis II, and mitosis (Learning Event#4)</td>
</tr>
<tr>
<td></td>
<td>products (7)</td>
<td>Segregation of homologous chromosomes occurs in anaphase II.</td>
<td>-</td>
</tr>
</tbody>
</table>

![Figure 5. Distribution of conceptual understanding on the cell cycle concept.](image)
Mitosis | Process and products (4) | When mitosis completed, there is followed by meiosis.  
--- | --- | ---  
Cytokinesis | Comparison between animal cell and plant cell (8) | Similarly, both plant and animal cell have process of mitotic karyokinesis.  
Cell cycle | Importance of Cell cycle (9) | Comparison between cytokinesis of plant cell and animal cell (Learning Event#5)  
Type of cells (10) | There may be fix over. | Comparison of different types of cell (Learning Event#6)  

### 4. The Design of Digital Games about Cell Cycle

According to the stage 4 of DSLM, learning events associated students' unscientific conceptions on cell cycle has been design and presented in the previous section (See Table 1). To develop the digital games which facilitate process of conceptual change, the researchers employed the designed learning events as a basis to create a prototype of "The Cell Cycle Game". This game consists of two parts: game playing and visualization. Figure 6 illustrates interaction part of game playing in the cell cycle game, and Figure 7 displays visual representation about cell division, both mitosis and meiosis.

![Figure 6](image)

Figure 6. Example illustration of "The Cell Cycle Game": (A) a screen for selecting a car represented a type of cell; (B) a screen for controlling the car (a type of cell) and collecting nutritive essence for cell development.

![Figure 7](image)

Figure 7. Example illustration of visualization, embedding in the game: (A) a screen representing mitosis process of cell division; (B) a screen representing meiosis process of cell division.

### 5. A Proposed Learning Process of Digital Game-based Open Inquiry with Dual- situated Learning Model on Cell Cycle

This section presents a proposed inquiry learning process using the cell cycle game. The simulation-based open inquiry with dual-situated learning model (Srisawasdi and Kroothkeaw, 2014;
Srisawasdi and Sornkhatha, 2014) was applied for the proposed learning process. Table 2 displayed an example of the learning process on cell cycle concept.

Table 2: Example of the design of learning process by game-based open inquiry with dual-situated learning model

<table>
<thead>
<tr>
<th>The main stage</th>
<th>Components of the proposed learning process</th>
<th>Example of learning process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-gaming</td>
<td>Open-ended inquiry question</td>
<td>Teacher provides an open-ended inquiry question: “How many DNA during the cell division?”</td>
</tr>
<tr>
<td></td>
<td>Scientific background/information</td>
<td>Teacher encourages collaborative discussion on basic information related the question by presenting a concept map of cell cycle.</td>
</tr>
<tr>
<td>Collaborative gaming</td>
<td>Procedure/design</td>
<td>Students are classified into small group to play game. Each group designs their own task, independent selecting a type of cell, to play game.</td>
</tr>
<tr>
<td></td>
<td>Data and result analysis</td>
<td>After the interacting with the game, students make a decision to analyze obtained playing game data e.g. scores and interpret it into a graphical representation.</td>
</tr>
<tr>
<td>Post-gaming</td>
<td>Result communication</td>
<td>Students have to select the way to present, communicate, and discuss the meaning of data for whole class.</td>
</tr>
<tr>
<td></td>
<td>Conclusion</td>
<td>Students have to collaboratively make a relationship between each group results and then show conclusion as the best answer to the provided question.</td>
</tr>
</tbody>
</table>

In this learning process, student will collaborative work together in small groups of three to five members. This pedagogy begins with an open-ended driving question targeted to alternative conceptions about cell cycle commonly found in students. To assist the process of hypothesis generation addressed the question, essential scientific backgrounds are provided to students. Then, students are required to perform generating testable hypotheses, designing an investigation with the cell
cycle game. During playing the game, each group was assigned to access Google Drive spreadsheet, preparing by instructor, for recording scores and what they found into a predetermined table. In an addition, each group was assigned to analyze the recorded data by comparing individual score and also use Google Chat for discussing in the group. When they finished the game, all groups have to communicate findings among groups by creating a PowerPoint presentation via Google Drive presentation. Finally, instructor induces students into a forum for drawing a conclusion based on evidence and collaborative explaining the result of hypotheses testing.

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References


Mobile Augmented Reality in Supporting Performance Assessment: An Implementation in a Cooking Course

Kuo-Hung CHAO a, Chung-Hsien LAN b*, Yao-Tang LEE c, Kinshuk d, Kuo-En CHANG e, & Yao-Ting SUNG f

a Assistant Professor, Hsing Wu University, Taiwan
b Assistant Professor, Taoyuan Innovation Institute of Technology, Taiwan
c Assistant Professor, Nan Kai University of Technology, Taiwan
d Professor, Athabasca University, Canada
e,f Professor, National Taiwan Normal University, Taiwan

*chlan@tiit.edu.tw

Abstract: In this study, a conceptual system framework was developed by integrating augmented reality (AR) technology to reduce the limitations in observation and assessment during performance assessment. Thus, the efficiency and reliability of mobile performance assessment can be enhanced. The processes of student performance can be presented from diverse approaches by using the characteristics of mobile devices and AR and considering the categories and situations of student performance. In this study, a novel mobile performance assessment system that incorporates AR to the processes of observation and assessment in performance assessment was developed. The mechanism emphasises the approaches adopted to present student works and provides opportunities for enhancing student communication and interaction. In addition, the system enables students to explain their works and incorporate the feedback they receive into future work. More importantly, mobile AR can be applied to offer personalised features and appropriate information in particular areas. Hence, students can interact with real or virtual information based on their needs. During this process, students can observe their own works from varying perspectives, acquire vital knowledge, develop the skills of critical thinking, and transform the process into a substantial self-established learning process.

Keywords: Augmented reality, performance assessment, mobile learning

1. Introduction

Conventional paper-based tests are adopted extensively in school education because the scoring is objective and the tests are easy to implement and have relatively high reliability and validity. However, this type of test has been criticised for being fragmented, having situations removed from the learning process, overemphasising cognition, and confining learning. Based on the popular educational philosophy of allowing students to develop diverse capabilities and achieve active knowledge building, performance assessment should be considered as a vital link in teaching. In addition to assigning a final score to students, the purpose of assessment is to develop a highly in-depth understanding regarding the process that students undergo during learning and to provide feedback to assist in student growth. Performance assessment, which is an assessment method that became widely used again after the 1980s, emphasises assessing actual performance and behaviour. This approach can be employed to compensate for the inadequacy of the paper-based test approach and assess the diverse disposition- and
skill-based achievements of students. O’Neil (1992) indicated that assessment plays a vital role in teaching and that the process of assessment consists of goal setting, data collection, organisation, and result analysis. The results can be used to enhance teaching and report the actual progress of students. By conducting assessments, teachers can evaluate students’ learning outcomes and identify relevant factors, which can be used to devise improved methods for enhancing the effectiveness and quality of teaching. Considering the value of assessment, establishing a sound assessment mechanism is imperative for achieving multiple purposes and functions. Most teachers have had the experience of being questioned by parents if their children have failed tests because the teachers are biased against their children. In the assessment of design works, particular students have the misconception that they should receive a passing grade as long as they submit their assignments. This phenomenon has generated the discussion whether a well-defined set of assessment criteria should be applied when teachers are assessing the design works of students, who are highly self-aware. These students directly question teachers regarding the assessment criteria once they realise that their grades are unsatisfactory. In other words, students are no longer passive recipients of assessment results, but rather are attentive regarding their learning outcomes.

Nevertheless, a major problem encountered by the education community is determining the appropriateness of educational evaluation. Beywl and Speer (2004) found that previous studies had emphasised that the various dimensions of assessment in the narrow and broad senses must be consistent for an evaluation to be substantial, indicating that the assessment methods employed should be diverse. Problem-solving abilities are often regarded as abilities that require high-level reasoning or thinking and intelligence. Performance assessment has been recognised as one of the most effective methods for assessing this type of high-level thinking because this approach emphasises the application and demonstration of abilities in problem-solving situations and the complexity of problem-solving processes (Wiggins, 1993).

Although less objective and convenient compared with conventional paper-based tests, performance assessment can result in encouraging education outcomes when implemented under certain conditions. Previous studies (Dunbar, Koretz, & Hoover, 1991; Jiang, Smith, & Nichols, 1997; Baker, 1996; Messick, 1992) have indicated that the primary limitations and disadvantages of the performance assessment approach include the lack of comparison, limited reliability, unsatisfactory economic performance, and low validity. However, the majority of these factors can be attributed to the subjective consciousness of the assessors and errors in the measured situations. By contrast, augmented reality (AR) technology can be employed to display, in real situations, real-time information that is necessary for assessing or learning. From the perspective of cognitive psychology, this approach can be applied to reduce the errors resulting from the process of performance assessment and to minimise the time and economic costs that teachers must bear when observing student behaviour. Therefore, we examined the meaning, relevant studies, and limitations of performance assessment before investigating the effects that incorporating AR technology exert on improving performance assessment systems. Subsequently, we applied an AR-based performance assessment system to a cooking course to explore the effects of the application. The results yielded by conducting the performance assessment and paper-based tests were compared before a conclusion and recommendations were provided. The results of this study can serve as a reference for implementing performance assessment in teaching.

