



EFFECTS OF INTERACTIVE MULTIMEDIA AND TRADITIONAL MEDIA ON STUDENT ACHIEVEMENT: AN EXPERIMENTAL STUDY

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Abstract


This study compared the extent of student achievement in the cognitive and psychomotor domains upon use of an interactive digital game and print media. Students' attitudes toward the use of the interactive digital game and print media were also explored. Mixed methods research with pretest-posttest control group design was employed. Samples consisted of 60 Thai undergraduate students of Maejo University, Chiang Mai who were assigned to experimental and control groups by random selection. The experimental group used *Eternal Story* digital game to learn selected lessons in Fundamental English while the control group used a print media to learn similar lessons. The instruments comprised of cognitive and psychomotor domain achievement tests and survey questionnaires. Results of independent samples t-test showed that the interactive digital game was not as effective in increasing students' cognitive and psychomotor domain achievement when compared with a print media. Print media users reported significant higher gain scores in the cognitive domain achievement test ($\bar{x}=21.17$), ($p<.05$) compared with the interactive digital game users ($\bar{x}=12.17$), ($p<.05$). Likewise, print media users reported significant higher gain scores in the psychomotor domain achievement test ($\bar{x}=24.33$), ($p<.05$) compared with the interactive digital game users ($\bar{x}=18.17$), ($p<.05$). Analysis on students' attitudes indicated that the interactive digital game was effective in providing motivation and teaching new English words. It can also improve the quality of learning experience. Moreover, students perceived the booklet effective in improving knowledge of the instructional content. Majority of the participants perceived the content of the booklet easy to understand because of the organization, lay-out, graphics, and availability of Thai translations.

Keywords: digital games, cognitive theory of multimedia learning, student achievement

Introduction

Digital games are known for its potential in providing high levels of engagement and entertainment among its users. As an example, more than 11 million subscribers spend an average of 23 hours per week immersed in World of Warcraft. The digital game industry is also considered to be a multibillion-dollar entertainment industry that often exceeded the movie industry (Kirriemuir, 2002).

Aside from providing engagement and entertainment, digital games have been discussed to promote higher-order skills such as the ability to think, collaborate, solve complex problems, or communicate through media which many experts believed to be the skills needed in the twenty-first century. Because of these advantages and people's massive use of digital games, educators have begun to tap its potential and use it as an instructional tool.



Prensky (2001), one of the pioneers of digital game-based learning, supports the use of digital games in learning contexts to transform the way students learn and engage a new generation of learners in a way that traditional education does not. Other findings from research about the use of digital games include increasing social interaction (Oliver & Carr, 2009) and providing individualized instruction (Switzer, 2004).

Although most agree that digital games can be engaging and instructive, there is little consensus about the essential characteristics of digital games that improve student achievement specifically in terms of knowledge acquisition and skill development. Much of the existing research literatures on digital games and learning suggest that pairing instructional content with features like rich graphics (Prensky, 2001), interactivity (Fladen and Blashki, 2005), or immediate feedback (Shute, Ventura, Bauer, & Zapata-Rivera, 2009) can lead to greater student interest and increased learning. On the other hand, the cognitive theory of multimedia learning (Mayer, 1997) argues that multimedia messages that are designed in light of how people process information are more likely to lead to meaningful learning. Furthermore, the theory posits that learning occurs from multimedia tools such as digital games when instructional content are presented using words and pictures than words alone. Words can be printed words or spoken words and pictures can be illustrations, animation or video clips. In connection with this, this study investigated whether an interactive digital game, designed to motivate students and present instructional messages using on-screen texts, improved student achievement in the cognitive and psychomotor domains in comparison with a traditional print media which presented instructional messages using texts and pictures. Students' attitudes toward the use of interactive digital game and print media were also explored.

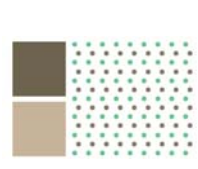
Methodology

Participants

The participants were undergraduate students of Maejo University, Chiang Mai enrolled in PS 103 (International Relations) during the Academic Year 2011-2012. Sixty students were selected using simple random sampling technique and were distributed into experimental and control groups. Each group consisted of 30 students.

