Perceived Effectiveness of Using the Life-Like Multimedia Materials Tool

Hung-Hsu Tsai[1*], Yen-Shou Lai[2], Shih-Che Lo[3] and Pao-Ta Yu[4]

[1]Department of Information Management, National Formosa University, Huwei, Yulin, Taiwan // [2]Shin Kong Elementary School, Gukeng, Yulin, Taiwan // [3]Department of Industrial Management, National Taiwan University of Science and Technology, Taiwan // [4]Department of Computer Science and Information Engineering, National Chung Cheng University, Taiwan // thh@nfu.edu.tw // laiysmail@gmail.com // sclo@mail.ntust.edu.tw // csipty@cs.ccu.edu.tw

[*]Corresponding author

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ABSTRACT

The paper investigates the impact of learning effects on the study of life-like multimedia materials (LMMs) which are produced by the LMM tool. Teachers can readily utilize the tool to make the LMMs for their instructions in traditional classrooms. When students study the LMMs out of class, they can realistically recall teacher's teaching situations and/or the instructional procedures in traditional classrooms. The materials powerfully possess high media richness because of their crucial features such as displaying teacher's face, hearing teacher's sound, and presenting teaching materials in the largest region of the screen. A quasi-experiment was also involved to examine the impact of learning effects while using the LMM tool in class and studying the LMMs out of class. In this study, an exploratory method was conducted with 87 students. They were divided into the experimental and the control groups. The results reflect that the experimental group achieved a significant increase in the perceptional effectiveness of the multimedia-based cognitive process with the LMMs in comparison to the control group. Finally, the paper offers discussions for the impact on learning effects when students studied the LMMs out of class.

Keywords

Classroom learning, Multimedia learning, Media richness theory, Teaching strategy, Learning strategy

Introduction

A popular issue for the contemporary education in Taiwan is to integrate information technologies into classroom learning so as to improve students' learning effects. Consequently, a key point of the issue is that teachers can readily make multimedia materials for classroom learning. As a result, students can easily access multimedia materials and then review them out of class. The way helps students quickly gain abundant multimedia material resources teachers made so as to promote their learning achievements (Zhan, Xu, & Ye, 2011).

Nowadays, several presentation software tools can produce multimedia materials which often include slides, texts, videos, graphics, sounds, etc. Currently, Microsoft PowerPoint is one of the most popular presentation software, which is widely adopted in the traditional classroom for instructions (Susskind, 2008). While using PowerPoint lectures, teachers spend less time in writing or maintaining lecture contents in contrast to the way lecturing with handwriting on a blackboard or whiteboard. Accordingly, teachers can readily highlight key points of teaching materials. However, many articles indicated no significant increase in students' learning performance while using PowerPoint lectures (Apperson, Laws, & Scepansky, 2008; Susskind, 2008). The reason is that each slide generally comprises 6 lines for texts and/or a few pictures (Apperson, Laws, & Scepansky, 2008). Lai, Tsai, and Yu (2011) pointed out that the PowerPoint presentations do not entirely support the effect of simultaneously containing both verbal and imagery representations during instruction. Accordingly, it is necessary to create a new kind of learning multimedia materials which at least consist of teacher's handwriting, action on PPT slides, and voice. As a result, students can repeatedly review the kind of multimedia materials out of class so as to get more understandings for teaching materials they still do not figure out in class. The reason is that students can gradually recall teachers' explanations for their misunderstanding contents via watching the multimedia materials repeatedly.