2. Performance Assessment

Performance assessment requires that students apply the knowledge and skills they have learned to perform hands-on practice rather than simply revalidating and recollecting the experience of learning (Roeber, 1990). This assessment method satisfies the needs of the current trend of constructivist learning and teaching (Chang, 2002b). Performance assessment motivates students to integrate the knowledge, skills, and dispositions required in the subject, and the results of the assessment can reflect students’ problem-solving abilities in real life and the interest and needs of the students. Performance assessments, which can be conducted to evaluate high-level cognitive abilities and the dispositions and skills of students, are more comprehensive in the contents tested compared with conventional paper-based tests. Performance assessment can be integrated into teaching activities rather than being separated from teaching. Thus, teaching can be performed without interruptions. Furthermore, by adopting specific performance and assessment criteria, teachers can provide students with specific feedback, which motivates students to take initiatives in learning and assume the responsibility to
critique their own works and strategies. Therefore, performance assessment is an effective approach for facilitating teaching and learning.

Performance assessment was initially called performance-based assessment when the concept was first applied to education. Specifically, performance refers to the process of completing a task. The concept emphasises the authenticity and representativeness of the assessment regarding particular abilities as well as the significance of learning and evaluating in meaningful and real situations. By contrast, the concept of performance emphasises the necessity in challenging the intelligence, knowledge, and skills of the learners and the necessity in mastering the contents, processes, and outcomes of learning (Wiggins, 1993). Airasian (1996), Fitzpatrick and Morrison (1971), and Wiggins (1992) have indicated that in performance assessment, students are required to participate in an activity or create a piece of work to demonstrate the knowledge and skills they possess. Thus, students are required to demonstrate what they know and are capable of in actual situations. Aschbacher (1991) argued that the performance assessment in teaching-learning situations refers to teachers using their professional judgment to assess students’ learning performance, which includes students’ responses to tasks, the works delivered, and the process of learning. The characteristics of the performance assessment in this context are listed as follows: (a) students are expected to perform tasks or create objects that require high-level thinking or problem-solving skills; (b) the tasks based on which the students are assessed are meaningful, challenging, and integrated with teaching activities; (c) the tasks based on which the students are assessed are connected with real life; (d) processes and products are often the focuses of assessment; and (e) the assessment criteria and standards, which are vital dimensions and standards of the assessment, must be defined in advance (Herman et al., 1990).

The purpose of performance assessment is to motivate students to engage in useful, beneficial, and meaningful activities. Regarding form, this type of assessment is a component of learning activities, which require high-level thinking skills, an understanding of relevant concepts, and the ability to link various forms of knowledge. In addition, this type of assessment involves a specific explanation regarding the bases upon which student works are assessed. Therefore, the assessment is essentially a process of standard building rather than standard testing. Thus, the ultimate objective of performance assessment is to motivate students to comprehend the teaching contents and reach achievement standards by participating in teaching activities (Dorn, 1999). When performance assessment is conducted, students are required to apply particular learning results to daily situations. During the process of problem solving, students can reference necessary knowledge and independently build subject-specific knowledge and evaluate the possibility of the results. By so doing, students are motivated to independently determine what they want to learn and thus acquire knowledge actively. During performance assessment, the processes of thinking and the results yielded from the processes are both assessed. When implementing performance assessment, teachers can evaluate students’ understanding of the problems, involvement, problem-solving skills, and self-expression abilities. Thus, the learning outcomes and learning processes of students can be fully reflected.

The purpose of performance assessment is using assessment to promote student development. The tasks designed for performance assessment, such as design-related experiments and system operation tasks, are often difficult for students to complete independently. Instead, students must work in teams and cooperate with their team members. Hence, during assessment, allowing other students and teachers to provide feedback on the assessment standards, record the processes, and evaluate the progress made by the student under assessment offers more opportunities for teacher–student and peer interactions. During these interactions, students can communicate and explain their learning experience and contemplate the learning process. In addition, the process of teamwork enables students to develop the abilities to communicate and cooperate with their peers and to develop favourable work attitudes. The difference between teachers (experts) and novices is that experts understand how to effectively use the knowledge they have acquired. Performance assessment enables teachers to comprehend the thinking process students undergo by observing the process of students’ operations. Thus, teachers can understand whether the students’ operations comply with the prescribed procedure.

To determine the effectiveness of a test or an evaluation method, we must explore the effectiveness of the method and the results based on the intended purposes. Ou (2002) asserted that one of the purposes of performance assessment is to offer a real and specific situation for students to demonstrate their knowledge and skills and thus make correct inferences regarding students’ learning achievements. In this context, the accuracy with which the assessment results reflect the teaching goals can be enhanced. One of the characteristics of performance assessment is that students are allowed to flexibly use days of
a week or several weeks to engage in high-level thinking before completing their tasks. In terms of presentation, no correct answers or uniform patterns apply in performance assessment. Instead, the ambiguity of situations enables students to adopt various approaches to demonstrate individual creativity.

Gronlund (1993) and Linn (1991) have indicated that the purpose of performance assessment is to establish a model that enables students to focus on real learning activities. A course-oriented assessment approach is established when performance assessment is closely integrated with a course. This form of assessment system can inspire students and teachers to strive to enhance learning outcomes. The methods used in performance assessment are often one of the following: (a) checklists, which are used to evaluate whether the asseesees exhibit a particular behaviour; (b) rating scales, which are employed to evaluate whether the asseesees exhibit a particular behaviour and to rate the behaviour based on the extent; and (c) anecdotal records, where texts are used to describe and interpret assessee behaviour.

3. Limitation of Performance Assessment in Learning

Performance assessment, where the rating is often performed by professionals based on their observation and judgment, is subjective, demanding, and low in reliability compared with paper-based tests. In addition, the fairness of performance assessment is often questioned because the results cannot provide immediate feedback on student performance. Therefore, a critical problem that necessitates solution in implementing performance assessment is devising fair and objective rating criteria that are easy to apply and can be used to provide feedback to students (Lu et al., 2005). According to Lu et al. (2005), the criteria must also be able to provide specific answers to parent questioning, enable students to understand the dimensions of their learning capabilities, provide students with information that can be used to examine and evaluate their performance, offer feedback on student performance, and enable teachers to determine whether the assessment results truly reflect the response processes of students. Performance assessment often simultaneously involves multiple rating standards, some of which are objective and quantitative (e.g., completion time, quantity of completed work, materials consumed, and error) and some are subjective and qualitative (e.g., the originality and comprehensiveness of the completed work, the proficiency of action, and safety; Ou, 2002).

The application of performance assessment ranges from classroom teaching to large-scale surveys such as those conducted for appraisal purposes. A major concern in these forms of assessments is general quality control (Dunbar, Koretz, & Hoover, 1991). A previous study regarding performance assessment found that errors in the generalisation of performance assessment is primarily affected by the following four factors: (a) the items or activities used in the assessment, (b) the assessors, (c) the situations in which the assessments are conducted, and (d) the unintentional influence of assessesees or other people (Jiang, Smith, & Nichols, 1997).

To determine whether a student has mastered a skill, the evaluator must collect performance data on multiple occasions. The number of observations necessary for making decisions can be determined based on the importance of the decision, the amount of time that an observation consumes, and whether the teacher has collected sufficient samples for evaluating student performance and behaviour. Hence, carefully and comprehensively observing all details in a single observation is equally vital for the assessors and asseesees. Thus, the assessors can obtain all details by conducting only a minimal number of observations, thereby reducing the cost of assessment. Simultaneously, the asseesees can benefit from fair assessments performed based on records that contain all details regarding their performance.

Another question involves assessor selection: Should teachers or professionals act as the assessors or should students perform self-assessment or peer assessment? Regardless, the assessors should have received training on rating.

Performance assessment has long been extensively applied to various fields primarily because this assessment method has advantages that cannot be achieved by conducting paper-based tests. Nevertheless, this method has limitations that must be overcome. Previous studies have shown that the limitations of performance assessment include the following concerns: rating is subjective; the criteria adopted by various assessors are inconsistent; the assessors do not truly understand the connotation of the assessment; the assessors do not follow the standardised assessment processes; and the rating
standards are undefined and time- and energy-consuming. To enhance the fairness and objectivity of performance assessment, scholars have developed procedures for implementing performance assessment. Among the steps defined by multiple scholars, the following four steps are indispensable: (a) defining the purpose of assessment, (b) confirming the assessment standards, (c) designing tasks or activities, and (d) selecting a rating or assessment method (Chen & Martin, 2000).

