

# Analyzing the Effects of Different Multimedia Materials on Learning System

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**Abstract**— Personalized learning has recently become an innovative trend in digital learning. The adaptive material could enhance the intention of learning, and motivate learner to concentrate on learning activity. Information technology have flourished, multimedia have been widely applied in learning materials. Various types of multimedia are designed on learning activities, how they affect individual's satisfaction and system performance is therefore essential for personalized learning. This study was interesting to determine the effect of multimedia material on user satisfactions, user's technology of acceptance, and the system performance, thus we applied the multimedia in learning system consisted of audio based material, animated based game and static text. We take problem-solving learning activities which includes a series of scenario as example [1]. The presentation of scenario were categorized as static text, audio based material, and animated based game. Providing the adaptive learning material to response the need of individual, learner can select the prefer material on learning system. Real case included in this study, the purpose of which was to examine the performance and reliability of the learning material. The experimental results show that the participants have a 95% probability of obtaining an above-average user satisfaction with static text material, audio based material, animated based game which suggests that the employed multimedia can be a good vehicle for learning system.

**Keywords**—Multimedia, personalize learning, digital learning audio based material, technology acceptance, system performance

## INTRODUCTION

Related scholars proposed that the personalized learning is necessary to improve learning programs [2]. However, multimedia employed in the learning activity to enrich the content of learning, and the diversity of presentation is benefit for personalized learning. In recently, multimedia was widely used to web based learning [3] [4]. Information and communication technology (ICT) empowers learners interact with multi-media material on web based learning platform. Based on the web technology, the material and learning content could be timely retrieved [5], thus various kind of learning material recently is extend applied in learning activities. Personalizing the learning activities by providing adaptive material is raised more interesting than ever, and researches of the learning material have paid much attention.

Multimedia based learning material plays important role on learning system. The content of learning has different presentation of multimedia [6]. Textual descriptions are considered as the static material, and audio, game or animations belong to the dynamic material. The presentation of static materials is particularly effective to concentrate the mental representation [7]. The dynamic material, for example, animation or audio conveys changes in the described phenomenon and movement over time. For all of multimedia materials, the game mechanisms have the most potential to improve the learners' learning performance. Game based materials are widely used to e-learning system for maintaining the enjoyable nature of the games [8]. The explosions of learning material design have the uniqueness of technology acceptances on learning system. This study aims to explore the difference in system performance between multimedia materials. We not only applied static text, audio material, and animation based game in learning system, but also evaluated learners' preferences and system performance.

## RELATE WORK

With the repaid development of multimedia materials, learning materials are not constrained by convention paper-based material [9]. Therefore, applying multimedia materials in digital learning has attracted a considerable amount of attention from researchers [10]-[12], the purpose of promoting learning interest as well as attention. The multimedia materials affect learning performance in different way. Some studies indicated that the developed visual style might congruent to a certain degree, because visual material can strength problem-solving comprehension and raise problem-solving transfer [13] [14]. A view of some studies indicates that the dynamic materials have positive affect on raising the learning attention and interest than static textual material, as follows:

### ■ Animation material:

The animated illustrations have positive effects on understanding complex systems [15]. The difference between animations and static material existed on cognitive style, because animation is the explicit external representations [14]. Accordingly, animations is used to conduct the mental representation with a less developed visual style [16], and provide learners compensatory illustration with less pronounced visual styles [17]. Therefore, animation is

efficient to assistant learners to conduct the mental representation, and imagine processes. Animation regarded as the good tool for problem-solving activities.

■ Game based material

In addition, game based material defined as one of the learning material that aims to enhance the problem-solving skills and motivate learner to solve problem by interacting with the game scenario. The scenario could help learner to link the abstract concept to the concrete game experience in an attempt to solve a problem [18] [19]. The related literature supported the view and showed that games can be a stimulating motivator for students of all ages [20]. To summary, the game based material have been recently considered as an innovative development in digital learning, and game techniques are included positive effect in individual learning. In ordered to impress the learner cognize by the dynamic display the text and picture, we analyzed the effect of the animation game based material in learning system. The animated based game will compare with static text and audio material in this study.

