DEVELOP AND EVALUATE THE EFFECTS OF MULTIMODAL PRESENTATION SYSTEM ON ELEMENTARY ESL STUDENTS

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ABSTRACT
The purpose of this study is to develop and evaluate the effects of multimodal presentation system (MPS), a multimodal presentation software integrated with interactive whiteboard (IWB), on student learning in the elementary English as second language (ESL) course. It focuses primarily on techniques and tools to enhance the students' ESL learning achievement and learning satisfaction in the classroom setting. This paper utilizes the MPS, based on Mayer's cognitive theory of multimedia learning (CTML), to present the multimedia instructional materials in auditory and visual modalities. This learner-centered instruction was compared with a traditional teacher-centered English teaching using blackboard. An experimental research design was employed and 134 fifth-graders were involved in this study. Evaluation of the instruction was based upon data from test scores and questionnaire related to students' learning satisfaction. In addition, semi-structured individual interviews were conducted with randomly selected participants from experimental group to express their perspectives on the merit of using the MPS. The results revealed that there were statistically significant differences between the students in experimental group and control group on measures of learning effectiveness. More details of the results and implications are also discussed in the study.
Keywords: Interactive Whiteboard, Multimedia, Multimodal, English Learning, Storytelling

INTRODUCTION

The purpose of this study is twofold. First, this study develops a multimodal presentation system (MPS), a multimodal presentation software integrated with interactive whiteboard (IWB), to support the classroom learning in the elementary English as second language (ESL) course. Second, this study evaluates the effects of MPS on student learning achievement and learning satisfaction in the classroom setting.

English is regarded as a second language in Taiwan. Teachers usually present text-centered materials with little pictures on blackboards and the students read directly following the teachers. This blackboard teaching provides an inflexible presentation of teaching materials in the way of colors, styles, as well as multimedia formats. The language learning process is a complicated, intelligible and meaningful activity. Krashen (1982) claimed that second language acquisition was an implicit process. Regardless of learning context, all learners must ultimately create an implicit linguistic system in order to be successful language learners and users (Ellis, 1994; Krashen, 1982; VanPatten, 2003). Students are unable to effectively internalize language as parts of the cognitive system via mechanical exercises and repetitive operations (Lightbown, 2003). According to Mayer's (2001) cognitive theory of multimedia learning (CTML), learning from distinct channels leads to a general improvement in learning. Also, the modality principle of multimedia learning (Mayer, 2001) suggests that students learn better when words in a multimedia message are presented as spoken text rather than printed text. Since the last 20 years, e-learning has become a modern teaching method in using information technology within the classrooms. The e-learning includes all forms of electronically supported learning and teaching, by taking advantage of computer technologies and software, to enrich and improve the teaching and learning quality (Hussein, 2011). Recently, information technology has enabled an explosion in the availability of visual ways of presenting materials. Large amount of multimedia English learning materials and computer assisted language learning software have been developed to enhance the learning performance of English pronunciation, spelling, phonics, and word attack skills (Beatty, 2010; Lee et al., 2005; Towndrow, 2007). Therefore, many English teachers have started to make use of technological tools to present teaching materials in multimedia formats.

Recently, interactive whiteboard (IWB) has been used to replace the traditional blackboard in the classroom. It

provides medium to display teaching materials including files, educational software, web sites, and others for providing powerful multimedia/multimodal presentation (Ekhami, 2002; Isman et al., 2012; Jang, 2010; Smith et al., 2005; Türel & Johnson, 2012). In educational research discourse the term 'interactive' concerns with pedagogy and new technologies in education. Beauchamp & Kennewell (2010) claimed that interactive teaching towards a more student-centered approach will be valuable and there is potential for technology to support more dialogic and synergistic approaches in group and individual activity. Glover et al. (2005) demonstrated that there is a progression at all levels in learning for using the IWB and associated software. Smith et al. (2005) reviewed the literature and claimed that the literature preponderantly endorse the positive impact and potential of IWB, based on the views of teachers and students. Accordingly, using IWB brings the change of linking technology and pedagogy in the classroom (Beauchamp & Kennewell 2010; Glover et al., 2005; Smith et al., 2005).
Many studies related to the use of IWB in educational settings have shown that IWB technology can promote teacher-student interaction and student participation in classroom (Higgins et al., 2007; Kennewell et al., 2008; Schmid, 2008, 2010; Smith et al., 2005). For example, Smith et al. (2005) claimed that the pedagogical potential of IWB technology is to provide higher level of interactivity and participation over traditional blackboard. Also, some research on IWB prove the positive improvement of learning achievement (Digregorio & Sobel-Lojeski, 2009; Jang, 2010; Lewin et al., 2008; Slay et al., 2008; Thompson & Flecknoe, 2003). Although the aforementioned positive effect of IWB, there are some controversial point of view about IWB use. For example, Coyle et al. (2010) analyzed the influence of IWB technology on the language use of a primary school and revealed that the failure to promote verbal interaction for the group of non-native speaker (NNS) in an English language immersion classroom. In addition, in the claim of interaction improvement, many teachers tend to dominate the IWB lesson without inviting the students to interact with the board themselves (Levy, 2002).