In summation, when performance assessment is applied to assess the operation and production of actual works, the fairness, objectivity, convenience, and timeliness of assessment must be considered to overcome the limitations of this method. These factors were used as the references for developing the questionnaire employed in this study. The following paragraphs list the primary limitations of performance assessment and how AR technology was employed to solve the problems:

Lack of comparability: In conventional standardised tests, the results can be compared against established norms; therefore, result interpretation is specific and clear. By contrast, the results of performance assessment are often affected by the subjective judgments of teachers; additionally, the criteria employed are occasionally confusing, thereby increasing the difficulty involved in comparing and interpreting the assessment results. The process of student performance can be recorded and students and teachers can employ AR technology during the rating process. Thus, the assessors and assessee can appear in real-time situations and serve as the direct references for assessment processes, thereby enhancing the accuracy of assessment.

Limited reliability: The majority of manual assessment methods are subject to the subjective influence of the assessors. Unlike standardised tests, for which computer scoring can be adopted, performance assessment relies on assessor observation and judgment. Consequently, the reliability of the assessors should not be overlooked. The errors in assessor reliability result from the assessors, and a satisfactory rating system can reduce assessor errors (Baker, 1996). We can employ AR to present the processes of work production or the implicit details hidden in the works. Thus, assessment accuracies can be increased substantially and the risks of rating errors resulting from assessor negligence or excessively short observation time can be reduced.

Unsatisfactory economic performance: The amounts of time and money spent on performance assessment are considerably greater than those spent on paper-based tests. Using AR to present the production processes of works can reduce the travel costs that teachers would otherwise spend for conducting on-site observations. In addition, the assessors can watch videos repeatedly to reduce rating errors and the amount of effort that teachers must spend on assessments can be reduced. Furthermore, occasionally teachers must simultaneously observe multiple students, thereby rendering them unable to observe all details within a particular period. Adopting AR can prevent this problem.

Low validity: In performance assessment, ambiguous problem situations are designed to test the high-level thinking abilities of assessee. Nevertheless, the validity of ambiguous problems is difficult to control; consequently, the assessment can be irrelevant to the teaching contents. An AR-integrated system can show in real-time the rating standards and the feedback from teachers or peers; thus, the associated cognition of feedback materials and student works can be enhanced. Therefore, students can more effectively immerse themselves into the teaching situations, thereby improving the validity of assessments.

4. Methods of the Performance Assessment Conducted in Hands-on Performance Courses

The assessment conducted in implementation activities are considered assessments conducted during activities. Performance assessment is often based on observation; thus, it can also be referred to as the work evaluation method (Tsai, 1996).

Establishing a set of criterion to be used in performance assessment enables designers to perform self-assessment during the processes of creation and development and the completion stage and enables assessors to eliminate uncertainty and overcome the complexity involved in the assessment. According to Wolansky (1985), a U.S. scholar specialising in vocational-education studies, teachers must focus on the following concerns when evaluating student works or productions: (a) the performance of the works
should accomplish the required purposes; (b) records regarding the production processes of the final products should be made available for assessment purposes; and (c) teachers should provide well-defined explanations or standards regarding the quality of the final products. Wolansky emphasised that a standard table or a criteria table is a convenient and informative tool that enables students to understand the standards for excellent work and the contents of assessment. Yunghans (1981) indicated that the standards for evaluating art works should be (a) the purity and openness of expressions, (b) the problem-solving methods exhibited, (c) the duration of focused attention on production, and (d) the attention to detail in images.

Khattri et al. (1998) argued that the results of performance assessment differ when the methods or systems employed vary. Specifically, the following five characteristics of performance assessments should be considered: (a) the purpose of a performance assessment, (b) the format of assessment, (c) the subject areas being assessed, (d) the levels of students, and (e) the implementation of performance assessments.

Gronlund (1993) categorised performance assessments into the following types based on the extent to which the situations used in the tests are true to reality: (a) paper-and-pencil performance, (b) identification tests, (c) structured performance tests, (d) simulated performance, and (e) work samples. The experiments in this study were conducted using a structured performance test and simulated performance.

In summary, the specific steps of rating criterion design are (a) teachers must first determine the target of assessment, be it the process, the result, or both; (b) subsequently, teachers must identify the contents or scopes of observation, list the focuses of the observation and assessment, and explain the significance of the criteria adopted; (c) teachers can discuss the rating criteria with students and ensure that the students truly understand the connotations of the criteria; the rating criteria can also be established by students or jointly by students and teachers; and (d) before conducting a performance assessment, teachers must carefully examine the items regarding detailed behaviour and apply necessary revisions.

5. Performance Assessment with Mobile Augmented Reality

AR enables users to visualise real environments in a real world with the digital information overlaid on real environments (objects or locations), thereby improving user experiences (Berryman, 2012). The combination of additional information and real situations can enhance the senses of reality and presence for people. The theoretical basis for the mobile AR system that integrates human–computer-context interactions is situated cognition. The fundamental argument of the theory is that knowledge acquisition and learning occurs after people interact with situations, which include social environments such as people and social culture, and physical environments such as the contexts formed by scenes and artefacts (Brown, Collins, & Dugid, 1989; Greeno, Collins, & Resnick, 1996).

Applications of AR and high-tech products to situated teaching activities are lacking because the attention that users direct toward additional information and real scenes is difficult to balance. In addition, human–computer-context interactions are difficult to achieve. Participants may focus excessively on human–computer interactions and overlook human–context (objects in scenes and information contexts) interactions, which are more crucial than human–computer interactions in real situations. Therefore, the link between additional information and real environments should be emphasised in the virtual contents presented in AR (Klopfer & Squire, 2008; Chang et al., 2014; Zhang et al., 2014).

In informal learning, the application of mobile devices has recently attracted an increasing amount of attention (Semper & Špasojevic, 2002; Kwak, 2004; Cabrera et al., 2005; Chang et al., 2006; Sung et al., 2010a). However, studies regarding the application of AR navigation are scant (Barber et al., 2001; Sparacino, 2002; Damala et al., 2007; Damala et al., 2008; Portalés et al., 2009).

The mixed reality spectrum (Fig. 2-2) developed by Milgram and Kishino (1994) offers a valuable basis for exploring the integration of reality and virtual reality. AR is situated on the spectrum between virtual and real environments. Based on the definition of mixed reality, Milgram and Kishino developed the linear spectrum, showing the transition from real environments to virtual environments. With real
environments on the left end of the spectrum and virtual environment on the right, AR is located toward
the left end of the spectrum, indicating that the main subject in AR is real objects and that virtual objects
are additional and supplementary. When AR is applied to spaces, implicit spatial information is
transformed to explicit spatial information by employing technologies that incorporate virtual objects
with the real world. Hence, additional values and meaning are added to spaces.

![Mixed Reality (MR)](image)

**Figure 0. Reality-Virtual Continuum**

AR is a technology that incorporates virtual and real objects in real environments (Azuma et al., 2001). AR enables users to visualise real environments in a real world with digital information overlaid on actual environments (objects or locations), thereby improving user experience (Berryman, 2012). Initially, most studies used head-mounted displays to present the results of virtual–real environment integration. Azuma (1997) defined three criteria for AR: (a) the combination of virtual and real environments, (b) real-time interaction, and (c) 3D referencing. Scholars generally agree that AR can be used to enhance the experience that users have when interacting with real environments. In addition, virtual information enables users to obtain information that otherwise cannot be directly acquired from the real world. Because of this feature, AR is considered an effective tool that users can employ to achieve objectives in the real world (Azuma, 1997).

Technically, AR presentation can be divided into the following two types: marker-based and marker-less identification. Specifically, marker-based identification operates based on the principle of quick response codes, which are 2D bar codes or dot matrices in square icons. The markers are locked and read using the cameras on mobile devices and identification software. Subsequently, the interaction is activated using 3D objects or videos. By contrast, marker-less identification is based on the global positioning system. Users can use mobile devices to locate objects that interest them and floating markers or chat boxes are shown to display information through the cameras installed in devices.

Since the 1990s, AR has been applied in various fields, including geography (Vlahakis et al., 2002; Portalés, Lerma, & Pérez, 2009; Priestnall, 2009), linguistics (Liu, 2009), social sciences (Hedley et al., 2002; Mathews, 2010; McCall et al., 2011), mathematical sciences (Wang, 2007; Yim & Seong, 2010), natural sciences (Klopfer & Squire, 2008; Liu, Tan, & Chu, 2009; Zhang et al., 2014), biomedicine (Vilkoniene, 2009; Strickland et al., 2011), arts and humanities (Shen, Ong, & Nee, 2010; Chang et al., 2014), leisure and recreation (Portalés et al., 2010; Wang & Chen, 2009), and advertising and marketing (Moltenbrey, 2011).

Barber et al. (2001) indicated that using smartphones to display additional information and placing the screens next to student works is essentially integrating virtual and real environments into the same view. Thus, the number of times users switch between the exhibited works and description plaques can be reduced and the number of searches users must make can also be minimised. In a study conducted by Dunleavy et al. (2008), the students engaged in role-playing tasks by using AR. Specifically, the students walked around campus while the cameras on the mobile devices they were holding displayed digital objects and virtual characters that were overlaid onto real spaces. Video, audio, and text files were used to provide clues and challenges for narration, navigation, and cooperation. Thus, the learning objectives for subjects such as math, language arts, and scientific literacy at junior and senior high schools can be accomplished.