METHODOLOGY

Theories of learner behavior and problem-solving education applied in multimedia materials to design the multimedia learning activity. In this study, we provide the three types of learning materials (audio / text/ animated based game) for learner to meet their needs while they attending the problem-solving activities. The multimedia learning approach based on the web based architecture that acts as a medium between system and learner. Fig. 1 illustrated the architecture of the proposed on-line multimedia approach. Three types of multimedia: audio, static text, animated based game employed in problem-solving activity in this study. The problem-solving activities was included a series of solution inferring tasks we used to train problem-solving skill via multimedia material. As learners finished the problem-solving task, the results collected into learning database for data analysis. On the purpose of discovering whether the using acceptance or system performance were depend on multimedia. Knowledge management (KM) and statistical test employed to data analysis. Finally, learner obtained the analysis result of learning material preference and user’s technology acceptance.

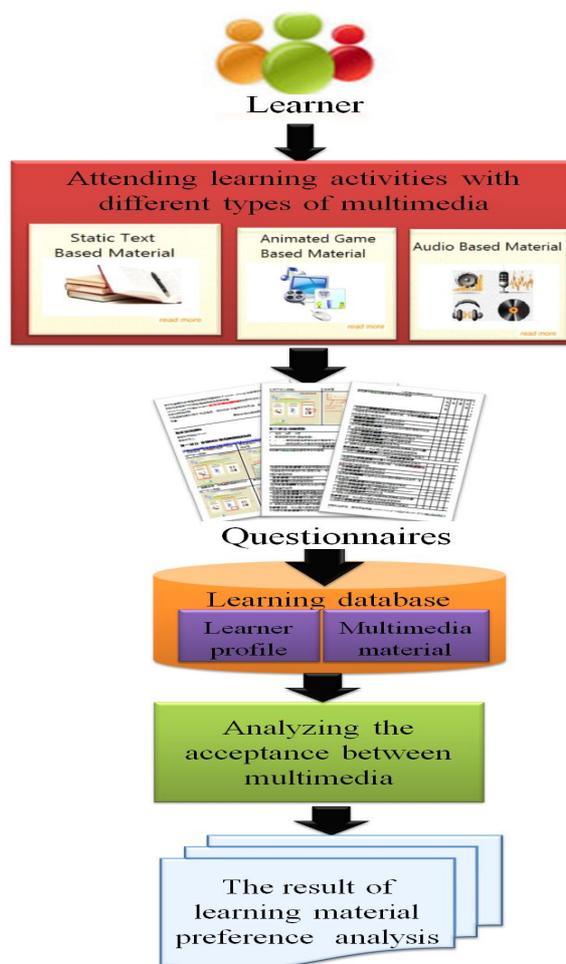


Fig. 1 The architecture of the proposed on-line multimedia approach

To enhance the portability of system, we programed the learning activities based on the web technique. Accordingly, the content of learning systems such as broadcasting audio or animation can regularly excuse on the web based platform (See Fig.2), allowing the learner to obtain real-time information. To summary, the proposed on-line multimedia material approach can adapt the learning material to achieve the goal of personalized learning.



Fig. 2 The audio material can be broadcasted anywhere

Fig. 3 illustrated three types of multimedia included in learning activities, and this study establishes a multimedia including static and dynamic material. The static text based material is which use the textual to describe the content of learning scenario. The animated based games consist of the animation and game technology to present the scenario, and the audio based material is used to illustrate the content of scenario with audio.