With recent advances in multimedia recording technologies such as digital video (DV) camera and screen capture software, they have been widely applied in making multimedia materials for classroom learning. Teachers can easily exploit the DV camera in class to create video materials recording their lecturing with a blackboard, whiteboard, or screen. However, to display the kind of materials mentioned above is not clear sufficiently when students study them out of class (Lai, Yu, & Tsai, 2011; Simpson, 2006). A main reason is that the screen layout of the kind of materials

is not devised for the deployment of the display with respect to several resources such as teacher's face, the presentation material, drawing attention to key points, etc. This leads to that students cannot easily comprehend teacher's presentation for their teaching materials. A solution to overcome the above shortcomings adopts screen capturing software which can record teachers' all actions on the computer desktop and their voices (Lai, Yu, & Tsai, 2011). Nowadays, several popular products are used for screen capturing such as PowerCam, Articulate Presenter, and Camtasia Studio (Lee & Chao, 2007). However, these capturing software cannot simultaneously record teachers' action on the screen, teacher's face, and drawing attention to key points for lecture materials. Another kind of the capturing software is applied for video conferencing such as X-learn, Co-life, and JoinNet. They are developed to avoid the disadvantage of exploiting the screen-capturing products mentioned above (Chao & Lin, 2009). The kind of software can capture the display contents on screen and, meanwhile, record the teacher's voice and face. A critical limitation of the kind of software is to produce low-resolution video due to a need of performing high compression ratio for video via installing software in local computers. Another shortcoming of the products is that they require a high bandwidth network environment. In addition, it requires company-dependent video player software to play the kind of multimedia materials. Unfortunately, these players are not only expensive but also platform-dependent due to special compression protocols and transmission techniques being employed for the video.

Consequently, the paper presents an LMM tool which helps teachers to easily produce the high-quality multimedia materials (the LMMs) for their lecturing in traditional classrooms. The LMMs can help learners effectively and repeatedly to review teacher's instructional processes. While studying teaching materials via watching a simple display, for example, PowerPoint-made materials, this kind of learning situations just provides what is happening. In contrast to studying PowerPoint-made materials mentioned above, learners can gain more benefits via studying the LMMs. The learning situation of reviewing the LMMs not only offers what is happening but also explains why the content is happening. The LMMs are also helpful for students who can clearly recall the teaching actions in the traditional classroom, including all teaching actions on the computer's desktop while lecturing. Moreover, the materials the LMM tool produces are helpful to students who can review teacher's explanations for teaching materials by simultaneously offering teacher's voices, handwritings, and annotations. Additionally, the screen layout of the LMMs can be flexibly designed to attract students' attention. An example of the LMMs consists of three main data resources: teacher's face, computer desktop, and marquee area that can be used to display notes to remind students. An important feature of the tool is that the region exhibiting computer desktop is the largest among four regions comprising a screen. Another feature of the tool is to offer a scrolling marquee and a displaying note for texts which can be used in the design of the screen layout. Teachers can exploit the feature to provide students with explicit or implicit annotations while lecturing so as to promote students' memorization, thinking, and clarification (Hwang, Wang, & Sharples, 2007). Students can effectively recall teaching activities via repeatedly reviewing the LMMs out of class. Furthermore, the LMM tool offers the on-line broadcasting function. Therefore, students being outside classroom can use the function to synchronously receive teacher's lecturing in classroom in a way of distance learning.

The remainder of this paper is organized as follows. Section 2 briefly reviews related multimedia learning and media richness theory. Section 3 describes the LMM tool. Section 4 shows the experimental results. Discussions and conclusions are drawn in Section 5.

Literature review

Multimedia-based cognitive process

With the rapid growth of computer technology, it is an explosion in the availability of presenting materials with different formats including on-screen texts, words, pictures, animations, audio and video (Zhang, Zhou, Briggs, & Nunamaker, 2006). Note that, in general, these formats of materials mentioned above can be divided into visual and verbal representations. The learning via studying the materials with several formats stated above is called multimedia learning (Mayer, 2001). Multimedia learning theory works an integration of cognitive load theory, dual-coding theory, and working memory model. Cognitive process refers to holding a mental representation in working memory over a time interval (Feldon, 2007). During multimedia learning, multimedia-based cognitive process lets the learner hold verbal and visual mental representations while reading multimedia materials (Reed, 2006).

