A STUDY OF FACILITATING COGNITIVE PROCESSES WITH AUTHENTIC SUPPORT

Rustam Shadiev[1], Wu-Yuin Hwang[2], Yueh-Min Huang[1] and Tzu-Yu Liu[3]
[1]*Department of Engineering Science, National Cheng Kung University, Taiwan*
[2]*Graduate Institute of Network Learning Technology, National Central University, Taiwan*
[3]*Bei-Zheng Junior High School, Taiwan*

ABSTRACT

This study designed learning activity to enhance students' cognitive processes. Students could learn in class and then apply and analyze new knowledge to solve daily life problems by taking pictures of learning objects in familiar authentic context, describing them, and sharing their homework with peers. This study carried out an experiment and it aimed to assess the effectiveness of learning activities supported by a mobile learning system on students' cognitive processes. Furthermore, this study explored what learning strategies experimental students use during learning and how frequently. This paper discusses results, research findings, and implications along with conclusions and several suggestions for future development and research.

KEYWORDS

Cognitive process; Mobile learning; Learning strategy.

1. INTRODUCTION

Cognitive processes are the mental processes by which knowledge is acquired and understood through thought, experience, and the senses. Cognitive processes can be simple or complex. The Taxonomy for Learning, Teaching, and Assessing (Anderson & Krathwohl, 2001) was proposed to monitor, assess, and understand complex cognitive processes. This taxonomy includes six levels which increase in complexity as the learner moves up through the levels, from simple cognitive processes to complex cognitive processes: (1) Remember - Retrieve relevant knowledge from long-term memory; (2) Understand - Construct meaning from instructional messages, including oral, written, and graphic communication; (3) Apply - Carry out or use a procedure in a given situation; (4) Analyze - Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose; (5) Evaluate - Make judgments based on criteria and standards; and (6) Create - Put elements together to form a novel, coherent whole or to make an original product.

One important issue to consider in the learning process is to engage students not only in simple cognitive processes but also in more complex cognitive processes (Hwang & Shadiev, 2014). However, in the traditional context (i.e. paper and pencil), learning takes place but new knowledge is not applied and analyzed (Hwang & Shadiev, 2014; Hwang et al., 2014). To change this, (1) the instruction should focus not only on learning the basic knowledge and concepts or preparing for the exams, but also on their practical application, and analysis of knowledge; (2) students need to learn both at school and outside by applying and analyzing new knowledge in a wide range of daily life situations; (3) knowledge application and analysis should be linked to outside of school situational and authentic environments (Scardamalia & Bereiter, 1994).

One major drawback of previous research is that not much attention was paid in related studies on cognitive processes during learning. Particularly, little is known about how to promote students' cognitive processes from simple to complex. This study attempted to address this limitation. First, this study designed storytelling learning activity with the focus on both, knowledge acquisition and its practical application and analysis. In this study, students learned in class first and then they applied and analyzed new knowledge in a wide range of daily life situations in authentic learning environment with familiar context. Second, a mobile learning system was developed that enabled students to participate in learning activity.

Students could learn and apply new knowledge by taking pictures of learning objects, describing them, and sharing their homework with peers. This study aimed to test the effectiveness of learning activity supported by the system to enhance students' high level cognitive processes. What learning strategies students use during learning and how frequently were also investigated.

2. LITERATURE REVIEW

Practice involves repeatedly and regularly using skills in order to improve and to master them (Guha et al., 2007). Storytelling is an instructional approach that has a potential to facilitate language practice (Nilson, 2010). Storytelling was defined as a highly-effective instructional method that has students surrounded with the target language and enables them to communicate intentionally by using narrative sentences (Guha et al., 2007). According to Nilson (2010), storytelling promotes verbal skills and supports literacy development (Harmer, 2007); students interact, associate with each other, negotiate meanings, learn from each other, and share experiences through storytelling.

Cognitive processes can be greatly promoted if language learning takes place in an authentic environment with familiar context (Hwang & Chen, 2013; Shadiev, Hwang, & Huang, in press). Such environment features the following critical characteristics. First, it provides authentic contexts that reflect the way the knowledge will be used in real life. Second, it provides authentic activities that have real-world relevance, and which present complex tasks to be completed over a sustained period of time. Third, it creates an opportunity for the sharing learning experiences and accessing to learners in various levels of expertise. Finally, it promotes reflection and offers authentic assessment of learning within the tasks (Nilson, 2010). In such environment, students are more inclined to learn and they apply new knowledge to solve daily life problems (Hwang et al., 2011) as they can expose themselves to the familiar context that surrounds them more frequently.