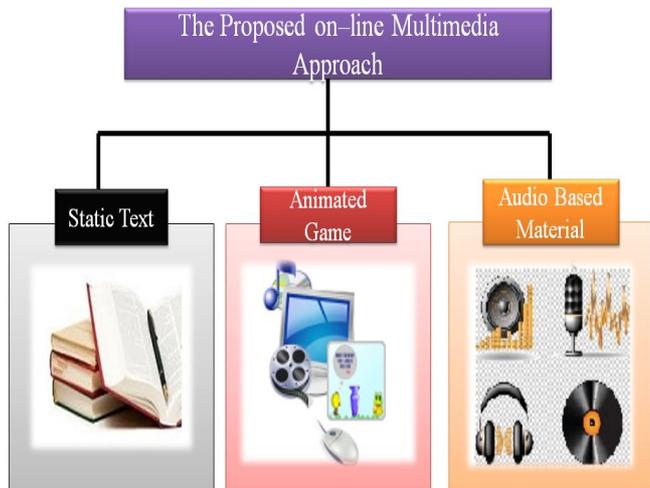


Fig.3 Three multimedia materials included in learning activities

In this study, the learning activity includes four scenario subjects: “mathematic computation”, “associating ability”, “observation”, and “logic inference”. We display these scenarios with multimedia. The static text material applied in the learning activity, each scenario has clear instruction with textual descriptions. The animated based game was employ in learning activity with the same scenario to compare static text and audio material. The audio based material applied in learning activities, the content of each scenario was present with audio media. Learner attends in learning activities by listen the conversation of scenario (See Fig.4). Based on the same time of text and animated game, learner could repeat the context in the scenario.



Fig. 4 The interface of learning activities with audio material

EXPERIMENT

A. Experimental design

This study aims at analyzing the effects of different multimedia materials on learning system. The data source is therefore essential for multimedia preference analysis and performance evaluation. Fig. 5 showed the participants’ information, we collected data from 17 participants consisted of teachers and students. The 64.7% of participants is female, and 82.4% of participants is student.

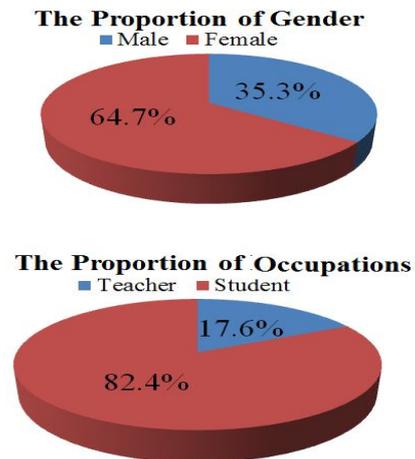


Fig. 5 The result of participants’ information

The collected parameters is displayed in Table 1. For the purpose of adapting the analysis result in real cases, the performance evaluation based on the successful information system model and “user’s technology acceptance” included in the research questions. All participants completed the experiment in approximately 1.5 hour, and they were paid US \$ 5 dollars to participate.

TABLE I  
THE VARIABLE OF LEARNER PREFERENCE SURVEY.

Variables	Description	Type
ID	Identify sample	Numerical
Gender	1=Male 2=Female	Categorical
Learning material		
The Material preference of the proposed material	1 =Static text based 2 =Animated based game 3 =Audio based material	Categorical
Self-perception of material preference		
Participants	1= Teacher 2 =Student	Participants
11 evaluation items (see result session for the items)	5-point Likert type questionnaires with response options of strongly disagree to strongly agree (type=1~5)	Categorical

B. Analysis of integral effect of the different multimedia material

In this study, the order of the favourite multimedia as follows: animated game, static text, and audio material (See Table 2). The level of user satisfaction ranging from strongly satisfying to strongly unsatisfying, the lower score means the participants strongly satisfying with the material we proposed. The order of user satisfaction is: animated based games (2.04 points), static text (2.37 points), and audio (2.38 points). Animated based games had the good evaluation on the proposed activities.