The instructional multimedia material is an input of the cognitive process while learning (Astleitner & Wiesner, 2004). It is processed through triggering attention and working memory. More specifically, learners' attention can be contracted on the inputs (Wiebe & Annetta, 2008). Additionally, the retention of inputs can be emphasized in learners' working memory if learners rehearse on the inputs. Moreover, based on multimedia learning theory, visual and auditory information can be simultaneously processed in learners' working memory. This way can increase learners' attention and motivation (Astleitner & Wiesner, 2004). Therefore, presenting the LMMs in the traditional classroom became an emergently important issue. For example, the study of Yu et al. showed that using multimedia devices can effectively improve instructor's teaching ability and student's learning performance in the classroom learning environment (Yu, Lai, Tsai, & Chang, 2010).

Media richness theory

Media richness is regarded as the ability to facilitate the shared meaning and understanding within a time interval (Rau, Gao, & Wu, 2008). Media richness theory means that richer communication media in terms of representations for uncertain issues are generally more effective and adequate than insufficient or lean media. The information which is represented with high richness media representations can be effectively communicated and conveyed when the information is highly uncertain and equivocal (Sun & Cheng, 2007).

Media richness supports communication activities in education. The richness of each media can be calculated using four criteria (Daft, Lengel, & Trevino, 1987).

- Capacity for immediate feedback: The speed and quality about the medium facilitate convergence on a common interpretation.
- Capacity to transmit multiple cues: An array of cues, including physical presence, voice inflections, body gestures, words, numbers, and graphic symbols, facilitates conveyance of interpretation and information.
- Language variety: It indicates the level of concept convection such as numbers and formulas which provide greater precisions. In contrast, natural language conveys a broader set of concepts and ideas.
- Capacity of the medium to have a personal focus: This refers either to the conveyance of emotions and feelings, or to the ability of the medium to be tailored to the specific needs and perspectives of the receiver.

The LMM tool

The structure of the LMM tool

Figure 1 exhibits the structure of the LMM tool, which consists of four main components: Signal Composition Model (SCM), Screen Deployment Model (SDM), Video Compression Model (VCM), and Live Broadcasting Model (LBM). First, the SCM efficiently combines audio and video devices into a single signal. Second, the SDM offers a user-friendly interface. Teachers can employ the SDM to create a screen layout. According to the screen layout, teachers can devise the deployment of displaying their teaching contents and the supplementary materials. Figures 2(a) and 2(b) exhibit the design of a screen layout and an example using the screen layout, respectively. Third, the VCM plays a role to compress the audio and video signals to form multimedia data and then to produce the corresponding streaming version of the multimedia data. Finally, the LBM serves as an Internet protocol television (IPTV), which provides students with multimedia materials through Internet.

Table 1 presents a comparison among the existing recording tools considered in this paper. The merits of using the LMM tool for learning can be mentioned as follows. First, users can flexibly design a new screen layout as shown in Figure 2. Second, in Figure 2(a), two areas, marquee and supplement information, of the screen can offer explicit and implicit annotations, respectively. Texts belong to the kind of explicit annotations. In contrast, the sort of implicit annotations includes graphics, images, highlights, etc. (Hwang, Wang, & Sharples, 2007). The purpose of offering explicit and implicit annotations, as shown in Figure 2, is to promote student's memorization, thinking, and clarification (Ovsiannikov, Arbib, & Mcneill, 1999). Third, the LMMs with high resolution can be clearly displayed for students. Finally, the compression format of the LMMs is open-form, which can be read by several popular media players.