Storytelling by adults is considered as a critical step that can facilitate comprehension and increase interest in teaching (Smith, 1988). Especially for language learning, storytelling is a practical and powerful teaching tool (Tsou et al., 2006). Chien and Huang (2000) claimed that predictable storybooks are effective in building ESL kindergarteners' oral and literacy development. Recently, storytelling as a way of teaching children English has been flourishing in Taiwan (Lee, 2012). In addition, researchers have demonstrated successful usages of computer assisted English learning in significantly facilitating teacher's storytelling and children's learning in ESL classrooms (Lee, 2012; Tsou et al., 2006). However, to the best of our knowledge, research of exploring the effectiveness of IWB in English vocabulary learning through storytelling teaching method is rare, and therefore this has become an important issue of research.

As a result, this study develops a multimodal presentation system (MPS) to present multimedia instructional materials and manage interactive learning activities in the classroom. More specifically, the MPS is used to support the verbal instruction materials (e.g., printed words, spoken words) and the corresponding visual instruction materials (e.g., illustrations, photos, video, and animation) in the interactive instructional activity. In addition, learning achievement and satisfaction are the major objectives of learning activities (Long, 1985; Lu et al., 2003), this study thus to explore the learning achievement and satisfaction of English learning activity by use of the MPS.

The remainder of this paper is organized as follows. Section 2 reviews pertinent literature on the research of Mayer's cognitive theory of multimedia learning (CTML) and learning effectiveness. Section 3 then describes the architecture of the multimodal presentation system (MPS) and section 4 presents the experimental design and process. Section 5 presents the experimental results, as well as discussion on the findings. Finally, Section 6 addresses conclusions, limitations and directions for future research.

LITERATURE REVIEW

Mayer's cognitive theory of multimedia learning (CTML)

Multimedia is defined as the presentation of materials using both words and pictures and thus focused on the auditory/verbal channel and visual/pictorial channel (Mayer, 2001, 2003, 2005). Mayer (2001, 2003, 2005) presents a theory of multimedia learning in terms of an information-processing model, called cognitive theory of multimedia learning (CTML), by integrating Sweller's cognitive load theory (Chandler & Sweller, 1991; Sweller, 1988), Paivio's dual-coding theory (Clark & Paivio, 1991; Paivio, 1986), and Baddeley's working memory model (Baddeley, 1986, 1993, 1999).

The CTML provides empirical guidelines to promote instructional design to achieve meaningful learning (Mayer, 2001). Based on three main assumptions (dual channel, limited capacity, and active processing), seven principles (multimedia principle, spatial contiguity principle, temporal contiguity principle, coherence principle, modality principle, redundancy principle, and individual differences principle) are proposed in this theory. The modality principle suggests that as textual information, presented in an auditory mode, with concurrent visuals

are displayed, students have greater knowledge acquisition (Ginns, 2005; Mayer, 2009). The visual information processing channel may become overloaded when students must process on-screen graphics and on-screen text at the same time. Van Someren et al. (1998) suggested that the educational representations should be developed to utilize this multimodality approach to allow learners to learn by exploring and linking different modalities. Also, some literatures show supporting evidence that presenting information in auditory mode with concurrent visual mode leads to deeper understanding (Mayer, 2003; Mayer & Sims, 1994; Paivio et al., 1998).