Interventions

This study used *Eternal Story*, a high quality 3D Massive Multiplayer Online Role Playing Game developed and owned by the Information and Technology Service Center, Chiang Mai University and Thai Cyber University, Commission on Higher Education (<http://itscgames.cmu.ac.th/home.html>), since it is considered as the first and one of the game-based learning tools in Thailand used in Higher Education. This game aims to make learning fun by engaging students so they could improve their knowledge and skills on Fundamental English course. In the game, players take the role of warriors and complete missions by interacting with non-player characters. The engagement part is derived from traveling through a fantasy world environment and gathering rewards by destroying monsters. The instructional content of *Eternal Story* consisted of selected lessons in Fundamental English presented using on-screen texts (Figure 1 and 2). The instructional contents were 1) References, 2) Topic, 3) Main Idea, 4) Skimming, 5) Scanning, 6) Context Clues, 7) Word Analysis, 8) Organization of Text, 9) Supporting Details, 10) Using Dictionary, 11) Making Inferences, 12) Identifying Fact and Opinion, and 13) Transition Words. The instructional contents covered in this study were References, Topic, and Main Idea. These contents were selected because students will gain knowledge on how to define and identify reference words for better writing skills in English. Moreover, students will gain knowledge on how to define



and identify a topic and main idea in reading passages for better reading comprehension in English. These contents were not related to the participants' courses thus avoiding potential threats to internal validity of the study. In comparison, a booklet was developed by the researcher containing similar instructional contents but presented using texts and pictures (Figure 3). This booklet was reviewed and validated by a group of experts.

Research Design

This study used a pretest-posttest control group design. During the pretest, all sample respondents answered a cognitive and psychomotor domain achievement test to measure their existing knowledge and skills. The cognitive domain achievement test was divided into three categories: knowledge, understanding, and application. The psychomotor domain achievement test was divided into two categories: imitation and manipulation. The posttest was conducted after two weeks. During the posttest, the experimental group played *Eternal Story* for about 40 minutes and then answered the cognitive and psychomotor achievement test and an attitude survey. On the other hand, the control group read the booklet for about 40 minutes and also answered the cognitive and psychomotor achievement test and an attitude survey.

Data Analysis

Students' pretest and posttest scores on the cognitive and psychomotor domain achievement tests were analyzed using measures of central tendency (means and standard deviations) and independent samples t-test. The level of significance chosen was .05. Moreover, students' responses to open-ended questions were analyzed using thematic analysis.


Results and Discussion

Demographic Information of Sample Respondents

The results of the study showed that the samples were mostly 20 years old and in their second year in university. Their majors were mostly Public Administration, Economics, Information Technology, Engineering, and Agriculture. The samples were interactive multimedia users but have limited knowledge and skills in English.

Student Achievement in the Cognitive Domain

Results of cognitive domain achievement scores between the two groups are presented in Table 1. An independent samples t-test showed no significant differences in the total pretest scores of experimental and control group students ($t = -.851^{ns}$, $p > 0.05$). This result indicated that both groups had equal prior knowledge on selected topics of Fundamentals of English. On the other hand, an independent samples t-test showed a highly significant difference on the total posttest scores of the experimental and control group students ($t = -3.734^{***}$, $p < 0.05$). In particular, a highly significant difference was found in posttest scores in the knowledge level or the students' ability to remember previous information ($t = -3.686^{***}$, $p < 0.001$). However, no significant difference was found in posttest scores of the two groups in the comprehension level or students' ability to understand key concepts ($t = -1.785^{ns}$, $p > 0.05$) and in the application level or students' ability to apply learned information in new contexts ($t = -.950^{ns}$, $p > 0.05$). Finally, an independent samples t-test indicated a significant difference in overall gain scores of the experimental group and control group students ($t = -3.169^{**}$, $p < 0.05$). The results implied that although the use of interactive digital game improved students' ability to recall, understand, and apply learned material ($\bar{x} = 12.17$, $S.D = 9.87$), it did not appear to be as effective compared with the use of the booklet ($\bar{x} = 21.17$, $S.D = 12.01$). The possible explanation from this is because the digital



game used plain texts to present the instructional content without any supporting graphics (Figure 1). Also, the digital game did not take advantage of using visual signals such as highlights, symbols, or arrows to emphasize certain information (Figure 2). Thus the experimental group participants did not engage in active learning – cognitive processes that are intended to help the students make sense of the material such as the construction of coherent mental representations. With regard to the booklet, texts and supporting graphics were used to present the instructional content. Additionally, bold and styled texts were used indicating important information on a page (Figure 3). Visual signals such as highlights, circles, and arrows were placed to emphasize certain information (Figure 3).