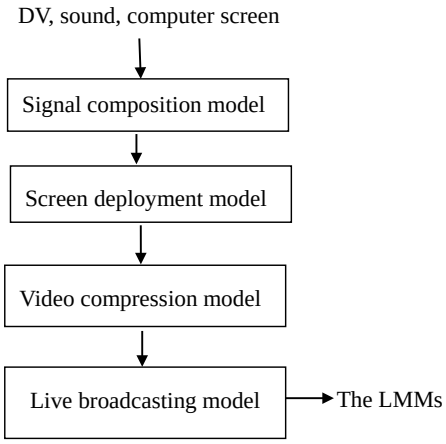
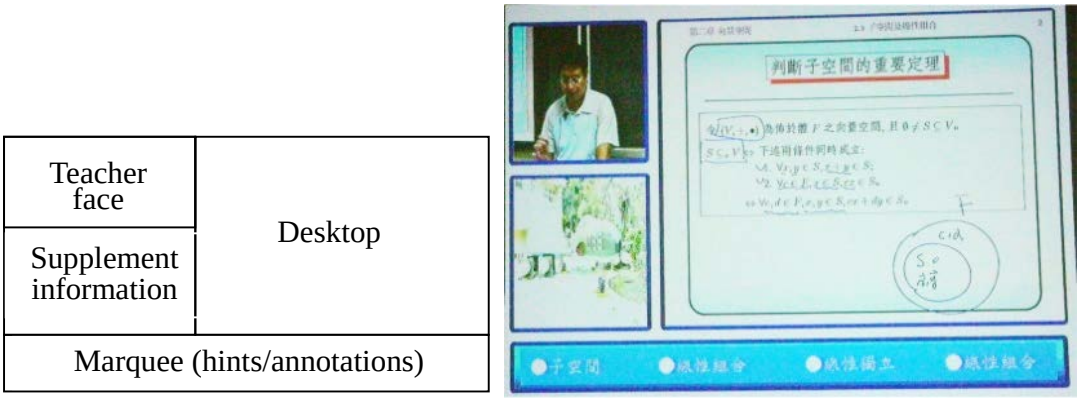


Figure 1. The structure of the LMM tool



(a) (b)

Figure 2. (a) the design of a screen layout; (b) an example for the screen layout

Table 1. A comparison among the tools producing mutlimedia materials

Categories	DV	Screen capture	DV camera	Life-Like
Examples / Parameters	DV recording	PowerCam, Articulate Presenter, Camtasia Studio	X-learn, JoinNet	LMM tool
Resolution	Low	High	Low	High
Network requirement	No	No	Yes	No
Cost	Low	Low	High	Middle
Teacher face capturing	Middle	No	Yes	Yes
Computer screen capturing	Middle	Yes	Middle	Yes
Quality	Low	Middle	Low	High
Supplement	No	No	No	Yes
Marquee	No	No	No	Yes
Flexible layout design	No	No	No	Yes
Multimedia format	Open	Close	Open	Open

The learning environment using the LMM tool

Figure 3 displays a learning environment which is composed of five components. The first component, the LMM tool, marked by ① is used to produce the LMMs. Second, a PC or notebook (NB) marked by ② is exploited to present teacher's instructional materials. Third, a DV camera is marked by ③, which is employed to capture teacher's face. Subsequently, an additional DV camera marked by ④ can be utilized to capture students' learning

activities. Finally, a live-video broadcasting device marked by ⑤ is an optional component while building a classroom-learning environment. The component is required if it is needed to display teachers' lecturing in two or more classrooms at the same time. When a teacher lectures in a classroom, it can almost synchronously deliver the corresponding LMMs of his/her lecturing to other classrooms.