Learning effectiveness

In general, learning effectiveness can be measured using two variables: academic achievement (e.g., semester grade, test score) (Alavi et al., 1995; Shih et al., 2012) and learning satisfaction (Knowles, 1970; Maki et al., 2000; Piccoli et al., 2001). Correspondingly, the study of Huang et al. (2012) took academic achievement and learning satisfaction as two criteria for measuring student's learning effectiveness. Learning satisfaction can be regarded as the learners' feeling (Long, 1985; Tough, 1982), the learners' attitude (Long, 1985), or the learners' sense of pleasure (Johnson et al., 2000) toward their learning activities. Piccoli et al. (2001) and Maki et al. (2000) believed that learning satisfaction expresses learners' satisfaction derived from the learning process and learning results. Hence, learning satisfaction is a very suitable criterion for assessing learners' satisfaction with classroom learning. In summary, we can obtain better understanding of a student's learning effectiveness according to both academic achievement and learning satisfaction. As a result, academic achievement and learning satisfaction are considered as two important criteria for measuring student's learning effectiveness in this study.

THE ARCHITECTURE OF THE MULTIMODAL PRESENTATION SYSTEM (MPS)

In multimodal learning environments, students are presented content knowledge with a verbal representation and one or more corresponding visual representations. According to the modality principle of instructional design, learning outcomes will be optimized by presenting the verbal and visual representations of the knowledge in auditory and visual modalities (Moreno & Mayer, 2007). An interactive multimodal learning environment is the one in which the presented words and pictures depend on the learner's actions and the communication is multidirectional during learning. Figure 1 shows the architecture of the multimodal presentation system (MPS). The MPS in the environment consists of four primary components, which are Office Card Component, Media Card Component, Annotation Card Component, and Manager Card Component. This multimodal presentation software was designed to bring students to the interactive whiteboard, more directly involving them in the lesson.

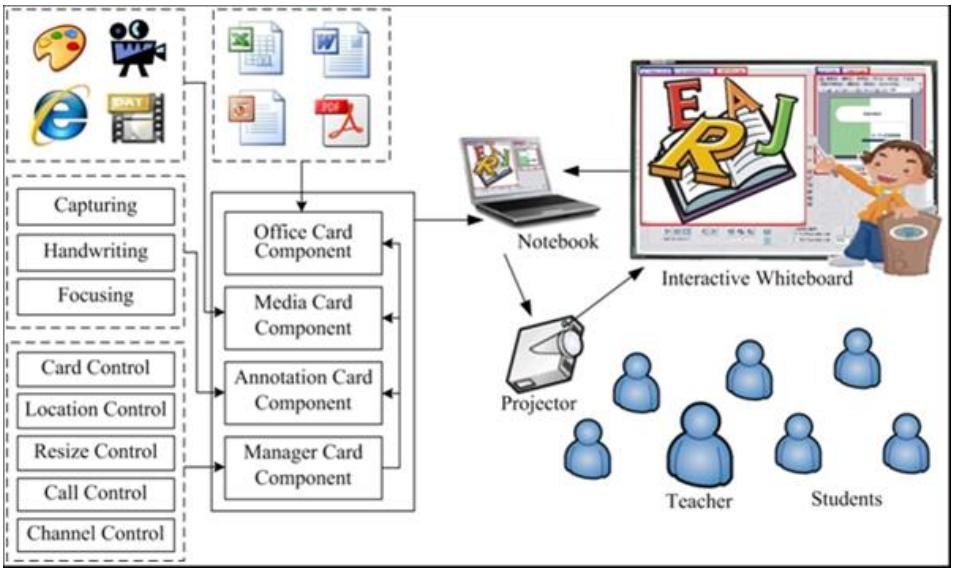

Figure 1: The architecture of the multimodal presentation system (MPS)

Office Card Component is used to manage software applications simultaneously, especially for Microsoft Word, Excel, and PowerPoint software. Normally, for multiple PowerPoint presentations there is only one PowerPoint application can be activated at the same time. By using the functions provided by Microsoft OLE and COM Automations, Office Card Component is able to support the control of document, such as page up, page down, page jump, and change the view of document, etc.

Media Card Component is used to manage media object containers. For example, Digital Video is used to connect video devices and audio devices to display and record as a real-time streaming. Media Player Control provides scroll bar with play, stop, pause, etc. Browser Control and Image Control provides users with connecting Internet and image objects, respectively.

Annotation Card Component supports three major functions. Capturing is used to record screen operations and sounds into video movie files. Handwriting is used to support teacher's lecturing handwriting with notebook without electromagnetic digitizer. Focusing is used to emphasize the teaching materials by changing the background or frame color of the object containers.