Mobile technology provides rich resources for students to learn and creates an authentic learning environment with familiar context (Kim & Kim, 2012). For example, mobile assisted learning offers seamless learning experience, i.e. anytime and anywhere (Hwang & Chen, 2013). According to Huang et al. (2011), mobile technology aids both, formal learning in the classrooms and informal learning outside classes. This increases access to learning activities and engagement in learning tasks in and outside classroom. With mobile multimedia tools, students can create learning material in authentic environment. The utilization of multimedia aids, such as pictures and audio, for learning tasks makes learning more interactive, information richer, and more engaging (Huang et al., 2011). Furthermore, multimedia objects in learning stimulate students' imagination and helps in giving meaningful output. Students in the study of Hwang et al. (2012) took pictures of learning objects in authentic contexts and then described them by using vocabulary and grammar learned in class. In the study of Hwang et al. (in press), students practiced the target language by speaking out learning material from the textbook, taking pictures of learning objects from daily life, and orally introducing them. Besides, all speeches were recorded by students. Hwang and Chen (2013) argued that, with multimedia aids students could practice the target language repeatedly and regularly and access diverse learning objects which increased the richness of their language experience. Harmer (2007) suggested that if students record their speech, they (and teacher) can listen to recordings, evaluate language performance, and see how much progress they have been making. Hwang et al. (2011) claimed that sharing homework with peers allows further reflection, discussion and collaboration. Besides, sharing homework increases practice opportunities and helps students engage in EFL contexts. For example, students can listen to others' audios with diversity of speeches (i.e. accent, fluency, and level of learning performance) after sharing. Students in study of Hwang et al. (in press) listened to files recorded by peers and pre-recorded by the teacher pronunciation of learning material. Through sharing, students also exchanged meaningful comments (Hwang et al., in press). For example, students gave reflective comments and suggestions to a peer who did not complete homework correctly (Hwang et al., 2011). Students' comments were useful to revise or to improve homework.

3. METHODS

A total of 58 junior high school students (between 13 and 14 years of age) participated in this study. One class with 30 students served as the control group, and the other class with 28 students served as the experimental group. Most students in both groups were thirteen years old with four to six years' experience of using computers. Besides, most students had less than one to three years' experience to use tablet PCs.

A pre-test was conducted in the first class. Two groups had the same amount of hours of a course: one-hour lessons for three times a week, on a weekly basis for two and half months. After lessons, students participated in learning activity. Lessons and learning activity taught in the two classes were guided by the same instructor and shared the same learning content. However, the control group completed a learning activity with traditional textbooks while the experimental group with a learning system installed in the tablet PCs. Learning activities included three tasks; each of them was complete within two weeks. In the first class, every experimental student received tablet PC and students were explained how to use it and the system by the instructor. Experimental students were provided with an immediate assistance in troubleshooting technical problems during the experiment to reduce negative effect caused by technical problems. A post-test with all students and interviews with experimental students were carried out in the last class.

This study designed learning activity based on storytelling instructional method; students were asked to tell stories through introducing, describing and explaining learning objects found in an authentic environment with familiar context. Learning activity included three tasks:

1. My meal and food critic. In this task, every student was asked to take a photo of his /her three meals (i.e. breakfast, lunch, and dinner) during the last Saturday and Sunday. Students then were asked to introduce their meal. Finally, each student was asked to become a food critic and to express what he/she thinks of a partner's meal.

2. Make my own salad! Every student was asked to help their parent to do a food shopping, take a photo of and introduce what they bought. Students then made a salad from ingredients they bought, took a photo of a salad and introduced their recipe. Finally, each student was asked to write/tell how his/her salad is different from his/her partner's.

3. Do you often clean your room? In this task, students took a photo of their room before and after cleaning it up. Students then described what the difference in a room is before and after cleaning it up. Finally, students were asked to take a look at photos of their partners and make written and oral comparison with their own.

This study developed the learning system to support students to carry out the learning activity tasks. With the system, students could annotate important parts of learning material on tablet PCs. For example, students could write description of a learning object by creating a textual annotation. Besides, students could take photos of learning objects in familiar authentic environment and attach them to an annotation. When students spoke out descriptions of a learning object, they could record their own voice and play it afterwards. In this way the system enabled students to find their mistakes and improve content of audio recorded files. Besides, students could record the instructor's lectures and play some parts to recall important concepts. A Dictionary was also provided by the system. Students could find a list of new words with their meaning and translation. Finally, students could share their own annotations, photos, and audio recorded files with peers. This allowed students to study peers' annotations, to enhance their understanding of learning material, and to improve their own annotations.