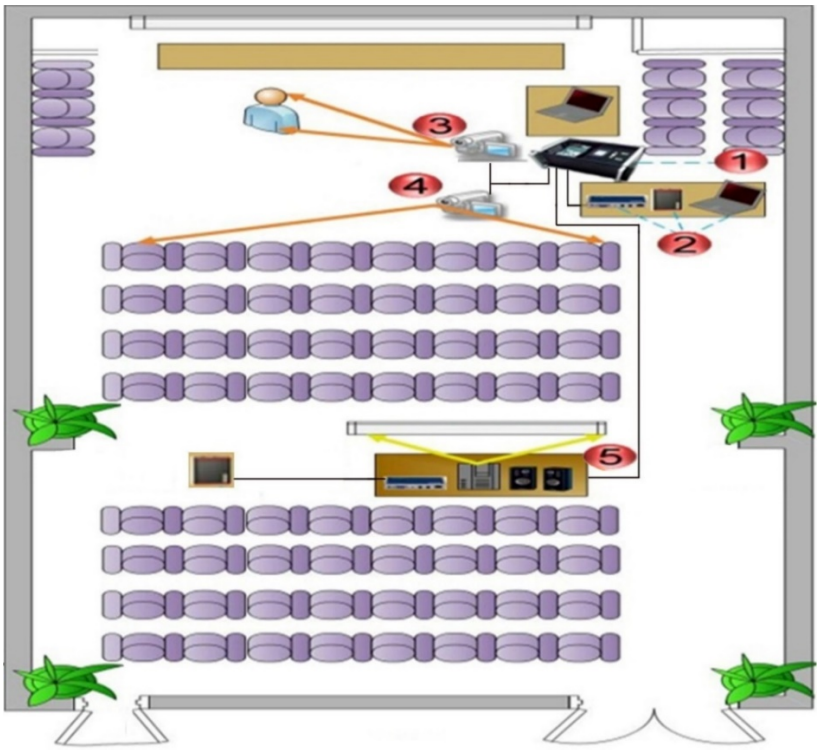


Figure 3. The LMM tool learning environment can be exploited in a large classroom while lecturing

Experiment

Participants

Students in a university of science and technology in the middle of Taiwan contributed to the experiment. Eighty-seven sophomore and junior students (48 males and 39 females) with a mean age of 20.1 years old in the two classes participated in the experiment. Students in the two classes were randomly assigned to the experimental group and the control group. The experimental group (44 students) was lectured using the LMM tool (as shown in Figure 4) and the control group (43 students) was lectured using PowerPoint presentation.

Figure 4. The LMM tool

Learning procedure

The learning procedure consists of three phases. First, before lecturing, the teacher prepares the teaching contents presented with PowerPoint. Then, the teacher can add the hint items and annotations in the two areas, marquee and supplement information, as shown in Figure 2(a), in order to clarify the contents in PowerPoint slides the teacher currently explains. The way of using annotations can powerfully convey more meanings and explanations for the contents in PowerPoint slides than without using annotations. Second, during lecturing, the experimental group receives teaching contents using the LMM tool (as shown in Figure 5). Meanwhile, the teacher can utilize the LMM tool to record teacher's lecturing to form a multimedia material which consists of instructional actions such as teacher's voices, commentaries, cues, handwritings, narrations, and classroom situations. Accordingly, the multimedia material is so-called the instructional life-like multimedia material. The LMM tool can conveniently offer teachers to produce the LMMs while teaching in a traditional classroom. Subsequently, the LMMs can be uploaded to the learning management system (LMS). The students in the experiment can repeatedly study the LMMs on the LMS out of class. Consequently, the LMM tool also provides a way of asynchronous learning. Additionally, when students cannot show up in the traditional classroom, they can receive teacher's lecturing through the IPTV of the LMM tool to perform a fashion of synchronous learning. Third, after lecturing, students in the experimental group just get the LMMs for reviewing, and vice versa for students in the control group merely have PowerPoint slides.

Figure 5. The LMM tool applied in the traditional classroom

All students received a six-week instruction from the same teacher based on the same teaching contents (PowerPoint slides). That is, the six-week learning activity was conducted in the experiment. Table 2 presents a comparison for two groups conducted in the experiment for the six-week learning activity. Figure 6 illustrates the experimental design of the paper.