Manager Card Component is used to manage authoring and presenting containers of materials. It includes five major control functions. Card Control is used to create, add, copy, rename, and delete the object containers. Location Control is used to move, switch, and arrange the location of object container. Resize Control is used to change the size of object container. Call Control can create the relation between related materials such as the major container and the child containers. It can record the numbers of object containers, show the previous pages of containers, and call the containers back to the primary monitor. Channel Control is used to present the object container to different monitors. Teachers can present instructional content in one or more columns scenario.

RESEARCH DESIGN

Procedures

One purpose of this study is to evaluate the elementary student learning achievement and satisfaction within classroom English vocabulary acquisition by utilizing the multimodal presentation system (MPS). At the end of the learning students took a post-test for measuring the learning achievement and questionnaires for measuring the learning satisfaction. Owing to the fact that questionnaires and interviews are often used together in studies investigating educational assessment (e.g., Brookhart & Durkin, 2003; Lai & Waltman, 2008), semi-structured individual interviews were also conducted with randomly selected participants from the experimental group in this study. In compliance with the assertion of Kendall (2008), the qualitative interview data are helpful in gathering more in-depth insights on participant attitudes, thoughts, and actions. Procedures of the experiment are shown in Figure 2 and the details are described as follows.

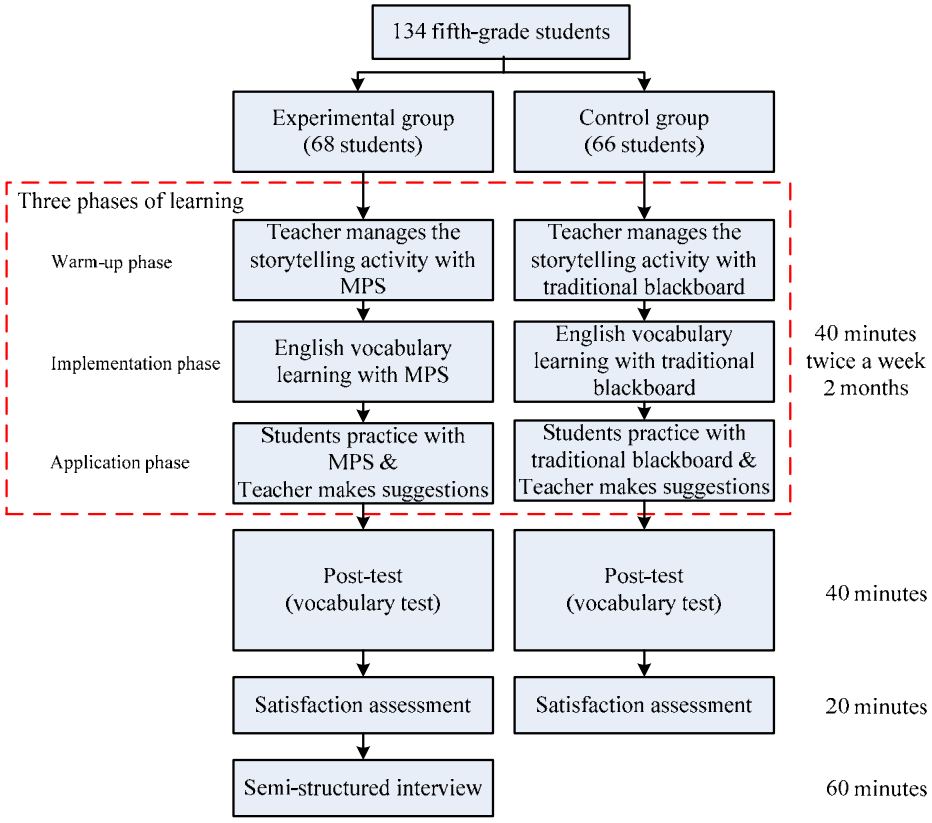

Figure 2: The experimental procedures

Participants

The participants were 134 pupils (72 boys and 62 girls) from six classes of two public elementary schools in Taiwan. All subjects, ranging in age from 11 to 12, were fifth-grade students. The instructional approaches were assigned randomly to six classes. The experimental group (68 students, 37 boys and 31 girls) was lectured with MPS and the control group (66 students, 35 boys and 31 girls) was lectured with blackboard. A summary table describing the distribution of participants is shown in Table 1. The experiment was held in the "English as a second language" course and lasted for two months from mid-March 2011 to mid-May 2011. Lectures were given twice a week, and each was taught for 40 minutes. Both groups were taught with the same learning materials by the same teacher. Although this type of experimental design is not completely followed by a randomized selection and assignment, it is often necessary in educational settings because intact classes are already constructed before the research is begun.