TABLE II  
THE INTEGRAL PERFORMANCE EVALUATION BETWEEN DIFFERENT TYPES OF MULTIMEDIA

	Static Text	Animated Game	Audio
User satisfactions	2.34	2.04	2.38
5-point Likert type scale with response options ranging from strongly satisfying to strongly unsatisfying			

Fig. 6 is shown the result of multimedia preference evaluation. Most of participants have preference for animated based game on not only the proposed system, but also their self-perception. The preference result of static text is interesting, the few proportion of participants percept their favourite material is the static text material. While they had used the proposed material, the preference of static text had drastically growth. The audio material had the fewest of preference on the proposed approach in this study. It might be influenced by the content of learning, the problem-solving scenarios is hard to present with a single audio material.

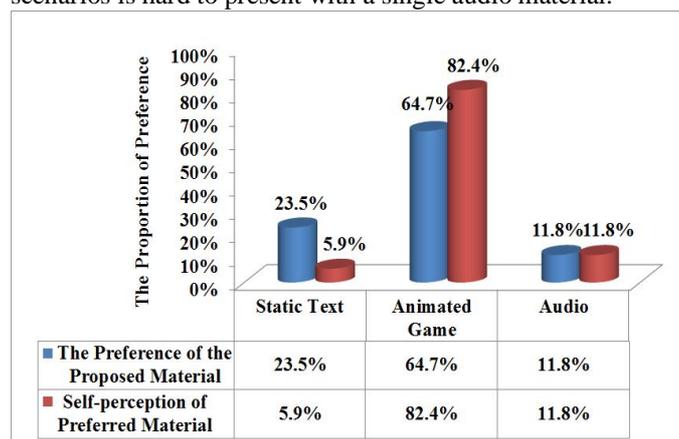


Fig. 6 The result of the multimedia material preference analysis

C. Analysis of system performance effect on the different multimedia

The following eleven items were separately included in the performance evaluation and user cognition between three types multimedia: “This type of multimedia could stimulate the ability of problem-solving” (Q1); “This type of multimedia material could enhance learning efficiency in the current task” (Q2); “The user interface provides a "user-friendly" experience by using this type of multimedia ”(Q3); “The function of this type of multimedia is well defined in the proposed learning activities”(Q4); “Have intentions to use this type of multimedia for problem-solving activities” (Q5); “This type of multimedia material could enhance the ability of problem-solving”(Q6); “This type of multimedia enhances learning motivation” (Q7); “This type of multimedia is useful for problem-solving activities”(Q8); “Information acquisition and sharing could assist the performance of learning based on this type multimedia” (Q9); “The incorporation of IT technology into this type of multimedia is effective for attracting learners’ attention to the problem-solving activities” (Q10). “This type of multimedia is efficient for learner to concentrate on learning activities” (Q11). Moreover, we examined the significance of these items. The response options were scored with a Likert’s five point scale ranked from strongly agree (1 point) to strongly disagree (5 points), to examine whether the mean of each item was significantly different from the median.

In this study, we used a t-test to separately examine the questionnaire items between the different types of multimedia. The multimedia was classified with three types: static text, animated based game, and audio. In addition, the lower score mean the participants have strong agreed on the view we proposed. Table 3 illustrated that score of each questionnaire item concerned with the static text. The results show that the participants have a 95% probability of obtaining an above-average performance evaluation. In particular, participants had significantly agree ( $t=5.4$   $p$ -value =  $0.000 < 0.05$ ) that user interface provides a "user-friendly" experience by using static material.