Student Achievement in the Psychomotor Domain


Results of psychomotor domain achievement scores between the two groups are presented in Table 2. An independent samples t-test showed no significant differences in the total pretest scores of the experimental and control group students ($t = -.756^{ns}$, $p > 0.05$). This result indicated that both groups had equal prior skills related to selected topics in Fundamentals of English. On the other hand, an independent samples t-test revealed a significant difference in the total posttest scores of the experimental and control group students ($t = -2.475^*$, $p < 0.05$). In particular, a highly significant difference was found in the posttest scores of the two groups in the imitation level or the students' ability to duplicate learned information ($t = -4.002^{***}$, $p < 0.001$) but no significant difference were found in the manipulation level or the students' ability to perform certain actions by following instructions ($t = -1.621^{ns}$, $p > 0.05$). Finally, an independent samples t-test showed a significant difference in the overall gain scores of the experimental group and control group students ($t = -2.282^*$, $p < 0.05$). A review of the descriptive statistics showed that although the use of the interactive digital game improved students' ability to duplicate learned information and perform certain actions by following instructions ($\bar{x} = 18.17$, $S.D = 9.69$), it did not appear to be as effective compared with the use of the booklet ($\bar{x} = 24.33$, $S.D = 11.20$). The possible explanation from this is because majority of the students reported that they had limited knowledge in the English vocabulary used in the narratives. Moreover, most of the learners were unfamiliar with the main concepts included in the lesson even though they were able to control the time spent on learning. As a result, learners had difficulty processing information.

Students' Attitudes toward the Interactive Digital Game

Results of thematic analysis on open-ended questions revealed that experimental group students perceived the interactive digital game effective in teaching new English words. The participants also responded positively to the immediate feedback feature of the game since it informed them how to accomplish goals and motivated them to learn the contents. Majority of the participants perceived the contents of *Eternal Story* difficult to understand because they were not familiar with most of the English words used. But the participants believed that their instructors would use digital games to teach a lesson because digital games could motivate students at the same time could promote knowledge acquisition and skills development. Moreover, the participants considered the contents of the *Eternal Story* important because it could help improve their grades and they could use the knowledge and skills acquired to teach their friends and family members. Finally, the participants suggested that a tutorial may be included containing information on the covered contents, game objectives, game missions, and game controls.

Students' Attitudes toward the Print Media

Results of thematic analysis on open-ended questions revealed that control group students perceived the booklet effective in increasing their knowledge and understanding of



references, identifying topic, and identifying main idea. Moreover, majority of the participants responded that the contents of the booklet were easy to understand because of the organization, lay-out, design, and availability of Thai translations. The participants also considered the contents of the booklet beneficial because it could improve their knowledge. It could also improve their communication skills especially in the workplace. Finally, the participants suggested that relevant pictures may be added, texts should be more organized and divided into sections, and exercises and definition of key terms should be included.

Table 1 Cognitive Domain Achievement Scores of Experimental and Control Group Participants

Cognitive Domain	n	Pretest Scores				Posttest Scores				Gain Scores			
		\bar{x}	S.D.	t-value	sig	\bar{x}	S.D.	t-value	sig	\bar{x}	S.D.	t-value	sig
1. Knowledge Level													
(60 points)													
Control Group	30	33.33	12.34	-.446 ^{ns}	0.657	46.33	8.40	-3.686 ^{***}	0.001	13.00	9.88	-2.760 ^{**}	0.008
Experimental Group	30	31.83	13.68			38.17	8.76			6.34	8.80		
2. Comprehension Level													
(20 points)													
Control Group	30	8.83	5.03	-1.099 ^{ns}	0.276	13.17	5.33	-1.785 ^{ns}	0.079	4.33	4.50	-1.208 ^{ns}	0.232
Experimental Group	30	7.33	5.53			10.50	6.21			3.17	2.78		
3. Application Level													
(20 points)													
Control Group	30	5.83	4.93	-.125 ^{ns}	0.901	9.67	5.40	-.950 ^{ns}	0.346	3.83	4.86	-.965 ^{ns}	0.338
Experimental Group	30	5.67	5.37			8.33	5.47			2.67	4.50		
Total Score of 3 Levels													
(100 points)													
Control Group	30	48.00	13.49	-.851 ^{ns}	0.398	69.17	12.04	-3.734 ^{***}	0.000	21.17	12.01	-3.169 ^{**}	0.002
Experimental Group	30	44.83	15.28			57.00	13.17			12.17	9.87		