Damala et al. (2008) agreed that the integration of virtual and real environments revolutionised the interaction between people and objects in an unanticipated manner. The tiny screens on the devices can represent complete environmental spaces and facilitate establishing a close relationship between the
appreciated works and additional information. However, AR technology requires improvement when applied to learning activities (Billinghurst et al., 2003; Dunleavy et al., 2008; Wang & Chen, 2009; McCall et al., 2011). For example, considering the coexistence of virtual and real environments in AR, the additional information presented in AR may be designed to attract participant attention so that the participants can see the information. Consequently, the participants may excessively focus on the contents shown in the AR system, particularly on the additional information, and ignore the actual environment and surroundings (Billinghurst et al., 2003; Dunleavy et al., 2008; Wang & Chen, 2009). In summation, to design a performance assessment learning system that achieves human–computer-context interactions, we employed AR technology to develop a performance assessment system that enables peer assessment. In this system, the criteria based on which learners produce their works or assessors evaluate the works are predefined. Thus, students can evaluate their own works or peers’ works based on sufficient information, thereby developing strong learning motivations and achieving great efficacy. In addition, teachers or assessors can spend comparatively less time and simultaneously evaluate assessee’s works accurately and fairly.

6. System Realization and Illustrative Example

6.1 System Architecture
In the field of education, numerous situations cannot be experienced or represented in the classroom setting. AR is the most appropriate technology for incorporating or adjusting students’ learning experience based on specific needs. AR is defined as a real-world environment whose elements are built upon computer-generated sensory input such as sound, video, graphics or GPS data. In this study, AR allows students to see virtual objects about peers’ works or contents in a real world environment with the aid of camera during the assessment process. The overall framework of the use of mobile AR technique in performance assessment is described in figure 1.

![Figure 1. The architecture of the mobile AR technique](image)

The entire processes of learning and assessment can be divided into the following three modules: the authentication module, the context-aware module, and the interactive assessment module. In addition, the process is supported by four databases on cloud servers, which are student profiles, a hardware sensor, the AR and virtual object database, and the assessment database. The authentication module enables authorised people to obtain appropriate information for completing corresponding tasks. The context-aware module enables assessors to employ appropriate device functions for accessing suitable information for performing rating. In the context-aware module, mobile devices list appropriate learning contents after detecting student locations and collecting onsite information. Thus, learners can select appropriate learning materials from the content model. The content model retrieves appropriate materials from the virtual object database before providing them to assessors. Subsequently, learners
can use the authoring tool provided by the system to establish an AR marker, work descriptions, and an AR context object. Once all steps are completed and the information is uploaded to the system, appropriate virtual information is used through AR technology to overlay images onto corresponding objects in the real world. Thus, assessors can rate the works conveniently and accurately. Through the AR work presentation technology employed in the system, the assessment module enables assessors to conveniently and directly observe the works of peers. Hence, assessors can provide feedback for the peers they evaluate. In addition, the system can be employed to develop a work-specific exhibition situation for peer references, thereby enabling peer assessors to provide feedback. Additionally, teachers can use the AR performance assessment system to understand the peer assessment performed by students before providing feedback for the assessors and assessees. More importantly, teachers can integrate previous cases to develop new teaching situations that are highly appropriate and inspiring.

6.2 Walk-through Illustrative Example

The methods for conducting performance assessment are diverse, including observation, document records, and real-time performance. The methods adopted in this study were real-time performance and peer assessment. Peers who possessed similar knowledge levels observed and learned from each other before offering recommendations. Specifically, a class of 50 sophomore students at the culinary department of a technical institute were recruited as the participants of this study. A performance assessment experiment was conducted during a training course for cooking licenses in Western cuisine. The students were divided into groups of five, obtaining a total of 10 groups. The group members divided the labour between themselves. The students were randomly assigned to the groups without considering sex or cooking skills. During class, the teacher designated an item from the licensing examination as a task. The teacher demonstrated the cooking procedure once, after which the completed set was recorded and used as an item marker in the AR performance assessment system. Before the students began the performance, they used mobile devices (tablet personal computers) to photograph the sample. Subsequently, the system displayed real-time information (learning mode) that corresponds to the dish onto the dish image, such as the ingredients that should be prepared and the steps of cooking. Thus, students can follow the instructions during the performance and record the process of cooking by using mobile devices. Subsequently, the videos were uploaded to cloud servers and arranged by the
names of the dishes. After all the dishes were completed, the system integrated all the data and was prepared for peer assessment. The system enables assessors to review the records of assessed dishes for reference. After the assessment mode began, the system listed the content and assessment criteria of the set for the assessees rather than listing information regarding the dishes after the samples were scanned. The assessees prepared the ingredients for cooking the dishes and had every step recorded before the videos were uploaded to cloud servers. Subsequently, the system integrated the information for the teachers to provide ratings and feedback. The procedure of the experiment is shown in Fig. 2.

During assessment, the AR performance assessment system identifies each dish and lists the contents when the assessors use the cameras on their mobile devices to photograph the sets completed by the assessees. When an assessor selects the name of a particular dish, the video showing the cooking process is immediately shown on the screen. In addition, the assessment criteria are displayed simultaneously, enabling the assessors to perform the assessment intuitively and clearly. Because the entire cooking procedures were videotaped, the assessors were able to observe all the details that interested them. Thus, the assessors did not miss crucial details as they otherwise would when simultaneously observing several groups of students. Additionally, the assessment criteria adopted are consistent because they are shown in real-time. Hence, the errors in performance assessment can be minimised.

Furthermore, the assessors can provide real-time feedback and recommendations during assessment. The feedback can be uploaded to cloud servers immediately following assessment. Thus, the students can immediately review and share the feedback and recommendations regarding their works and further discuss among themselves by using the system. Real-time sharing and the real-time display of assessment criteria enable students to immediately understand the advantages and disadvantages of their works and to use the feedback to improve their works. Thus, the learning objectives were achieved.

7. Conclusion

This paper presents the novel framework of an enhanced performance assessment system complemented by the use of smart and mobile devices. Integrating the AR technology overcame some of the limitations of conventional performance assessment systems, such as the implementation method, excessively high costs, and substantial errors. In this framework, the AR technology enables students to observe how their peers completed their works by displaying videos of the cooking process over the completed dishes. During the assessment, students can determine whether their peers followed the instructions correctly by comparing the performance against the assessment criteria. By doing so, students can discover their own inadequacies or learn from other people’s methods. In addition, the system provides each student stable and convenient information and digital content based on environmental parameters or the identification of particular objects. Thus, students can learn while engaging in activities based on which their performance is assessed. Students can obtain appropriate learning information by using mobile devices to photograph and identify target objects at appropriate moments and particular locations. The novel framework developed in this study, in which the AR technology was integrated, enables students to use various methods to observe the cooking processes and completed works of their peers. Simultaneously, the students can receive real-time feedback and recommendations regarding their own works. Hence, the barrier resulting from conflicting opinions between students can be eliminated, and students’ understanding of each other’s opinions can be enhanced. Thus, the accuracy of the results of performance assessment can be improved. From the perspective of cognitive psychology, showing assessment criteria and feedback in real-time situations during assessment enables students to develop strong impressions of the feedback. Therefore, the students are highly capable of incorporating the feedback into their future work to achieve improvement and growth. The novel AR-integrated framework used in this experiment is almost complete. However, additional work is necessary. For example, studies can be conducted using an experiment sample that is larger than that used in this study, a large number of performance tests in a classroom setting, and an enhanced system.
References


Investigating effects of mobile learning in familiar authentic environment on learning achievement and cognitive load

Rustam SHADIEV\textsuperscript{a}, Wu-Yuin HWANG\textsuperscript{b}, Yueh-Min HUANG\textsuperscript{a} & Tzu-Yu Liu\textsuperscript{c}

\textsuperscript{a}Department of Engineering Science, National Cheng Kung University, Taiwan
\textsuperscript{b}Graduate Institute of Network Learning Technology, National Central University, Taiwan
\textsuperscript{c}Bei-Zheng Junior High School, Taiwan

Abstract: This study designed English as foreign language learning activities in a familiar authentic environment with mobile technological support. Students learned at school and then applied new knowledge to solve daily life problems by taking pictures of learning objects, describing them, and sharing their homework with peers. This study carried out two experiments in which 59 junior high school students participated. One class with 28 students served as the control group in the experiment 1 and as the experimental group in the experiment 2. The other class with 31 students served as the experimental group in the experiment 1 and as the control group in the experiment 2. Control students studied and completed each learning activity with traditional textbooks while the experimental group studied with an electronic textbook and a learning system installed in the tablet PCs. This study aimed to investigate effects of mobile learning in familiar authentic environment on learning achievement and cognitive load. This study discusses results, research findings, and implications along with conclusions and several suggestions for future development and research.