Table 1: The distribution of participants

Groups	*Boy*	*Girl*	*Total*
Experimental group	37	31	68
Control group	35	31	66
	72	62	134

Three phases of learning

Step 1: The warm-up phase

Both groups were taught with the same story but provided with different tools for presenting the contents. In the learning setting of experimental group, the teacher presented the story in video media form with Media Player to guide the thinking of students about the learning vocabularies. Figure 3 shows the authoring mode, used by the teacher for preparing the materials with multimodal presentations, of MPS. Figure 4 shows the scenario of video playing with the MPS in the warm-up phase. In contrast, the teacher managed the storytelling and drew the learning contents on the blackboard in the learning setting of control group.

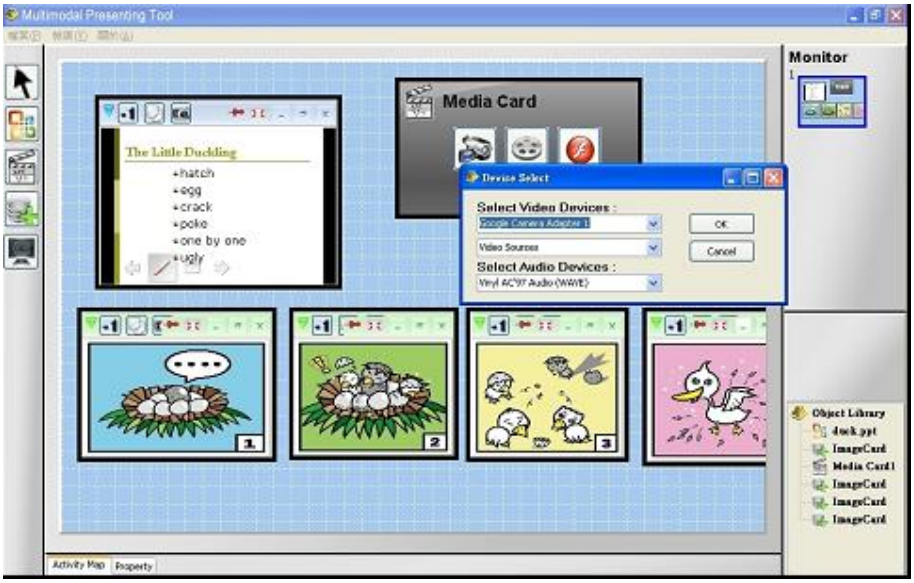

Figure 3: The authoring mode of the MPS

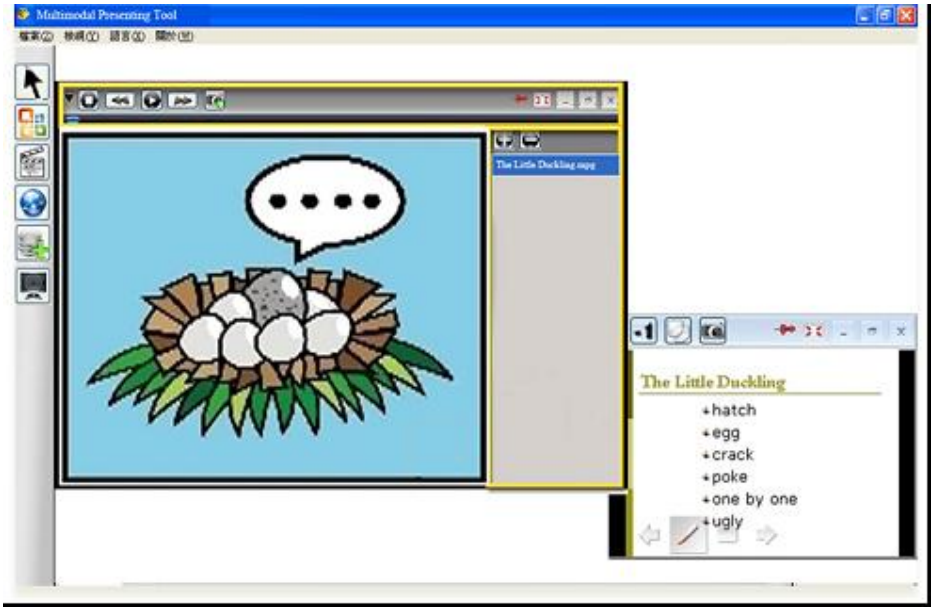

Figure 4: The video playing with the MPS in the warm-up phase

Step 2: The implementation phase

Both groups were taught with the same English vocabularies but provided with different tools for presenting the contents. In the learning setting of experimental group, the teacher presented the learning vocabularies and video media materials with the MPS. Also, while the teacher instructed, the whole teaching process on the IWB was recorded. This offered the students a chance to play back the recordings for refreshing their previous learning or inducing reflective learning. Figure 5 shows the scenario of vocabulary teaching with the MPS in the implementation phase.