Students' prior level of cognition was evaluated by a pre-test and students' post-experimental level of cognition was measured by a post-test. The content of the tests related to learning material covered during the experiment. Thirty items were included in each test. The items for both tests were similar in structure but different in content. This study adopted Anderson and Krathwohl's (2001) taxonomy to measure students' cognitive level. This study particularly focused on the first four levels, i.e. "Remember," "Understand," "Apply," and "Analyze." "Remember" level was measured by the first fourteen items of the tests. "Understand" level was measured by the next fifteen items, and "Apply" and "Analyze" levels were measured by the last item. A correct answer to an item from 1 to 29 in Table 1 was scored as "1," while incorrect one as "0." The item 30 is an open ended question; therefore, the content of students' answer to it was coded by using a sentence as a coding unit and scored on a 29-point scale (with 29 as the highest score). A score of "1" represented the lowest level of cognitive development, and a score of "29" represented the highest level.

Based on students' pre-test scores, this study formed two groups: low ability group (last eleven participants of the rank) and high ability group (first eleven participants of the rank).

This study developed a questionnaire (Huang et al., in press) to explore what learning strategies students used during learning and how frequently. Learning strategies are procedures that a student uses to succeed in a task that would be difficult without special effort (Shadiev, Hwang, Huang, & Liu, in press). Strategies are associated with internal mental procedures (e.g., note-taking) and used by learners to aid the acquisition, storage, and retrieval of information (Oxford, 1990).

One-on-one semi-structured interviews (Huang et al., in press) were conducted with randomly selected ten experimental students (five students from low ability group and five students from high ability group). Interviews aimed to explore students' learning experiences and insights of their perceptions toward the system usefulness for learning. Each interview lasted for 20 minutes.

4. RESULTS AND DISCUSSION

First, the difference in the level of cognitive development between the control and experimental students on the post-test with the pre-test as covariate was investigated by employing analysis of covariance. The means and standard deviations of students' pretest and post-test scores are shown in Table 1. The experimental group outperformed the control group only on the post-test items related to "Remember 2", $F(1, 55)= 7.075$, $p=0.010$, partial eta-squared=0.114, "Understand 2," $F(1, 55)= 8.876$, $p=0.004$, partial eta-squared=0.139, and "Analyze," $F(1, 55)= 11.173$, $p=0.001$, partial eta-squared=0.169.

Table 1. Results of the pre-test and post-test and analysis of covariance.

Cognitive level	Groups	The pre-test		The post-test		F	Sig.	Partial eta squared
		M	SD	M	SD			
Remember 1	Control	7.67	0.88	7.67	1.29	1.504	.225	.027
	Experimental	7.04	1.60	7.93	0.38			
Remember 2	Control	4.83	1.60	5.10	1.49	7.075	.010	.114
	Experimental	4.29	1.67	5.68	0.55			
Understand 1	Control	6.97	2.02	7.93	2.20	1.588	.213	.028
	Experimental	6.32	2.07	8.32	1.60			
Understand 2	Control	4.96	3.00	5.83	2.26	8.876	.004	.139
	Experimental	4.61	3.41	6.93	2.37			
Analyze	Control	5.87	8.76	9.67	10.56	11.173	.001	.169
	Experimental	6.00	8.29	15.50	8.46			

Test items related to "Remember" and "Understand" levels were organized with two difficulty levels. In "Remember 1" items, students were asked to match English word with the correct Chinese meaning while in "Remember 2" items, students wrote down the Chinese meaning of English word. Similarly, in "Understand 1" items, students filled in the blank, while in "Understand 2" items, they wrote down a question based on a sentence, a negative sentence from given one, or translation of a sentence. Students in both groups obtained high scores in "Remember 1" and "Understand 1" because the items were very easy to complete and students already had some prior knowledge. However, as difficulty level of the items increased, control students' performance decreased compared to experimental students. This finding suggests that learning activities supported by the system significantly promoted the experimental students cognitive processes. The experimental students could learn and better remember and understand new vocabularies, sentence structure, and how to change it into question and negative form.

In the item of "Analyze," students were asked to write about themselves when they were at the first grade of the elementary school and at present time. Then students compared the difference. The experimental students completed this task significantly better compared to the control students. This finding may suggest that learning activities supported by the system could significantly facilitate students not only to learn and understand knowledge but also to apply and analyze it to solve daily life problems.

Some reasons to support these findings were revealed from interviews with experimental students. Students mentioned that learning activities could be completed more efficiently and students had more opportunities for practice if using the system, compared to traditional approach.