Keywords: Mobile learning, familiar authentic environment, learning achievement, cognitive load

1. Introduction

The rapid advancement of information and communication technology created new opportunities in the design of the instruction (Hwang et al., 2014; Shadiev, Hwang, Huang, & Yang, 2014). According to the related studies, for instance, mobile technology provides such advantages as learning anywhere and anytime, and how one likes (Hwang, Chen, Shadiev, Huang, & Chen, 2012). Chang, Tseng, and Tseng (2011) suggested that mobile technology creates an authentic learning environment in a real-world context in which learners adapt learning content to the context they find themselves in. Furthermore, mobile technology can be used as a cognitive tool to aid the learning by decreasing the cognitive load (Hwang, Wu, Zhuang, & Huang, 2013). Therefore, mobile-assisted learning has been successfully implemented in many studies to manage cognitive load and facilitate learning; for example, in a social science course (Hwang et al., 2013) or foreign language learning (Chen, Hsieh, & Kinshuk, 2008; Chang et al., 2011).

The literature review of this study revealed several issues that they need to be addressed appropriately. First, several studies were carried out to reduce cognitive load in English learning; however, focus of most of them was limited to vocabulary learning and reading and listening comprehension (Chang et al., 2011; Chen et al., 2008). Therefore, cognitive load associated with speaking and writing skills, was overlooked in related studies. Second, familiar context that creates advantages in comprehension, recall, and cognitive load and which can be found in authentic environment, was not considered in most related studies. An authentic learning environment was created in a local temple (Hwang et al., 2013), in a zoo (Chang et al., 2011), or a classroom Chen et al. (2008) by employing mobile technology but learning context there was not so familiar to students. Third, in most previous related studies, active application of knowledge did not get sufficient attention (Chang et al., 2011; Chen et al., 2008; Hwang et al., 2013). In these studies, a mobile learning system provided learning content, guided students to the learning targets, displayed questions, and students
were asked to answer them. Such learning process facilitates only low level cognitive processes (i.e. information recall).

To address these issues, this study designed various learning activities supported by a mobile technology. In learning activities, students could learn in class and then freely apply what they learned to solve daily life problems in a familiar authentic environment (e.g. their home or a local convenience store). In this study, students took pictures of learning objects in a familiar authentic environment and described them by using English as a foreign language. This study aimed to investigate how mobile learning in familiar authentic environment effects learning achievement and cognitive load.

2. Cognitive load

Mayer and Moreno (2003) and Paas et al. (2003) argued that cognitive load is a central consideration in the design of the instruction. The reason is that a learner has limited cognitive capacity to accommodate demands imposed by learning task, due to working memory (Paas et al., 2003). According to Mayer and Moreno (2003) and Paas et al. (2003), learning performance can be negatively affected when cognitive load exceeds the limit of cognitive capacity. Three types of cognitive load were distinguished in related literature: intrinsic, extraneous, and germane (Brunken, Plass, & Leutner, 2003; Sweller, Van Merrienboer, & Paas, 1998). Intrinsic load is determined by the inherent nature of learning material, learners’ expertise and an interaction between them; that is, the amount of information units that a learner needs to hold in working memory to comprehend the information. Extraneous load is referred to cognitive load caused by the format and manner in which information is presented and by working memory requirements required to do the instructional activities. Extraneous load can be imposed by improper instructional design. Germane load is determined by learners’ effort to process and comprehend the learning material. This load is also associated with motivation and interest. Germane load is induced by appropriate instructional design and it can enhance learning.

3. Managing cognitive load in authentic learning environment

It is suggested that learning activities in authentic environment are likely to facilitate students' cognitive activity and conceptual change (Shadiev, Hwang, & Huang, in press). Furthermore, in authentic environment, cognitive tools, such as mobile multimedia applications, can aid the learning by decreasing the cognitive load. Hwang et al. (2013) introduced a mobile learning system to aid sixth grade students’ local culture learning during field trip in the social science course. With the system, students accessed physical and virtual resources in authentic environment; the system presented the learning tasks, guided students to visit the real-world learning targets for exploration, and provided them with supplementary materials via the mobile devices. The effects of this approach on students’ cognitive load and learning achievements were investigated. Results showed that students who learned with technological approach had better learning achievement and less cognitive load than those who learned with the traditional approach. Hwang et al. (2013) suggested that the mobile learning approach has positive effects on students’ local culture learning.

Chen et al. (2008) explored how short-term memory and content representation type affect language learning in mobile learning environment. EFL university students were divided into verbal and visual short-term memory group and all of them learned 24 English words (with written annotation and pictorial annotation) delivered by Short Message Service or Multimedia Message Service to their mobile devices. Chen et al. (2008) found that providing vocabulary with pictorial annotation is helpful to learners with lower verbal and higher visual ability. The reason is that these learners find it easier to learn words presented in a visual rather than in a verbal form. However, providing vocabulary with both written and pictorial annotation can also help learners with both high verbal and high visual abilities. Chen et al. (2008) concluded that providing the basic learning material is more helpful to learners with low verbal and visual abilities as too much information may produce a high cognitive load and shorten concentration time.

Chang et al. (2011) examined the effects of English proficiency (low vs. high) and material presentation mode (single channel vs. dual channel) on English listening comprehension and cognitive load in a ubiquitous learning environment. In an experimental learning activity, university students studied zoo animals by using PDA. The system guided students to target animal areas and then displayed related material (i.e. text) and played audio guide (spoken messages). Students in a single
channel group learned through spoken messages only, whereas students in a dual channel group learned by text and spoken messages. Results of the study revealed that high and low English proficiency learners in the dual channel group had better English listening comprehension than learners in the single channel group. Low English proficiency learners in the dual channel group possessed significantly lower extraneous load than those in the single channel group. Chang et al. (2011) concluded that dual channel presentation mode leads to an increased depth of information processing and different input modes reinforce one another.

4. Method

Two experiments were carried out in this study. A total of 59 junior high school students participated in two experiments. One class with 28 students served as the control group in the experiment 1 and as the experimental group in the experiment 2. The other class with 31 students served as the experimental group in the experiment 1 and as the control group in the experiment 2. Most students in both groups were thirteen years old with four to six years’ experience of using computers and less than one to three years’ experience of using tablet PCs.

The experimental procedure of this study is as follows. First, a pre-test was conducted before the experiment started. Then both classes had the same amount of hours of English course: three one-hour lessons a week. After lessons, students participated in learning activities to practice their skills and applied new knowledge in daily life situations. Lessons and learning activities taught in the two classes were guided by the same instructor and shared the same learning content. However, the control group studied and completed learning activities with traditional textbooks while the experimental group studied with an electronic textbook and learning system installed in the tablet PCs. Learning activities were three tasks; each lasted for two weeks. In the beginning of the experiment, every experimental student received tablet PC and students were taught how to use the e-textbook and system by the instructor. A post-test and cognitive load questionnaire survey took place in the end of the experiment with all students. Finally, interviews with experimental students were carried out one week later after the experiment.

This study designed learning activities that were focused on learning at school and applying knowledge learned in authentic environment outside of school with a wide range of daily life situations (e.g. at local convenience store or supermarket). Three topics from the textbook were chosen to design learning activities: (1) “Where Are You From?” (2) “You School Is Very Big,” and (3) “Be Quiet and Sit Down, Please” for the first experiment and (1) “Which do you like – Healthy diet,” (2) “How much / many do we need,” and (3) “We were in different classes” for the second experiment. Learning activities were three tasks, and each corresponded to its topic. In each task, students were asked to take a picture of a learning object (e.g. a sign for Topic 3 of the first experiment or a meal for Topic 1 of the second experiment) and then to introduce and to describe it by using at least 6-10 sentences.

This study developed the learning system to support students to carry out the learning activity tasks. The following four main functions were designed in the system: (1) Annotating. Students could annotate important parts of learning material on tablet PCs. Besides, students could take photos and attach them to an annotation. (2) Recording. When students spoke out to describe a learning object, they could record their own voice and play it afterwards. Besides, students could record the instructor’s lectures and listen to them. (3) Assistance. Students could get assistance from the system, such as (a) read text out loud (Text-to-Speech Recognition), (b) translate unfamiliar vocabulary and sentences (Translation), and (c) list of words in alphabetical order with their meaning and translation (Dictionary). (4) Sharing. Students could share their own annotations, photos, and audio recorded files with peers.