TABLE III  
THE STATIC TEXT MATERIAL EVALUATION

Item	Mean	p	t-value
Q1	2.41	0.011	2.28
Q2	2.41	0.011	2.28
Q3	1.88	0.000	5.37
Q4	2.24	0.001	3.05
Q5	2.24	0.001	3.25
Q6	2.41	0.029	1.90
Q7	2.24	0.002	2.89
Q8	2.47	0.026	1.94
Q9	2.24	0.001	3.05
Q10	2.41	0.015	2.16
Q11	2.76	0.174	0.94

Table 4 shows that each of questionnaire items reached significant high level, strongly evidence that animated based game is an efficient material for learning system. The result of experiment implied that the participants significantly agree that animated based game could promote the ability of problem-solving ( $t=5.22$   $p\text{-value} < 0.05$ ). In addition, it also could enhance learning efficiency ( $t=5.22$   $p\text{-value} < 0.05$ ). The participant felt that animated based game could provide a "user-friendly" experience in learning system ( $t=4.41$   $p\text{-value} < 0.05$ ), the game material we developed also had the characters of the high level of specificity ( $t=4.02$   $p\text{-value} < 0.05$ ), and using intention ( $t=3.92$   $p\text{-value} < 0.05$ ) which could enhance the learners' ability of concentrating ( $t=4.41$   $p\text{-value} < 0.05$ ). Moreover, the result of experiment indicated that the participants have a significantly level of satisfaction with the efficiency of the animated game to provoke a problem-solving ability ( $t=5.37$   $p\text{-value} < 0.05$ ). They significantly agree that animation-based material is useful for problem-solving activities ( $t=3.52$   $p\text{-value} < 0.05$ ), and information acquisition and sharing could assist the performance of learning based in the animated based game environment ( $t=3.77$   $p\text{-value} < 0.05$ ). The participants felt that the incorporation of IT technology into animated based game is effective for attracting learners' attention to the problem-solving activities ( $t=4.41$   $p\text{-value} < 0.05$ ).

TABLE IV  
THE ANIMATED BASED GAME EVALUATION

Item	Mean	p	t-value
Q1	2.12	0.000	5.22
Q2	2.00	0.000	5.22
Q3	2.00	0.000	4.41
Q4	2.06	0.000	4.02
Q5	2.12	0.000	3.92
Q6	1.88	0.000	5.37
Q7	2.24	0.004	2.63
Q8	2.00	0.000	3.52
Q9	2.06	0.000	3.77
Q10	2.00	0.000	4.41
Q11	2.00	0.000	4.41

TABLE V  
THE AUDIO BASED MATERIAL EVALUATION

Item	Mean	p	t-value
Q1	2.35	0.008	2.39
Q2	2.47	0.038	1.77
Q3	2.18	0.000	4.20
Q4	2.29	0.001	3.17
Q5	2.47	0.015	2.17
Q6	2.41	0.008	2.42
Q7	2.35	0.008	2.39
Q8	2.24	0.001	3.05
Q9	2.53	0.020	2.06
Q10	2.29	0.002	2.95

Q11	2.59	0.083	1.38
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In spite of the participants had significantly agree ( $t=4.2$   $p\text{-value} < 0.05$ ) that user interface provides a "user-friendly" experience by using audio material. Table 5 indicated that the participants has intention of using audio material didn't reach the significant level ( $t=1.38$   $p\text{-value} = 0.08 > 0.05$ ), the complex learning scenario is very difficult to describe via the single audio material. The picture and text incorporate in the audio could be improved the efficiency of presentation. To summary, this supports the claim that animated based learning has better performances which enhance both learning interesting and learning efficiency on the system. The different type of multimedia has effect on the learning system in different way. For example, static text, animated based game, and audio based material all can increase the convenience of interface, but audio material have attract the few of attention for learner to use.

### CONCLUSION

In this study, we analyzed how the different multimedia material effect on the system performance and system efficiency. Real cases were applied in the system and assured that the reliability and correction of the content of material. Our experiment shows that animated game had the most positive evaluation of system than static text and audio. The animated based game successfully employed the on-line problem-solving learning system and it obtained the high level of user satisfaction in problem solving learning system. The main contributions of this study are: (1) Determining the relationship between multimedia and learner. (2) This study also measured that multimedia material associated with performance of assistance learning. (3) This study also explores the difference in user acceptance and satisfaction between different types of multimedia. (4) The multimedia material average obtained 2.26 point of integral evaluation, implying that multimedia has positive effect on learning system. In future studies, we would expect multimedia to be widely used in various types of learning activity. To toward the development of personalized learning, future studies aim to analyze the correlation between the material preference and personal traits from teacher or learner.