First, students took pictures of learning objects and recorded their own voice when describing learning objects. Students admitted that in a way they learn with tablet PCs, they could communicate in the target language with less anxiety of making mistakes (Hwang & Chen, 2013). Students also preferred to review pictures and to listen to their own recorded files. If content quality of photos and recorded files was not satisfactory (e.g. mistakes in pronouncing some words, the use of incorrect grammar or not fluent speech), 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 use multimedia tools for language practice were reported elsewhere. For example, students in the study of Hwang et al. (in press) and Hwang et al. (2011) took advantage of the technology in the same way to practice 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.

Second, students shared recorded files with peers. In this way, students could listen to peers' recorded files (i.e. usually to those who perform well) to get inspirational ideas to complete their own assignments, to study 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.

Third, students recorded lectures of the teacher. If students forgot some particular parts of a lecture or they needed to listen to the teacher's pronunciation of the learning material, they would play the recorded lecture on Tablet PC. This was particularly useful outside of classroom where students could not consult their teacher and ask questions (Hwang et al., in press).

Fourth, students reported that the system featured a dictionary which was very handy when they were outside of school or at home and needed to translate some unfamiliar vocabularies to complete assignments. In this case, a dictionary translated these words. Moreover, with a dictionary students could find multiple meaning of a word and how it can be used in different context. Hulstijn, Hollander, and Greidanus (1996) 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. Those students who read texts using a dictionary can understand texts better and remember more word meanings.

These findings about benefits of the learning activities and multimedia support to learning are in line with other related studies (Harmer, 2007; Hwang et al., 2011; Hwang & Shadiev, in press). However, in contrast to other related research, this study designed the learning activity supported by the mobile learning system and it focused on enhancing students' cognitive processes, particularly application and analysis of new knowledge to solve daily life problems in authentic environment.

Next, this study investigated what learning strategies students use during learning and how frequently. Results showed that students employed thirty different learning strategies (Appendix). The most used cognitive strategies were: (1) take a photo of learning object (imagery), (2) write and (3) record speaking about learning object (summarizing), (4) use electronic dictionary (organization), and (5) improve and re-write about learning object (elaboration). That is, students took photos of learning objects (Strategy 1) and they wrote about learning objects (Strategy 2) and recorded audio (Strategy 3) description. Besides, students used electronic dictionary (Strategy 4). Finally, students improved and re-wrote their own writing about learning object (Strategy 6). Top metacognitive strategies in this study were: (1) prepare and rehears speaking about learning object (planning), (2) read my own and (3) partner's writing, (4) review partner's photo, and (5) listen to partner's recorded audio (monitoring). Students prepared and rehearsed their speaking about learning object (Strategy 9). That is, after completing homework, students read their own (Strategy 10) and partners' (Strategy 11) writing about learning objects, they listened to partners' recorded audio (Strategy 16), and reviewed partners' photos (Strategy 13). All these strategies were consistently and frequently used in three lessons. However, the number of strategies usage decreased in Lesson 3. It was the end of the semester when students studied Lesson 3; they were busy preparing for the final exams.

Therefore, the instructor asked students to complete only one part of the task (i.e. describe their own room only and do not compare it with partner's). As a result, students did less and the number of strategies they used also decreased. According to the result, this study suggests that abovementioned strategies are important for learning. Cognitive strategies helped students to complete their homework and metacognitive strategies assisted to make content of homework better. According to the result, no evaluation metacognitive strategies were used by students. In the interview, the instructor mentioned that some students knew some strategies but some did not. Therefore, this study suggests that the instructors need to teach students learning strategies, emphasize their importance, and encourage using strategies frequently.

Finally, this study explored the relationship between learning strategy usage and students' learning achievement by employing a Pearson product-moment correlation coefficient. No significant correlation was revealed between learning strategy usage and students' learning achievement, $r=0.155$, $p=0.480$. However, when considering strategy usage by students of different ability, significant correlation was found between strategy usage by low ability students and their post-test results, $r=0.758$, $p=0.007$. The difference in the post-test between low and high ability students with the pre-test as covariate was also investigated by employing analysis of covariance. According to the result, there was no significant difference between low ($M=37.09$, $SD= 7.69$) and high ($M=43.09$, $SD=6.89$) ability students, $F(1,19)=0.549$, $p=0.468$, partial eta-squared=0.028. Therefore, this study carried out independent-samples test to compare the difference in learning gain between low and high ability students. According to the result, learning gain of low ability students ($M=19.64$, $SD=10.68$) was significantly higher than that of high ability students ($M=1.45$, $SD=10.33$), $t=4.059$, $p=0.001$. Based on these results, this study suggests that participants of low ability took better advantage of learning strategies while being engaged in learning. In the interviews, low ability students mentioned that they preferred to write and to speak out about learning objects (Strategies 3 and 4) first, and then to read peer's writing and to listen to peer's recorded files (Strategies 11 and 16). This helped them to improve and to re-write their own writing and to re-record their own audio files (Strategies 7 and 9). The results of Pearson correlation confirmed this finding; a significant correlation was found between strategies usage and post-test results for low ability students. Therefore, this study concludes that deeper engagement of low ability students in using learning strategies resulted into significant learning gain. This study also suggests that students should be taught to understand existing learning strategies and how to take better advantage of them.