The following are research tools that were employed by this study. Students’ prior knowledge was evaluated by a pre-test and students’ learning achievement was measured by a post-test in two experiments. The items of the pre-test and post-test for both experiments were similar in structure but different in content. Thirty items were included in each test: (1) Match English word with the correct Chinese meaning – eight items; (2) Write down the Chinese meaning of English word – six items; (3) Fill in the blank – ten items; (4) Write down: a) a question based on a sentence; b) negative sentence from given one; and c) translation of a sentence – 5 items; and (5) Write down about yourself when you were at the first grade of the elementary school, then write about yourself at the moment, and finally, compare the difference between when you were at elementary school and now – 1 item. Students’ answers to the tests were scored on a 100-point scale.
Cognitive load questionnaire (Huang, Huang, Liu, & Tsai, 2013) was developed with seven items: (1) Learning these materials was easy, (2) Learning these materials did not require a lot of mental effort, (3) Completing learning activities was easy, (4) Completing learning activities did not require a lot of mental effort, (5) I was concentrated during learning, (6) My mood was joyful during learning, (7) My frustration was low during learning. Items 1 and 2 of the questionnaire measured intrinsic cognitive load, items 3 and 4 measured extraneous cognitive load, and items 5, 6 and 7 measured germane cognitive load. All 59 students were asked to respond to the questionnaire and 59 valid answer sheets were obtained. Responses to the items were scored using a five-point Likert scale, anchored by the end-points “strongly agree” (1) and “strongly disagree” (5). The internal consistency of the survey was tested by employing Cronbach α; the values exceeded 0.80 demonstrating satisfied reliability of the items.

One-on-one semi-structured interviews were conducted with randomly selected ten experimental students from each experiment. Interviews aimed to explore students’ learning experiences with the system and insights of their perceptions toward cognitive load. Each interview lasted for 20 minutes and students were asked the following questions: 1) Please describe your learning experience with the system; 2) Was the system useful for learning? If yes, please explain why.

5. Results and discussion

5.1 Effects of mobile learning in authentic environment on learning achievement

This study employed analysis of covariance to measure the difference in the learning achievement of students in the control and experimental students on the post-test with the pre-test as covariate. In the experiment 1, a significant difference was observed between the control (M=53.50, SD=13.21) and experimental group (M=65.45, SD=18.59) on the post-test, F(1,56)=16.709, p=0.000, partial eta-squared=0.236. In the experiment 2, the experimental group (M=70.32, SD=17.01) outperformed the control group (M=58.30, SD=22.67) on the post-test, F(1, 56)= 20.345, p=0.000, partial eta-squared=0.270.

Students were asked to introduce and describe some learning objects (e.g. signs and rules in the convenience store of their local community). The experimental students in two experiments completed assigned tasks better than the control students. This finding may suggest that learning activities in familiar authentic context supported by the system could facilitate students learning.

This study interviewed experimental students to provide subjective evidence that may support abovementioned objective evidence. In the interviews, students mentioned that learning activities could be completed more efficiently if using the system instead of traditional approach. Furthermore, the system enabled more effective practice of EFL skills. First, students took pictures of learning objects and recorded their own voice when describing learning objects. Students were fond of reviewing pictures and listening to their own recorded files, and if content quality of photos and recorded files was not satisfactory (e.g. mistakes in pronouncing some words), students would want to improve it. According to students, such learning behavior led to more frequent language practice as well as to better quality of language output. Similar reasons to using multimedia tools for language practice were reported in other research (Harmer, 2007; Hwang, Shadiev, & Huang, 2011; Hwang & Shadiev, 2014;). For example, students in the study of Hwang, Huang, Shadiev, Wu, and Chen (in press) and Hwang et al. (2011) took advantage of the technology in the same way of practicing the target language repeatedly and regularly. In the study of Harmer (2007), after students recorded their speeches, they listened to recordings, evaluated language performance, and monitored how much progress made. However, in contrast to other related research, this study focused not on learning the basic knowledge at school only, but the application of learned knowledge to solve wide range of real life problems in familiar authentic environment.

Second, students shared recorded files with peers. In this way, students could listen to peers’ recorded files (i.e. usually to those who study hard and perform well) to get inspirational ideas to complete their own assignments or to learn how peers accomplished assignments and to improve their own homework. Students could exchange meaningful comments through sharing. That is, some students gave reflective comments and suggestions to a peer who did not complete homework correctly. Besides, students’ comments were useful to revise or improve homework. Students highly thought of sharing mechanism of the system as they were able to learn from others, and then to locate and revise
their own mistakes in homework. Hwang et al. (in press) and Hwang et al. (2011) argued that, with multimedia aids, students access more diverse learning objects and this may increase the richness of their language experience. They further suggested that sharing multimedia learning content with others not only increases practice opportunities but engages students in EFL contexts and allows their deeper reflection on learning content, discussion and collaboration.

Finally, students stated that the built-in dictionary was very handy when they needed to translate some unfamiliar vocabularies when completing assignments outside of school or at home. In this case, a dictionary could help to translate these words. Moreover, with a dictionary, students could find multiple meanings of a word and how it can be used in different contexts. Hulstijn and Laufner (2001) argued that the use of a dictionary positively affects vocabulary learning. Students look up target words in the dictionary during the reading session in order to find word meanings and to understand the main idea of texts. According to Hulstijn and Laufner (2001), those students who read foreign language texts and use a dictionary can understand texts better and remember more word meanings.

5.2 Effects of mobile learning in authentic environment on cognitive load

This study examined whether designed learning activities supported by the system brings extra cognitive load on students during learning. Therefore, cognitive load of the experimental and control students was measured and then compared by employing independent samples test. The means and standard deviations from the assessment with respect to seven items of the questionnaire and results of t-test are presented in Table 1. According to the table, the control students had higher cognitive load with regard to all seven items (p<0.05) than the experimental students. This finding suggests that learning activities supported by the system enabled students have less cognitive load compared to traditional learning setting.

Table 3: Cognitive load assessment and t-test results

<table>
<thead>
<tr>
<th>Item</th>
<th>The experiment #1</th>
<th></th>
<th>The experiment #2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control M</td>
<td>SD</td>
<td>Experimental M</td>
<td>SD</td>
</tr>
<tr>
<td>1.</td>
<td>1.90</td>
<td>0.94</td>
<td>1.48</td>
<td>0.51</td>
</tr>
<tr>
<td>2.</td>
<td>2.10</td>
<td>0.86</td>
<td>1.58</td>
<td>0.50</td>
</tr>
<tr>
<td>3.</td>
<td>2.07</td>
<td>0.84</td>
<td>1.61</td>
<td>0.50</td>
</tr>
<tr>
<td>4.</td>
<td>2.14</td>
<td>0.88</td>
<td>1.55</td>
<td>0.51</td>
</tr>
<tr>
<td>5.</td>
<td>2.21</td>
<td>0.82</td>
<td>1.77</td>
<td>0.43</td>
</tr>
<tr>
<td>6.</td>
<td>2.10</td>
<td>0.90</td>
<td>1.61</td>
<td>0.50</td>
</tr>
<tr>
<td>7.</td>
<td>2.03</td>
<td>0.87</td>
<td>1.58</td>
<td>0.50</td>
</tr>
</tbody>
</table>

This study further explored the changes of cognitive load in two groups of students across different approaches (learning activity with and without technological support). For example, the group A was the control group in the experiment 1 and used traditional method to complete the tasks; then, it became the experimental group in the experiment 2 and used technological support to complete the tasks. On the other hand, the group B was the experimental group in the experiment 1 and it became the control group in the experiment 2. So this study investigated how students’ cognitive load would change when approaches changed. Independent samples test was employed for such analysis. According to the results, there were significant differences in students’ cognitive load between two different approaches. Compared to the control students, those who were in the experimental groups had lower load with respect to all seven items (p=0.005). This result confirms the previous finding of this study that learning activities supported by the system helped to reduce experimental students’ cognitive load compared to control students.

One reason that may explain these two findings may be due to the nature of the learning material and activity for two groups. In this study, the learning materials and activities for the control and experimental students were identical apart from that the learning materials for the experimental students was in electronic form and they could take advantage of the system’s functions mentioned earlier, such as (1) Annotating, (2) Recording, (3) Assistance, and (4) Sharing, to complete learning tasks.

The system functions helped to keep intrinsic load from being overloaded while experimental students learned with the electronic textbook. Students could annotate important parts of learning
material (e.g. key concepts) by highlighting them or adding textual and multimedia explanation (e.g. a concept meaning and examples of its application in various contexts). Afterwards, these annotations helped students to find important concepts easily, to recall them, and to complete homework or to prepare for the exams. It is important to note that learning material and relevant annotations (i.e. text, photo, and audio) were located on the same screen. Students anchored their annotations to learning material which built a connection between the annotation and the learning material and gave students a clear picture of the whole learning scenario with an appropriate explanation of it. Mayer and Moreno (2003) called this form of presentation as integrated presentation; with such approach, learners would be more devoted to essential information processing, that is, more cognitive capacity would be activated. Apart from learning from the electronic textbooks, students could learn learning materials from peers’ annotations. Studying shared annotations including photos, texts, and audios helped students to enhance their understanding of learning material, to get new ideas and inspiration, and to improve their own homework. Students could also get assistance from the system as Dictionary, translation or Text-to-Speech Recognition to find translation and correct pronunciation of unfamiliar vocabularies or sentences. If students needed to recall some important concepts taught by the instructor from previous classes, they could listen to recorded lectures. Related literature suggests that intrinsic load lies in the nature of learning material, learners’ expertise and an interaction between them (Brunken et al., 2003; Sweller et al., 1998). It is argued that intrinsic load represents the amount of different types of information that students need to consider in acquiring new knowledge, i.e. how much information the working memory needs to deal with at the same time (Mayer and Moreno, 2003; Paas et al., 2003). Hwang et al. (2013) suggested that intrinsic cognitive load can be affected by the instructional learning material and students will be cognitively overloaded if the materials are poorly structured, difficult to read, or too complex. Based on the above-mentioned result and considering the fact that students in two groups learned with the same learning materials and tasks, this study suggests that the intrinsic cognitive load resulted from the method students used to access and to process the information. The interviews with students support this finding. Students mentioned in interviews that, compared to traditional approach, it was easier to learn with electronic textbooks and the system. Based on the abovementioned findings, this study concludes that, with the technological support, experimental students’ intrinsic load was lower; it was easy for students, and it did not require a lot of mental effort to learn learning material.