Note

- ns = value is not statistically significant at the .05 level of probability
- * = value is statistically significant at p < .05 level of probability
- ** = value is statistically significant at p < .01 level of probability
- *** = value is statistically significant at p < .001 level of probability

Control group = randomly selected students who were introduced to a booklet
 Experimental group = randomly selected students who were introduced to an interactive digital game



Table 2 Psychomotor Domain Achievement Scores of Experimental and Control Group Participants

Psychomotor Domain	n	Pretest Scores				Posttest Scores				Gain Scores			
		\bar{x}	S.D.	<i>t</i> -value	sig	\bar{x}	S.D.	<i>t</i> -value	sig	\bar{x}	S.D.	<i>t</i> -value	sig
1. Imitation Level													
(20 points)													
Control Group	30	7.83	6.91	-.779 ^{ns}	0.439	15.83	4.17	-4.002 ^{***}	0.000	8.00	6.64	-2.755 ^{**}	0.008
Experimental Group	30	6.67	4.42			10.83	5.43			4.17	3.73		
2. Manipulation Level													
(80 points)													
Control Group	30	25.00	14.08	-.658 ^{ns}	0.513	41.33	9.37	-1.621 ^{ns}	0.111	16.33	7.65	-1.114 ^{ns}	0.270
Experimental Group	30	22.67	13.37			36.67	12.69			14.00	8.55		
Total Score of 2 Levels													
(100 points)													
Control Group	30	32.83	18.83	-.756 ^{ns}	0.453	57.16	12.30	-2.475 [*]	0.016	24.33	11.20	-2.281 [*]	0.026
Experimental Group	30	29.34	17.01			47.50	17.51			18.17	9.69		

Note

- ns = value is not statistically significant at the .05 level of probability
- * = value is statistically significant at p < .05 level of probability
- ** = value is statistically significant at p < .01 level of probability
- *** = value is statistically significant at p < .001 level of probability
- Control group = randomly selected students who were introduced to a booklet
- Experimental group = randomly selected students who were introduced to an interactive digital game



Conclusion

This study investigated the effects of an interactive digital game and print media on students' cognitive and psychomotor domain achievement. Moreover, students' attitudes toward the use of the interactive digital game and print media were explored. Based on the results of the study, the following conclusions are drawn.

The interactive digital game, designed to motivate students and present instructional messages using on-screen texts, did not significantly improve students' cognitive and psychomotor domain achievement when compared with a print media which presented instructional messages using texts and pictures.

Students perceived the interactive digital game effective in providing motivation and in teaching new English words. They perceived that the game improved the quality of learning experience by the graphics, challenges, non-player interaction, immediate feedback, and chat feature. Moreover, students perceived the booklet effective in improving their understanding of the instructional content. Majority of the participants perceived the content of the booklet easy to understand because of the organization, lay-out, graphics, and availability of Thai translations.

Since this study did not investigate the effects of digital games on students with high prior knowledge or low prior knowledge about the instructional content, a future study is recommended.

ประเภทของ References

References ที่พบได้บ่อย ๆ มีด้วยกันทั้งหมด 7 ประเภท ได้แก่

1. Pronouns and adjectives เช่น he, she, it, we, they, him, her, us, them, his, hers, its, theirs เป็นต้น

As soon as my daughter arrived home, she called me.

she ในที่นี้ใช้แทน my daughter

2. Relative pronouns เช่น that, which, who, whom, whose, where, when, why

This book is very useful for students who score low on vocabulary tests.

who ใช้แทน students

Next

Figure 1 A screenshot of a lesson about “References” included in *Eternal Story* game