Table 2. A comparison for two groups conducted in the experiment for a six-week learning activity

		Experimental group	Control group
Before lecturing	Devise screen layout	Required	Not required
During lecture	Display teaching contents in classroom	The LMM tool	PowerPoint software
	Display multi-sources in a screen	A whole screen is comprised of four parts	A whole screen just has a single part
After lecturing (out of class)	Recall teachers' Q&A for students	Yes	No
	Review teaching contents	LMMs	PowerPoint slides

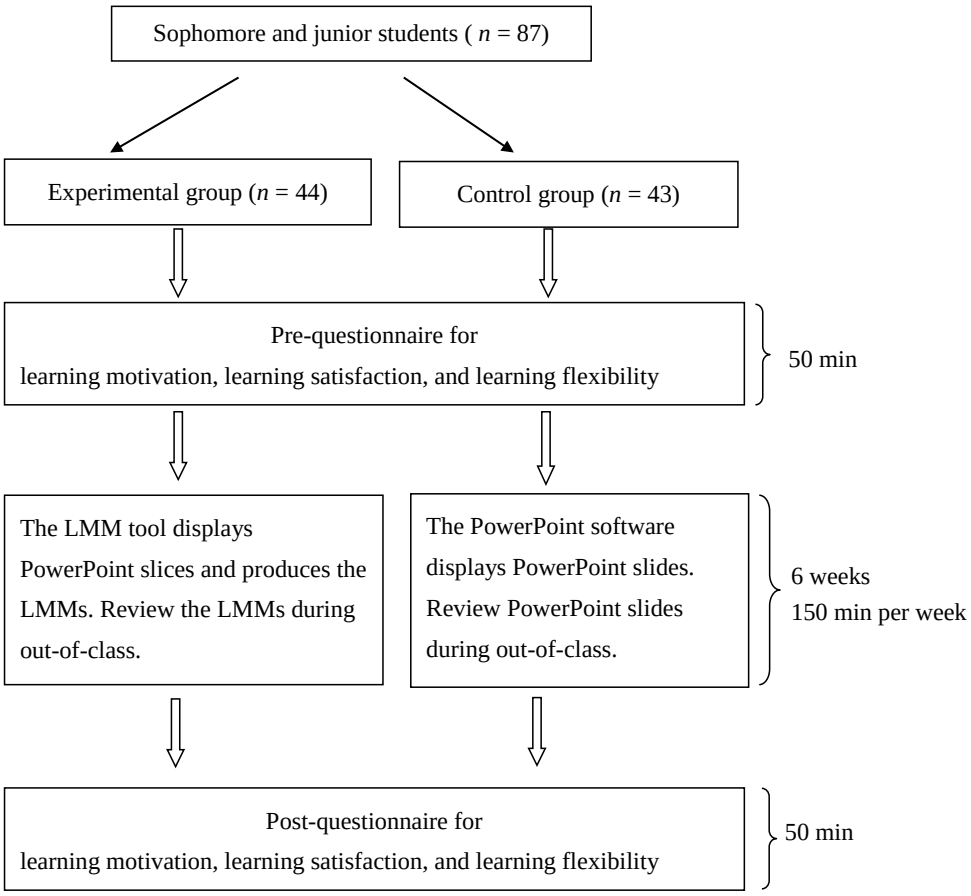


Figure 6. Experiment design

Instruments

The study builds a questionnaire related to the perception effectiveness of the multimedia-based cognitive process first using the LMM tool in lecturing in the traditional classroom then reviewing the LMMs. The questionnaire is written in Chinese. The students voluntarily answer the questionnaire. The questionnaire has 11 items, including three sub-questions: learning motivation, learning satisfaction, and learning flexibility. The items of the learning motivation were reedited according to Pintrich and DeGroot (1990) such as "the materials can help me to understand the difficult learning contents." The items of the learning satisfaction were reedited based on Alavi and Leidner (2001) such as "I can study the instructional materials, clearly hear and see the solving-problem procedures." The items of the learning flexibility were reedited according to Arbaugh (2000) such as "I can repeatedly study the material at any time and in anywhere out of class."

The questionnaire adopts five-point Likert scale. Each item has five options, from 1 "strongly disagree" to five "strongly agree." The higher score means the higher perception of effectiveness for the case of exploiting the LMM tool. The validity of the items is gained by two experts who major in information management and psychology. The Cronbach α is calculated for the internal consistency reliability. The total scale α coefficient was 0.83. It means the reliability of the scale is acceptable.