It is suggested that extraneous load can be caused by improper instructional design. Thus, in order to reduce extraneous load, instructors need to organize, present and carry out learning information and activities appropriately. In this study, functions of the system helped to reduce extraneous load while students participated in learning activities. When they exposed themselves to the authentic learning environment outside of the school, taking pictures of learning objects and describing them with text or voice annotations worked like gathering their thoughts and then transforming them into artefacts. Hollan, Hutchins, and Kirsh (2000) called such transformation of thoughts as distributed cognition. Hollan and his colleagues argued that knowledge and cognition are not confined to an individual but distributed by placing memories, facts, or knowledge on the objects, individuals, and tools in the learning environment as a set of representations. Lu, Lai, and Law (2010) argued that technology plays an important role to handle intellectual tasks and to ease individual cognitive load. Later, when students were at home, they could have a more tranquil environment and study created artefacts (i.e. pictures and their textual and audio descriptions). These artefacts would help students to easily recall details of learning objects from authentic learning environment, to find out what they missed while completing the tasks, and what else can be improved in their homework. Otherwise, students had to hold a mental representation of the context in working memory over a period of time which was called representational holding (Mayer & Moreno, 2003). According to Mayer and Moreno (2003), when students attempt to engage in both information processing (i.e., selecting, organizing, and integrating learning material) and representational holding, cognitive overload occurs. Our finding is supported by the interview with students. Students claimed in interviews that, compared to traditional method, it was easier to participate in learning activities with electronic textbooks and the system. Students also mentioned that a familiar authentic environment helped them to recall some important vocabularies; the context was related to students’ background and previous experiences and also very relevant to learning tasks. Therefore, this study may conclude that with technological support, experimental students’ extraneous load in a familiar authentic environment was lower. Thus, completing learning activities
with the support of the system a familiar authentic environment was easy and it did not require a lot of mental effort.

Related literature suggests that germane load is determined by appropriate instructional design and it can enhance learning. With the system support, this study attempted to direct students' attention to cognitive processes that are directly relevant to the learning material and tasks. The system functions enabled students to take pictures of learning objects in familiar authentic environment and then describe them with textual and voice annotations. Students could review their textual descriptions or listen to the audio recorded files afterwards. Students mentioned that completing the tasks in this way helped learning and made it more interesting. Furthermore, students claimed that learning in authentic familiar context and creating their own learning materials related to everyday life inspired students to engage in the materials and to try producing more meaningful output. Huang Chiu, Liu, and Chen (2011) suggested increasing students interest in learning and making them engaged in learning activities and tasks more by utilizing multimedia aids (e.g. pictures and audio). Furthermore, Caldwell (1998) argued that multimedia objects in learning stimulate students’ imagination and helps bring out meaningful output. Some students, particularly of low ability, admitted that in the way they learn with the system, they could communicate in the target language with less anxiety of making mistakes. Chen and Chang (2009) argued that anxiety is a subjective feeling of worry, nervousness, or unease associated with arousal of the autonomic nervous system. Anxiety interferes with cognitive ability to absorb, process, and produce a foreign language. Furthermore, it negatively affects cognitive load. In contrast to traditional learning, experimental students learned with more confidence and their learning was more creative and enjoyable. The interview with students verified this finding. In interviews, students confirmed that learning content and activities in the electronic textbooks with a familiar authentic context were more interesting, fun, and engaging than that in traditional method. Therefore, this study may conclude that, with the support of the system, experimental students’ germane load was higher in a familiar authentic environment. Experimental students concentrated more during learning in a familiar authentic environment; their mood was joyful and their frustration was low.

6. Conclusion

Two main findings were revealed in this study. First, the experimental students outperformed better than control students on post-test items in both experiments. Second, learning activities in a familiar authentic environment supported by the system enabled students to have less cognitive load compared to the learning setting without technological support. That is, the experimental students’ intrinsic and extraneous load were reduced while germane load was increased compared to the control students.

Based on these findings, this study recommends educators to employ appropriate learning activity design and the system to facilitate students’ learning achievement and their cognitive load management. In designing learning activities, the teacher has to consider how to make the best of the system to develop students’ productive skills and managing cognitive load. For example, in this study, students took photos of learning objects and described them with text and voice. Photos and textual and audio descriptions were shared among students so that they could learn from each other and get some new ideas to improve their own homework. The system provided multiple channels for students to present their language output (i.e. taking pictures of learning objects and then describing them in written and oral ways) and gave students more opportunity to use the language. Thus, the teacher may organize learning activities in the way they were designed in this study. Furthermore, the teacher may encourage students to use the functions of the system, such as annotating, recording, assistance, and sharing, to reduce their intrinsic and extraneous loads and increase germane load. In this way, students can efficiently study learning material, complete the tasks, and enjoy the learning process at the same time. For example, students can take advantage of annotating to reflect on learning material and review reflections afterwards for better understanding of new concepts or for exam preparation. Students can also distribute their cognition to artifacts created in authentic environment with familiar context. Furthermore, the learning environment created by the system can reduce students’ anxiety and help in giving meaningful output, especially low ability students.

There are several limitations found in the study that need to be considered. The first limitation concerns the relatively small sample size. The second limitation relates to short-term exposure of the technology to aid learning. For this reason, these findings cannot be generalized to a broader community based on this study alone or they have limited relevance to learning scenarios in which the
technology long-term exposed in “real-world” conditions. These limitations will be addressed in a future study. In the future, our approach can be applied to other domains (e.g. Mathematics or Biology), and cognitive load can be measured objectively by observations of behavior or physiological conditions. The future study will also focus on how a familiar authentic context without mind tools can help to decrease cognitive load of students by comparing cognitive load of control and experimental groups.

References


Applying Adaptive Hybrid Recommendation Technology for Searching Algorithm Learning Articles

Shu-Chen Cheng, Shih-Che Huang
Department of Computer Science and Information Engineering, Southern Taiwan University of Science and Technology, Taiwan
kittyc@mail.stust.edu.tw

Abstract: In this generation, technology is developed in tremendous speed. The Information on the Internet is increasing at a high speed each day. People get plenty of information via the search engine and spend much time to filter out insignificant information at the same time. Therefore, this research system can filter all kinds of articles to exclude advertisement, news from network bookstore, or insignificant information related to keyword. After filtering, this system will gather up all useful articles and provide users to review. This study proposes the hybrid recommended system with multi-adaptive recommendation to learners. Hybrid recommendation is divided into two ways to recommend “Content-Based Recommendation” and “Collaborative Filtering Recommendation” articles. First, content-based recommendation is based on Term Frequency- Inverse Document Frequency to estimate the characteristic values of articles. Then, we set the weight of difficulty of keywords. After that, people can decide the level of article in the beginning and use it for reference. Besides, collaborative filtering recommendation is applied based on user abilities estimated by IQ tests, quizzes, online tests, ability certificates, and other exams. When the result of two users is similar and one of them thinks it’s useful, the article will be automatically forwarded to the other.

Keyword: Content-Based Recommendation System, Filtering Recommendation, Term Frequency-Inverse Document Frequency.

1. Introduction

1.1 Background information

When searching for articles tend to obstruct because of too much information on the Internet. As shown in figure 1, users need to spend much time filtering information when they read it. In the search result, it also accompanies with irrelevant sites of learning such as: advertisement, information
of bookstore…etc. Owing to this reason, this study uses the hybrid recommendation to assist users to filter the articles they don’t need and learn efficiently.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>網頁</td>
<td>新聞</td>
</tr>
<tr>
<td>僅有 102,000,000 側結果 (搜尋時間：0.25 秒)</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. search result by Google*

### 1.2 Purpose of Research

This study will focus on hybrid methods recommended to build a system for recommended articles. The hybrid recommended system is combined with “Content-Based Recommendation” and Collaborative Filtering Recommendation.” Content-Based Recommendation is to analyze the content of articles keyword. And another one Collaborative Filtering Recommendation selects the recommended articles by the ability of learners and peer recommendation.

# 2 Literature Review

The chapter is to explore how to use the hybrid recommended system. Then introduce the advantage and disadvantage when users use this system and give the advice in detail to improve it. [1]

### 2.1 Classification

The most important part of Content-Based Recommendation is the classification. We need to analyze the content of article, set keywords, and article categories.