Figure 5: The vocabulary teaching with the MPS in the implementation phase

Step 3: The application phase

In the learning environment of experimental group, as shown in Figure 6, the learning contents including text, videos and graphs were presented on the IWB. The MPS provided convenient ways for students to practice or discuss through pictures or videos. For example, the students could use the MPS to review the unfamiliar vocabularies, pictures, or videos that have been recorded. The teacher was required to make comments or suggestions while students were practicing or implementing. For example, if the students were ever in doubt, they could enquire the teacher about how the new knowledge is related to other course materials.

Figure 6: The students managed the MPS for vocabulary learning

Post-test

At the end of the three phases of learning the students took a post-study written test of the vocabularies taught. The test score is used as the objective measurement of academic achievement, one of the criteria for measuring student's learning effectiveness in this study.

Satisfaction assessment

At the end of the post-test the students completed a self-questionnaire with regard to the learning satisfaction. A questionnaire, as shown in Table 2, was employed to understand the students' learning satisfaction. Particularly, our assessment of learning satisfaction is based on the questions proposed by Hui et al. (2008), with additional translations into Traditional Chinese to tailor the questionnaire to Taiwanese students in this study. Two professors were asked to pretest the questionnaire in order to ensure its clarity. Their feedback was incorporated into the final version. This questionnaire was composed of 6 items and each item was measured on a 7-point Likert scale where 7 indicated a strong preference and 1 indicated a weak preference for student's satisfaction. Internal consistency reliability, as represented by Cronbach's alpha, was 0.82, revealing an acceptable level of reliability (Chin, 1998).

Semi-structured Interview

At the end of the satisfaction assessment semi-structured individual interviews were conducted with 11 randomly selected participants from the experimental group. Finally, the results of this interview have been recorded in details.

RESULTS AND DISCUSSION

A t-test is used to test the null hypothesis that the population mean in each of the two groups is equal (Hair et al., 2010). Given the need to measure the differences between the experimental group and the control group in this study, regarding to the learning achievement and satisfaction, the independent samples t-tests were carried out. In addition, semi-structured individual interview data of some randomly selected participants from the experimental group were collected for building a better understanding of the students' user experience.

Learning achievement

Table 2 shows the statistical results of the experimental group and the control group on measuring the post-test scores concerning learning achievement. The mean of scores was 79.78 (SD = 11.13) for the experimental group, higher than the 76.20 (SD = 8.61) for the control group. There is a significant difference between these two groups, $t(125.794) = 2.087$, $p < .05$.

Table 2: *t* test result of the test scores

	Groups	*N*	*Mean*	*SD*	*df*	*t*	*p*
score	Experimental group	68	79.78	11.13	125.794	2.087*	.039
	Control group	66	76.20	8.61			

*$p < .05$

The empirical analysis results reveal that the students who used the multimodal presentation system (MPS), a multimodal presentation software integrated with interactive whiteboard (IWB), obtained a better result on average, implying that the system is able to lead students to significantly better learning achievement in English vocabulary learning, and is therefore useful. Previous studies of IWB (Digregorio & Sobel-Lojeski, 2009; Jang, 2010; Lewin et al., 2008; Slay et al., 2008; Thompson & Flecknoe, 2003) proved the positive improvement in developing the learners' learning achievement. The study of Lopez (2010) also indicated that a digital learning classroom project, using interactive whiteboard (IWB) technology, contributed to increase the English language learners' achievement, compared to those in traditional classrooms without IWB technology, in 3rd grade mathematics and 5th grade mathematics and reading.

Student satisfaction

Table 3 shows the statistical results of the experimental group and the control group on measuring the 6 survey items related to the learning satisfaction. The mean of overall satisfaction was 35.90 (SD = 4.91) for the experimental group, higher than the 25.91 (SD = 3.91) for the control group. There is a significant difference between these two groups, $t(127.120) = 13.049$, $p < .001$.