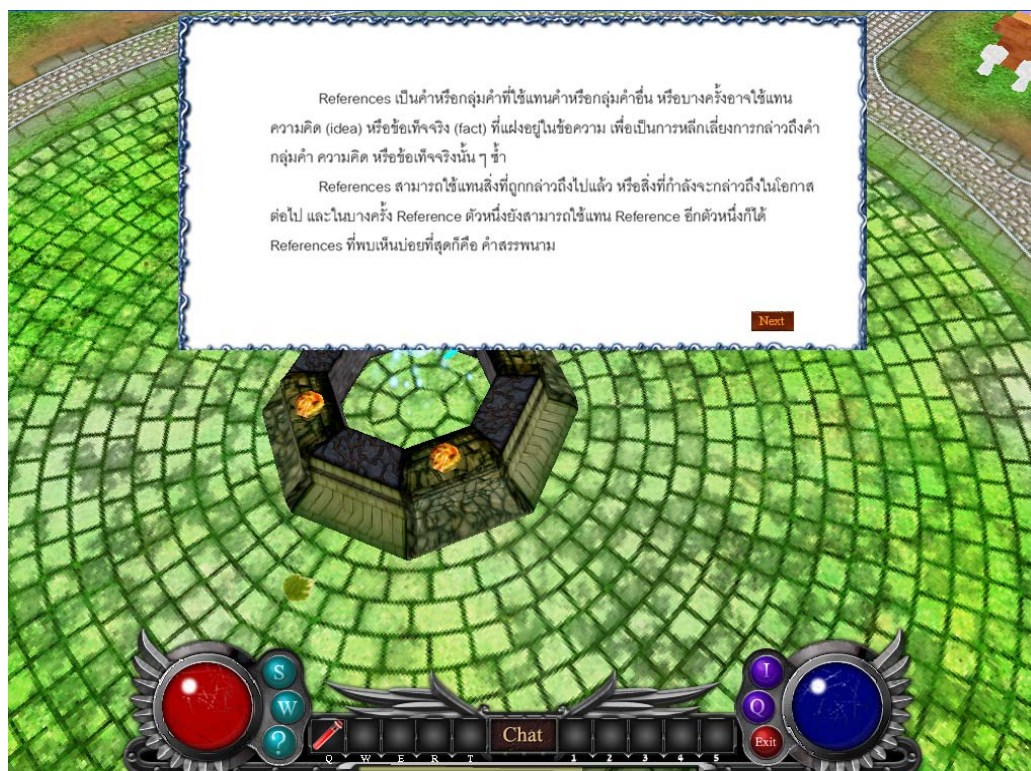


Figure 2 A screenshot of a lesson about “References” included in *Eternal Story* game

REFERENCES

Learning Objectives

Learners will be able to:

1. Define References;
2. Tell which word or Reference words refers to;
3. Use reference words to form a sentence.

References เป็นคำหรือกลุ่มคำที่ใช้แทนคำหรือกลุ่มคำอื่น หรือบางครั้งอาจใช้แทนความคิด(idea) หรือข้อเท็จจริง(fact) ที่แฝงอยู่ในข้อความ เพื่อเป็นการหลีกเลี่ยงการกล่าวถึงคำกลุ่มคำ ความคิด หรือข้อเท็จจริงนั้นๆ ซ้ำ

References สามารถใช้แทนสิ่งที่ถูกกล่าวถึงไปแล้ว หรือสิ่งที่กำลังจะกล่าวถึงในโอกาสต่อไป และในบางครั้ง References ตัวหนึ่งยังสามารถใช้แทน References อีกตัวหนึ่งก็ได้ References ที่พบเห็นบ่อยที่สุดก็คือ คำสรรพนาม

ตัวอย่างการใช้ References

1. A surprising fact about sailboats is that they can move against the wind.
ในที่นี้ they เป็น reference ที่ใช้แทนคำที่ถูกกล่าวถึงไปแล้ว คือ sailboats
2. Mike gave Paula a letter. This gave her food for thought.
This ในที่นี้ใช้แทน the fact that Mike gave Paula a letter หรือข้อเท็จจริงที่ Mike ให้จดหมายแก่ Paula
3. To the men who build them, modern skyscrapers are tools for the use of office workers.
them เป็น reference ที่ใช้แทน skyscrapers ที่ถูกกล่าวถึงในข้อความถัดไป



Of all the torments that women have suffered in the name of beauty, few can equal those of foot-binding. This extraordinary fashion was practiced until the last Chinese Emperor was overthrown is an evidence of the inferior status of women in Imperial China. No one seems to know the exact origin of this curious custom. One story says that it began around 500 A.D.

2

จากเส้นลูกศรจะเห็นการใช้ของ References และคำต่างๆ ที่ References เหล่านี้ถูกใช้แทนที่

Figure 3 A sample page of the booklet containing a lesson on “References”



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