#### 2.1.1 N-Gram word segmentation

After selecting articles by Crawler on the Internet, we need to deal with the content of these articles first. How to analyze these articles? We use each word of the articles to do the cutting so that the article presents the smallest unit of word. Then by smallest word unit of different lengths to make up words, it can form words and sentences. N-Gram word segmentation is used at the beginning[2][3] of the data processing. (Table1)
Table 1. Length of word segmentation (example: string of Algorithm by Chinese characters)

<table>
<thead>
<tr>
<th>N-Gram</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Gram</td>
<td>演、算、法、演算、算法</td>
</tr>
<tr>
<td>3-Gram</td>
<td>演、算、法、演算、算法、演算法</td>
</tr>
</tbody>
</table>

2.1.2 Term Frequency-Inverse Document Frequency

After using the N-gram word segmentation, the system starts to determine the importance of each string in the article. Take Knapsack algorithm for example, “Knapsack” and “Algorithm” will be the most important word. When the strings of the importance in the article to be found out, these strings are used for the characteristic value of this article. The characteristic value is determined by Term Frequency-Inverse Document Frequency (TF-IDF).

2.2 Recommendation System

2.2.1 Content-Based Recommendation System

On the basis of Content-Based Recommendation System is to analyze the content rather than the user for evaluation. This system will calculate the ability of user’s interest and then calculate the characteristic values of user. Therefore it can find the item user needs. In this study, the most important thing is to recommended articles through keywords and characteristic values. To achieve this recommended system, we need to use characteristic values to make up keyword and given the different scores by different rights then the result of recommendation will be come out.

2.2.2 Collaborative Filtering Recommendation System

CF system is abbreviated form of Collaborative Filtering Recommendation System. This method was successfully applied in a wide variety of fields, such as YouTube, Amazon, etc., are very famous examples. This system is based on the gathering user preferences, personal information, gender, browsing habits and other personal information [6], to make recommendation. Therefore, while user browsing merchandise or other things, CF system will recommend users the section plus the recommended information, not only can make commodities accelerated been viewed but also speed
up information dissemination.

### 2.2.3 Hybrid Recommendation System

Hybrid recommendation system recommended by Content-Based Recommendation System and Collaborative Filtering Recommendation system. We can use these two different systems which have different strength and shortages to improve recommendation system better. Therefore, hybrid will compensate for the shortcomings of their systems to each other. The advantage and disadvantage of two recommendation systems are shown in Table 2. [7][8]

| Table 2. Comparisons between Content-Based Recommendation and Filtering Recommendation |
|-----------------------------------------------|-----------------------------------------------|
| reference value                              | Content-Based Recommendation                  | Filtering Recommendation                       |
| advantage                                     | Quick Recommendation                          | Find out the preference of user                |
|                                               |                                               | High-automated                                 |
| shortage                                      | Can’t find out the user’s preference           | New Item                                       |
|                                               | Much time to do processing information         | Sparsity                                       |
|                                               | Can’t be recommended automatically            | Cold-start                                     |
|                                               |                                               | Scalability                                    |
|                                               |                                               | New user                                       |

Both of Content-Based Recommendation System and Collaborative Filtering Recommendation System all have drawbacks, so we combine[9] these two ways to be hybrid recommendation. (Table3)

#### Table3. Hybrid recommendation way

<table>
<thead>
<tr>
<th>method</th>
<th>hybrid recommendation way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method of weighting</td>
<td>Take two different recommendation methods to calculate, and in accordance with the result of calculate to given different weighting.</td>
</tr>
<tr>
<td>Method of selection</td>
<td>If there is users’ information, use Collaborative Filtering Recommendation and Content-Based Recommendation. If not, use Content-Based Recommendation only.</td>
</tr>
<tr>
<td>Method of mixing</td>
<td>When both content have recommendation systems, use the two recommended ways to calculate, and then generate a recommendation.</td>
</tr>
</tbody>
</table>
3 Research Method

3.1 System Framework

This study is based on the self-developed Algorithm platform to design a hybrid recommendation system to give users search teaching articles. (Figure.2) We use the Algorithm database to do the recommendation. The hybrid recommendation is divided into two modules which are “Content-Based Recommendation module "and" collaborative filtering recommendation module". In the Content-Based Recommendation module, the article needs to through preprocessing module first and then use N-Gram for word segmentation. After that, the characteristic value of the article will be selected which will be the keyword to analyze the degree of the article difficulties and make recommendation. The Collaborative Filtering Recommendation use the calculated module to calculate the users’ ability. Then in accordance with the users’ ability to recommend or accordance with the recommendation module to allows users with the same ability to recommend the article and share with them. Therefore, it will have many different recommended articles to let users read.

![Figure 2 System Framework](image)

3.2 Content-Based Articles Recommendation Method

When the analysis of the article that will be processed by the keyword of characteristic value and then in accordance with the value of calculation to recommend users. The weighting of keyword is the most important part of this method which is in accordance with given to those area of expertise; conducting analysis to improve ease of articles and recommended stability.
3.2.1 Articles Pre-process

Articles are pre-processed by N-Gram segmentation to handle the database articles. There are many Stop Words that needs to be removed. Chinese Stop word List is shown in Table 4.

### Table 4. Examples of Chinese Stop Words List

<table>
<thead>
<tr>
<th>Stop Words</th>
<th>Stop Words</th>
<th>Stop Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>嗎(麼)</td>
<td>吧</td>
<td>呢</td>
</tr>
<tr>
<td>問</td>
<td>啊</td>
<td>啦</td>
</tr>
<tr>
<td>哇</td>
<td>哪</td>
<td>罷了</td>
</tr>
<tr>
<td>而已</td>
<td>我</td>
<td>你</td>
</tr>
<tr>
<td>您</td>
<td>我們</td>
<td>他們</td>
</tr>
<tr>
<td>是</td>
<td>全部</td>
<td>所有</td>
</tr>
<tr>
<td>不知道</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.2.2 Initial Item Bank

This system is to determine whether the article for Algorithm teaching articles and set up the degree of difficulties to achieve recommendation. It needs to set up positive, negative item bank, and weighting. The positive item bank put in the words represents Algorithm; however, the negative item bank represents non-Algorithm.

First of all, the initial item bank set up by the artificial, the positive item bank select the keyword that can represent Algorithm from the book of Algorithm. The more abstruse terms set up higher weighting that represents the more difficult article. On the contrary. The negative key words comes out from the advertisement of on-line bookstore. Therefore, the system can exclude those of words to choose Algorithm article. (Figure.3)

![Figure 3 Positive and Negative Keywords and Weightings](image)

3.2.3 Recommendation Module

When the item bank set up, then the keywords in the item bank will be compared and do the weighting accumulated. If the article in the positive item bank has higher weighting, then it can be used as recommended priorities. This module can be used while users searching the article in accordance with the recommended system.
3.3 Collaborative Filtering Recommendation Methods

The system, another recommendation System, is Collaborative Filtering Recommendation. Since the algorithm belongs to professional in the field, not like English article which contains preference, and article style such as exercise, movies, and music. Therefore, in the study we propose a Peer Recommendation, which is based on user’s ability and preference from groups. They can find appropriate article by sharing and watching the recommended article from the same ability users.

3.3.1 Recommendation by Users’ Abilities

Although Algorithm is in the same article; however it can be different by users, articles and the degree of the articles. Sometimes it’s too difficult to let beginning user or not good at logical thinking user to understand. On the other hand, if it’s too easy to understand, it can’t help user who has higher ability learning. This study will be in accordance with the user's ability to recommend the article (Recommend Articles), initially to collect the user's test scores, and recorded data repository, such as intelligence tests, proficiency examinations test program, license, Algorithm online quizzes, etc. After that, set the initial capacity and in accordance with article difficulty keyword weighting to classify and control user ability to give a different degree of difficulty of the article. [11][12]

3.3.2 Group Preferences Recommendation Method

When one of users think the article is helpful, the system will record it. Next time, if there is a user of same ability appears, the system will recommend the article to him. Therefore, user can search appropriate article easily.

3.4 Hybrid Recommendation Method

When user enters the keyword in the Content-Based Recommendation, it will search out the article. After that, the collaborative Filtering Recommendation will offer recommended article to the user. Because Algorithm articles are not much, when users all recommended an article, the article will be exposed highly. Because of this reason, this type of the article order will increase and be found easily. If this article isn’t related to the keyword, it will give the system in return. The system will reduce the article exposure to avoid system erroneous judgment that causing users to research on the system distress to make the system more perfect. If the feedback has found that the article isn’t related to the
mathematics article or the article can’t be connected, the system will reduce the recommendation. When it comes to an certain amount, the system will not recommend to the user and remove it.

4 Conclusions

In this study, we design a hybrid recommendation system which offers user to find appropriate articles according to their abilities, keywords, or groups recommendation articles so that it can achieve hybrid recommendation effect. Users can follow their own abilities or similar users’ to read the recommended articles in accordance with collaborative filtering recommendation system. By the way, the feedback from user can increase the article exposure and improve the content-based recommendation. All of these systems can help users find appropriate algorithm articles and enhance learning abilities.

Acknowledgement

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