5. CONCLUSION

Based on the results, this study proposes some recommendations for teaching and research community of the field. This study suggests to design and to implement appropriate learning activities supported by the mobile learning system in order to help students' application and analysis of new knowledge in a wide range of daily life situations. Particularly, this study would like to emphasize the importance of preparing, creating, and sharing, multimedia learning content as well as consulting learning content created by peers during learning activities to enhance high level cognitive processes. This study also suggests extending proposed novel approach and applying it to other domains. That is, apart from the domain of foreign language learning, similar learning activities can be applied to other domains, like natural science (e.g. Biology) or Mathematics to promote complex cognitive processes. Within extended approach, students may acquire conceptual knowledge in class and then apply and analyze it outside of school, in authentic learning environment with familiar context.

There are two limitations to the study that need to be considered. The first limitation concerns the relatively small sample size; for this reason, these findings cannot be generalized to the broader community based on this study alone. The second limitation relates to the technology; students complained that the size of tablet PC was too big to carry out and take pictures in authentic environment. These limitations will be addressed in a future study. Besides, the future study will attempt to facilitate other higher level of cognitive processes, i.e. "Evaluate" and "Create," by introducing some scaffolding mechanisms into learning activities.

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APPENDIX

#	**Learning strategy**	**Lesson1**	**Lesson2**	**Lesson3**
	Cognitive strategies			
	Imagery	*Imagery*	*Imagery*	*Imagery*
1.	Take a photo of my learning object	91(8)*	81 (3)*	64 (1)*
	Summarizing			
2.	Write about my/partner's learning object	126 (2)*	90 (2)*	21 (6)*
3.	Record my speaking about my/partner's learning object	96 (7)*	77 (6)*	18 (8)*
	Organization			
4.	Use electronic dictionary to complete my writing/speaking	107 (5)*	66 (9)*	17 (9)*
5.	Others: Use google to get additional information	40	30	11
	Elaboration			
6.	Improve and re-write my writing about (my/partner's) learning object	86 (10)*	65 (10)*	27 (3)*
7.	Improve and re-take photo of my learning object	34	36	12
8.	Improve and re-record the audio about (my/partner's) learning object	85	44	12
	Metacognitive strategies			
	Planning			
9.	Rehears speaking about my/partner's learning object	88 (9)*	69 (7)*	15 (10)*
	Monitoring			
10.	Read my introduction/critique to my/partner's learning object	86 (10)*	69 (8)*	32 (2)*
11.	Read partner's introduction/critique to his/her/my learning object	146 (1)*	106 (1)*	25 (4)*
12.	Read others' introduction/critique to their/others learning object	98 (6)*	60	8
13.	Review photo of partner's learning object	112 (3)*	80 (5)*	20 (7)*
14.	Review photo of others' learning object	47	26	9
15.	Listen to the audio recorded by me	80	42	6
16.	Listen to the audio recorded by my partner	108 (4)*	81 (4)*	22 (5)*
17.	Listen to the audio recorded by others	84	40	4
	Evaluation			
18.	Compare my writing with my partner's	61	39	3
19.	Compare my writing with others'	71	30	4
20.	Compare my photo with partner's	35	20	10
21.	Compare my photo with others'	28	14	10
22.	Compare my audio with partner's	40	22	1
23.	Compare my audio with others'	43	26	0
24.	Use electronic dictionary for reading/listening and comparing partner's/others' learning object	62	25	2
25	Find mistakes in my writing about (my/partner's) learning object	78	64	12
26.	Find new ideas from writing of my partner	40	34	8
27.	Find new ideas from writing of others	30	31	10
28.	Find mistakes in the audio recorded by me	51	55	7
29.	Find new ideas from the audio recorded by my partner	40	22	4
30.	Find new ideas from the audio recorded by others	41	21	3

*Top ten frequently used strategies (the number in the rank).