Results

The analysis of independent *t*-test was conducted to assess the effects of the experimental group received the LMMs and the control group received PowerPoint materials on the 11 survey items. Therefore, the "LMMs" in all items in Table 3 is replaced with "PowerPoint materials" for the control group. Table 3 exhibits the significant results which

indicate that students in the experimental group was effective for the teacher who uses the LMM tool in lecturing, $t(85) = 2.509$, $p < .05$. Exploiting the LMM tool in lecturing may help students pay attention in class, $t(85) = 2.646$, $p < .01$. Students in the experimental group can easily recall the learning activities out of class, $t(85) = 2.804$, $p < .001$. Students in the experimental group can clearly hear and see the problem-solving process, $t(85) = 2.851$, $p < .001$. They also felt that the annotations are helpful to promote their memorization, thinking, and clarification, $t(85) = 1.965$, $p < .05$. The students in the experimental group deemed that reviewing the LMMs can reduce their learning anxiety, $t(85) = 2.641$, $p < .01$. More specifically, low-experience students may not understand the meaning of the materials teacher taught in class. This implies that the kind of students may be anxious in learning the materials teacher taught in class. Subsequently, they can repeatedly watch the LMMs for the problem-solving procedures out of class. Therefore, they can figure out teacher's explanations for solving problems. The experimental group gave 3.37 points to the 11 survey items on average, which shows that students in the experimental group have higher perceptional effectiveness of the multimedia-based cognitive process with the LMMs.

Students can study the LMMs in a way of asynchronous learning. That is, they can watch the LMMs to recall teacher's instructional activities out of class so as to promote their understanding for the contents of the LMMs. Accordingly, these experimental results reflected that the kind of LMMs made by the LMM tool was helpful for students in the experimental group. In contrast, students in the control group felt that PowerPoint presentation usually displayed static contents such as simple words, pictures, or some unrelated sounds provided in PowerPoint. They usually cannot deeply think what implicit meaning is for these learning contents.

Table 3. Means (*M*), standard deviations (*SD*) and *t* test of comparison results

Item (5, strongly agree; 1, strongly disagree)	EG(N = 44) *M* (*SD*)	CG(N = 43) *M* (*SD*)	*t* test
I thought I can pay attention in class while the teacher presents the materials with the LMM tool.	3.50 (0.79)	3.14 (0.52)	2.509 [a]
I thought it was effective for teacher to use the LMM tool while presenting the teaching materials.	3.70 (0.67)	3.28 (0.83)	2.646 [b]
When I studied the materials through the LMS platform, I can easily recall the learning activities.	3.59 (0.82)	3.09 (0.84)	2.804 [c]
The materials on the LMS platform can help me to understand the difficult learning contents.	3.66 (0.75)	3.21 (0.80)	2.708 [c]
I was more confident for the exams because I can repeatedly study the material at any time and in anywhere out of class.	3.45 (0.70)	3.09 (0.81)	2.231 [a]
I thought it was effective to clarify the materials displayed in "desktop" area by offering annotation presentation.	3.77 (0.68)	3.21 (0.89)	3.332 [c]
The LMM tool displayed annotations which were helpful for me to promote my memorization, thinking, and clarification.	3.65 (0.81)	3.30 (0.89)	1.965 [a]
It was helpful for me to repeatedly study the materials for self-pacing learning.	3.61 (0.65)	3.14 (0.86)	2.894 [c]
I can study the instructional materials, clearly hear and see the solving-problem procedure.	3.55 (0.66)	3.09 (0.81)	2.851 [c]
I thought it can reduce the learning anxiety by reviewing the LMMs.	3.43 (0.66)	3.09 (0.53)	2.641 [b]
I thought the materials benefit me to make notes by studying the LMMs.	3.36 (0.72)	2.93 (0.88)	2.513 [a]

[a] $p < .05$. [b] $p < .01$. [c] $p < .001$.