### REFERENCES

C. F. Lin, Y. H. Hung, and R. I. Chang, " Effect Analysis of a Multi-Material Approach to a Problem-Solving Learning System", *International Journal of Computer Trends and Technology*, vol.4, 2013.

C. Chen and C. Chen, "Mobile formative assessment tool based on data mining techniques for supporting web-based learning," *Computers & Education*, vol. 52, no.1, pp. 256-273, 2009.

C. Chen and L. Duh, "Personalized web-based tutoring system based on fuzzy item response theory," *Journal of Expert Systems with Applications*, vol. 34, no.4, pp.2298-2315, 2008.

Y. Lee, "Developing an efficient computational method that estimates the ability of students in a web-based learning environment," *Computers & Education*, vol. 58, no.1, pp.579-589, 2012.

M. Wang, H. Jia, and V. Sugumaran, W. Ran, and J. Liao, "A web Based learning system for software test professionals," *IEEE Transactions on Education*, vol.54, no.2, pp.263-272, 2011.

- R. C. Clark and R. E., Mayer, "E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning," *Pfeiffer*, 2011.
- J. M. Boucheix and E. Schneider, "Static and animated presentations in learning dynamic mechanical systems," *Learning and instruction*, vol.19, no.2, pp.112-127, 2009.
- C. F. Lin, Y. C. Yeh, Y. H. Hung, and R. I. Chang, "Data mining for providing a personalized learning path in creativity: an application of decision trees," *Computers & Education*, In Press, 2013.
- C. M. Chen and Y. C. Sun, "Assessing the effects of different multimedia materials on emotions and performance for visual and verbal style learners," *Computer & Education*, vol. 59, no. 1, pp.1273-1285, 2012.
- C. M. Chen, & T. H. Lee, "Emotion recognition and communication for reducing second-language speaking anxiety in a web-based one-to-one synchronous learning environment," *British Journal of Educational Technology*, vol. 42, no. 3, pp. 417-440, 2011.
- E. R. Um, H. Song, & J. Plass, "The effect of positive emotions on multimedia learning," *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Vancouver, Canada, 2007.
- G. J. Hwang, P. H. Wu, and C. C. Chen, "An online game approach for improving students' learning performance in web-based problem-solving activities," *Computers & Education*, vol.59, no.4, 2012.
- R. E. Mayer, "The Cambridge handbook of multimedia learning," *Cambridge: Cambridge University Press*, 2005.
- T. N. Höffler, H. Prechtel, and C. Nerdel, "The influence of visual cognitive style when learning from instructional animations and static pictures," *Learning and Individual Differences*, vol. 20, no.5, pp. 479-483, 2010.
- L. P. Rieber, S. C. Tzeng, & K. Tribble, "Discovery learning, representation, and explanation within a computer-based simulation: finding the right mix," *Learning and Instruction*, vol. 14, no.3, pp.307-323, 2004.
- D. Lewalter, "Cognitive strategies for learning from static and dynamic visuals," *Learning and Instruction*, vol.13, no.2, pp.177-189, 2003.
- Salomon, G., "Interaction of media, cognition and learning," *San Francisco: Jossey Bass*, 1979.
- J. Kirriemuir and A. McFarlane, "Literature review in games and learning," *Bristol, UK: Futurelab*, 2004.
- M. C. Lewis and B. Massingill, "Graphical game development in CS2: a Flexible infrastructure for a semester long project," *In Proceedings Of the 37th SIGCSE Technical Symposium on Computer Science Education*, pp. 505-509, 2006.
- A. Amory, "Play games to learn: Pre-service teacher development. The Proceedings of World Conference on Educational Multimedia," *Hypermedia and Telecommunications*, pp.2119-2118, 2011.