Table 3: Means (*M*), standard deviation (*SD*), and *t* value for learning satisfaction

Items	Experimental		Control		*df*	*t*	*p*
	M	*SD*	*M*	*SD*			
I like the idea of learning English in a class like this; i.e. the one I have this semester.	4.78	1.38	3.62	1.03	124.113	5.507***	.000
Learning English by taking a course like this is a good idea.	5.56	1.20	4.41	0.99	128.704	6.047***	.000
My learning experience in this course is positive.	5.07	1.11	2.42	0.91	132	15.063***	.000
Overall, I am satisfied with the course.	5.03	0.85	4.21	0.95	132	5.254***	.000
Learning English in a class like this is enjoyable.	5.10	1.12	3.91	1.08	132	6.281***	.000
As a whole, the course is effective for my learning.	5.18	0.95	3.67	1.11	132	8.468***	.000
Total	35.90	4.91	25.91	3.91	127.120	13.049***	.000

*$p < .05$, **$p < .01$, ***$p < .001$

Semi-structured Interview

As Kendall (2008) asserted, qualitative interview data could gather more in-depth insights on participant attitudes, thoughts, and actions. Thus, we collected semi-structured interview data from experimental group to attain a better understanding of the students' user experience with the MPS. Many factors can influence a user's experience with a system. To address the variety, factors influencing user experience can be classified into three main categories: user's state and previous experience, system properties, and the usage context (situation) (Hassenzahl & Tractinsky, 2006; ISO FDIS 9241-210, 2009). The opinions of students' user experience are classified into aforementioned three categories and described as follows.

1. User's state and previous experience

- *The MPS sometimes brings a little competition.*
- *By preparing and loading the resources required for a lesson in advance, we generate a kind of smoothness in our organizational activity, maintain a momentum to the flow of the lesson and feel that we keep others engaged more continuously than with traditional resources.*
- *The use of the MPS engages me in my pace of learning.*
- *Making processes happen more quickly than traditional blackboard. We can provisionally change the contents and repeatedly respond to the input. (This is also classified into usage context)*

2. System properties

- *I can easily move from one thing to another and this keeps the pace going.*
- *The IWB enables the range and the variety of materials for learning.*
- *Teacher uses the 'reveal' tool to focus attention on component part before revealing its place in the whole object or uses zoom/magnify to look closer at a seed to identify how it becomes attached to an animal for dispersal.*
- *We can select the appropriate words and pictures from a list.*
- *Features of same object from different views or different items displayed can be compared.*

- *The facility while using the MPS can combine visual, aural and textual display.*
- *While watching the video and providing annotations to the contexts, we do not need to switch page up and down.*

3. Usage context
- *Making processes happen more quickly than traditional blackboard. We can provisionally change the contents and repeatedly respond to the input.*

Specifically, the students highlighted that the MPS was especially valuable for combining words and pictorial representations of knowledge. The MPS can increase student engagement and help student control over the materials and processes. It seems that the use of the MPS had a positive impact on the affective dimension of the pedagogical process. According to the multimedia principle, students' understanding can be enhanced by the addition of non-verbal knowledge representations to verbal explanations (Fletcher & Tobias, 2005; Moreno & Mayer, 2007). The quality and clarity of multimedia resources may offer enhanced visual materials for presenting to a large audience, and the student is able to move between varieties of electronic resources, with greater speed in comparison to non-electronic resources, with opportunities to record and retrieve data represented. The learner-content interaction can increase students' engagement and enhance their controls over the materials and processes. Therefore, learner-content interaction improves the quality of multimodal learning environment.

In summary, interaction is such a powerful ability in human learning for improving learning effectiveness. Students do not passively accept knowledge that already exists but construct meaningful learning. The MPS in this study provides good quality software to bring students to the IWB, more directly involving them in the lesson. As Thompson and Flecknoe (2003) claimed that IWB worked best when used interactively, especially when students interact with the board themselves. Students in our case pointed out that the MPS was helpful for multimedia materials presentation and could provide a suitable and effective learning interactivity in the classrooms. The results indicated that multimodality presentations can be utilized to support the instructional activities for leading students to perceive complex ideas efficiently. Three interesting points are evident from observing the experiment as follows:

First, the MPS increases interactivities. The analysis of students' questionnaires and semi-structured individual interviews showed that the IWB technology enhance students mostly associated with interactivity and active participation (Schmid, 2008, 2010). For example, some students' statements showed that "Operating materials in front of classmates made me feel participating more in class"; "The IWB made me take a more active part in the activity than PowerPoint presentation"; and "Not just listen to what teacher said, he is joining the class". In traditional classroom, children generally took a somewhat passive role as learners. They usually simply acquired knowledge and skills, and were not engaging in their own thinking and learning. Blackboard writing was more limited in affordances and PowerPoint presentation was much less flexible in interactions than IWB. IWB was common for students coming to the board to write up ideas or drag an item into an appropriate position. Students focused attention on salient features of the task and content—labeling, highlighting, color coding, classifying—and for revisiting key points during reflective review at the end of the lesson. Second, the MPS was used to support multimedia-integrated and interactive learning. It integrated and synchronized multimedia content and provided interaction to students. For example, an image can be added to illustrate the meaning of an unfamiliar word. The displays (texts, images, sound, and diagrams) are easy for students to see or interpret. The opinions of some students from experimental group are described as above. Finally, instruction is student-centered. This study highlighted the way in which the MPS could support new opportunities to engage children in the process of learning. In an interactive multimodal learning environment, learning results depend on the actions of the learner. The finding is not similar to the quick-fire question and answer work of PowerPoint presentation. The IWB finding is also not similar to the research of Hall and Higgins (2005) that most examples observed about the control of content were fully in the teachers' hands.

CONCLUSIONS AND FUTURE RESEARCH

The purpose of this study was to develop a multimodal presentation system (MPS) to support the English learning in the elementary English as second language (ESL) course to enhance the students' learning effectiveness in the classroom setting. The results show that there are statistically significant differences between the students in experimental group and control group on measures of learning achievement and learning satisfaction. Here the mean of test scores was 79.78 (SD = 11.13) for the experimental group, higher than the 76.20 (SD = 8.61) for the control group. In addition, the mean of overall satisfaction was 35.90 (SD = 4.91) for the experimental group, higher than the 25.91 (SD = 3.91) for the control group. The MPS facilitates the ESL learning effectiveness at the interface of technology, providing high level of interactivity and multimodal

presentation, which are critical to the improvement of the whole-class teaching and learning processes. In addition, by conducting semi-structured interview of randomly selected students from the experimental group, the data show that the students are impressed by the interactive and multimodal features after study.

Several important practical implications arise from our findings. First, the MPS promotes a learner-centered pedagogy where both teacher and students are learners. For example, both teacher and students generated common topics and tried to find out the answers jointly from the internet with the MPS. In addition, the more the students interacted with the MPS, the more they became adept in using its functions and features, and the more they would like to play with the MPS to see what it could do. Second, in spite of the promising findings shown in this study, the MPS is not a magic tool for improving ESL student academic success. More specifically, MPS cannot compensate for the teacher's lack of subject matter content knowledge, capability to produce instructional materials, instructional competency, and classroom management skills. The MPS was simply a tool that improved the teacher's innate and teaching capability in the ESL classroom. However, this tool, more than the basic computer and overhead projector, offered teachers a broader range of functions and features from which to provide a variety of contexts for students with diverse learning needs. Third, how and what teacher does in the classroom, normally being expressed in the teacher-student interactivities, is important to students' academic success. Smith et al. (2005) claimed that teacher-student interactivity is the primary benefit of the IWB. Based on teacher feedback and observations in the classrooms, teacher-student interactivity could promote the students' attention to instruction and participation in classroom discussions with teacher and other students. For example, as the teacher was instructing the vocabulary by using the MPS and could not implement one of the MPS features, some students actively proposed step-by-step guides to help the teacher recover the error. Subsequent investigation revealed that it was quite common for the teacher and students to help each other when technical difficulties arose in the use of the MPS.

This study contains several limitations that suggest future research directions. First, this study does not completely follow a truly randomized selection and assignment. Although the instructional approaches were assigned randomly to classes, this study nevertheless is limited in the way that in educational settings the intact classes are already constructed before the research is begun. Efforts to replicate this study using a truly random design would be helpful. Second, this study evaluates the post-test scores concerning learning achievement. Further research should include a delayed post-test for evaluating whether there is a stable and persistent change in the vocabulary learning. Moreover, further research should examine whether and the extent the MPS is able to help ESL students learn more materials in the same unit of time or learn a given unit of materials in less time than students in traditional classrooms. Finally, this study evaluates the learning effectiveness of elementary student in the context of ESL subject. Further research should investigate the potential of its use in other subject areas, such as art or math, or for students at other elementary grade levels or in higher education to generate empirical evidence with greater generalization.

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