Discussion

It is useful for students to study the LMMs during learning. The following findings, based on the experimental results, are given to reflect that using the LMM tool can benefit teachers and students. First, students can easily recall the learning activities in the traditional classroom while studying the LMMs. The sort of the learning materials consists of teachers' facial expressions, voices, handwritings, annotations, and teaching actions on the desktop of

teachers' computers during instruction. According to multimedia learning theory (Mayer, 2001), students can process the information quickly because they can simultaneously review visual and auditory messages. Moreover, based on rich media theory (Daft, Lengel, & Trevino, 1987), the LMMs have a large capacity to transmit multimedia cues and to have a personal focus. Moreover, the LMM tool provides teachers with a flexible way to offer annotations so as to enhance students' memorization, thinking, and clarification. Teachers can provide students with the explicit and implicit annotations for teaching units via displaying texts, video, images, and graphics in two regions, marquee and supplement information, of the screen, as shown in Figure 2(a).

Second, the number of areas comprising a screen layout can be flexibly increased or decreased by teachers according to their teaching requirements. That is, there are different deployments of using these regions composed of a screen such as reducing the number of regions on a screen layout or changing the positions of regions of a screen layout. Moreover, these regions inside a screen can be enlarged or shrunk. Accordingly, teachers can adequately adjust the positions and/or sizes of regions on a screen layout so as to draw students' attention.

Finally, students can repeatedly watch the LMMs using the pausing/playing functions and the moving forward/backward functions. Students can effectively recall teachers' explanations for their misunderstanding materials using above functions. According to media richness theory, these functions also help students to gain effective and adequate media. Thus, students can foster their self-paced learning. For the learning of mathematics induction, students can repeatedly study the LMMs to watch teacher's solving-problem process so as to acquire more clear explanations for the process. Based on discussions mentioned above, the learning manner of using the LMM tool in classroom during instruction and then reviewing the LMMs out of class can definitely promote students' learning effects.

Conclusion and future work

Conclusion

This paper has presented the LMM tool which provides teachers with several user-friendly functions to create the LMMs. Herewith, teachers can readily make the LMMs in the traditional classroom. Subsequently, teachers can upload the LMMs to the LMS. This is helpful for the students in a way of asynchronous learning to study the LMMs on the LMS out of class so as to recall instructional activities in class. Furthermore, the tool can help students who cannot present in the traditional classroom in a way of distance learning. More specifically, the tool can be applied to perform synchronous learning since teachers can exploit the LMM tool to produce the LMMs during lecturing and then simultaneously broadcast the LMMs in almost real time. Recently, mobile learning is a popular issue (Wang, Shen, Novak & Pan, 2009). Consequently, learners can also study the LMMs at any time and in anywhere using portable devices to realize mobile learning.

Future work

Future work includes five issues stated as follows.

- A study of an impact on synchronous learning using the IPTV of the LMM tool: The kind of synchronous learning can help students who cannot present in the classroom. It can broadcast the LMMs in almost real time and the LMMs also have a higher resolution than those existing screen capturing software produce.

- To apply the LMMs tool in the flipped learning through a MOOCs platform: Before lecturing, teachers can assign the homework studying the LMMs which can be downloaded from the MOOCs platform (Kim, Kim, Khera, & Getman, 2014; Kennedy, 2014). The contents of the LMMs will be further explained or discussed in the class by teachers during instruction. Meanwhile, the LMM tool can produce the LMMs consisting of the learning activities concerning teacher's answers for students' questions.

- To design a blended learning environment (Hastie, Hung, & Chen, 2010): The LMM tool produces the LMMs for some teaching units of the practice training courses such as computer language programming, software operation, writing mathematical proofs or equations, etc.

- To increase interactivity during lecturing: Teachers can select video clips of the LMMs, which mainly contain the students' questions and then discuss these questions with students who never learn these teaching unit. This way will promote interactivity during lecturing.

- To improve teaching practices at classrooms: Teachers can watch the LMMs repeatedly to find out the shortcomings of their presentation and instruction for teaching lectures.

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