Investigating Collaborative Interaction using Interactive Table and IR devices

T. PUCKDEEPUN[1], J. JAAFAR[2] & M. F. HASSAN[3]
Computer and Information Science Department
Universiti Teknologi PETRONAS
MALAYSIA
[1]*sosazyza@gmail.com*
[2]*jafreez@petronas.com.my*
y[3]mfadzil_hassan@petronas.com.my

Abstract: - Recently computers have proved to be great tools for different kinds of collaborative works. The biggest challenge of computer integrated learning has been used to support collaborative learning activities for students while they sit in front of computer screens. Interactive Whiteboard (IWB) technology enhances this challenge by providing a large workspace with multimedia resources. Therefore, this research aimed to compare the efficacy used of computer-based and interactive table-based in face-face collaborative learning environment. Interactive table was developed by using a low-cost interactive whiteboard technology. This paper examines how such this technology impacts student's interaction in collaborative activity comparing to computer-based learning. It also included the experiment of IR(infrared) devices(IR pen and IR fingertip) which use with interactive table. The findings show strength and weakness of both devices which will be beneficial for future interaction technique in IWB technology.
.

Key-Words: - interactive whiteboard, IR device, Interactive table, interaction, collaborative, CSCL.

1 Introduction

In recent years, Interactive Whiteboard (IWB) has become an innovative mediating tool in teaching and learning pedagogy. Study has found that IWB provides an opportunity to enhance student's collaborative learning and build up interactive teaching approach [1]. However, the main barrier is off-the-shelf IWBs is still extremely expensive [2]. Apart from that, training is a crucial on how to use the technology and its component. Teachers should have basic ICT knowledge and pedagogical skills to maximize the usage of IWB and students should have an appropriate training before using IWB. It also allows student to engage and interact with the technology to become active and motivate in learning subjects. [2]

In 2007, a new technology of a low-cost IWB using wii remote has been introduced and been used by many schools [3][4][5]. It is a great alternative and reasonable solution compared to an expensive commercial interactive whiteboard that currently available in market. This low-cost IWB can transform any flat screen into interactive screen. Therefore is will improve learning and teaching environment in more interactive ways [6].

For the last ten years, most research focused on the technology's which have abilities to facilitate a social interaction between teacher and students as well as among students. This technology has demonstrated to be the great technological mediating to support collaborative learning activities. At the same time it also creates knowledge in order to develop social competencies and interpersonal skills [7]. However, not much research focus on efficacy used of computer-based learning compared with IWB technology in collaborative learning activities among students in school.

The aim of this research is to observe and analyze students' collaboration in the use of computer-based learning and interactive table-based learning in collaborative activities. The results of these studies are synthesized into implications for future design of IWB technology in education.

2. Related Works

Collaborative learning is an educational approaches for teaching/learning method based on group of learners working together to complete the tasks, solve a problem or create a product. It focuses on students' exploration or application of the course material, not about presentation or explication by teacher [8]. It is knowledge sharing by working group rather than working alone. [9]

Study is being conducted to prove the collaborative learning approaches using CSCL in different way such as evaluating collaborative learning process by implementing application design with students'

cooperative work and the result has shown that cooperative work process influenced by students' personal styles, behaviors and individual collaborative attitude [10].

Besides, an interactive media using CSCL has been developed to improve collaborative learning such as e-learning or ODL(open and distance learning). It is alternative way to solve education problem particularly on distance learning problem. However, it should take into account that working/learning face-to-face is different from using electronic tutorials through internet. Therefore some students who prefer face-to-face require asynchronous messaging (chat) to achieve their social interaction as well as it would be more interactively to include video conference into electronic communication [1]. On the other hand, computer support of learning does not always in a form of distance online communication medium. Computer can be used in shared environment or interactive presentation. A group of students might use computer to work, discuss, and browse through information on their task given [11].

A research of understanding children's interaction in shared environment had been investigating on how various collaborative computer settings impact to children's interaction. The findings reported that children exhibited off-task behaviors when forcing them to share one input device. It has shown that traditional computer technology offers limited support for face-face in synchronous collaboration. While using computer in collaborative activities, students must adapt their interactions into the use of single computer which is not sufficiently flexibility for students. Hence the advised solution to this problem is providing concurrent, multi-user input to application[12].Still, with a scientific computer model, this might be sufficient solution to solve a problem regarding to support two-three users but it would not be efficient to support multi users for five users and above.

Nowadays, IWB technology has been introduced to be used in collaborative learning activities. Most research aimed to capture, analyze the communication between teacher, students and technology occur in classroom and the results of case studies using interactive whiteboard technology are quite impressive. It has shown that IWB and electronic whiteboards are becoming popular supported in collaborative learning activities. It is available to empower students' collaborative learning and develop conceptual thinking and confidence in children [13][14][15]. Moreover, by providing a big screen that allowing more students interact directly to the screen that everyone can feel involved. [15].

3. The Method

This research intends to carry out further studies concerning a low-cost IWB technology supports for student's collaborative learning activities in face-face environment. According to the successful of a low-cost IWB technology, it was inspired to come up with an idea of developing an interactive table. This interactive table will be used to maximize usage of IWB technology that should not be limited as a presentation tool. Therefore, this experiment focuses on student's interactions when engaged in collaborative activities in a variety of collaborative settings.

3.1 Interactive table

Interactive table as shown in Figure 1 is a new system design. This new setting gives much more flexibility in terms of interaction technique rather than setting up on a flat wall. With this setup the student's body movement and position will not block projector's light beam which will disrupt the view of the screen. Moreover, projector is located under the table and Wii remote hangs on the hanger above the table which allows students to move more freely around the table.

Fig1. Interactive table

Tools, software and hardware required as follows:

- Wii remote whiteboard software
- Wii remote
- Bluetooth USB adapter, or laptop embedded Bluetooth
- Bluetooth driver
- Wii remote hanger
- 40" × 35" glass/plastic sheet
- Rear projection paper
- Projector

3.2 IR Devices: IR pen and IR fingertip

IR pen and IR fingertip are infrared devices use with interactive table. IR pen and IR fingertip are applied the same concept to activate the infrared light by pressing on a switch which allows the current to completely flow through the circuit. The differentiation between those devices is their components and the method applied to develop the devices. Developing IR pen is relatively easy and inexpensive. It is comprised of wires, momentary push switch, IR, magic pen, AA battery. While developing IR fingertip is more complicated because IR fingertip is built from pressure sensitive fabric sensor. It is small wearable device which users can wear on their fingers and it is activated when users press/touch on interactive screen.

The purpose of developing IR fingertip is inspired from a problem found by using momentary push button switch. Sometimes it is not convenient to use IR pen with interactive screen for some computer applications which are naturally playing by hand such as game applications (e.g. scrabble, chess, instruments and puzzle). For that reason, IR fingertip was developed to fulfill these requirements and later the experiment was conducted to evaluate the effectiveness and efficiency use of both devices with interactive screen.

In Table 1 shows the different characteristics between IR pen and IR fingertip. Figure 2 and Figure 4 have shown sketches of IR pen and IR fingertip as well as in Figure 3 and Figure 5 show IR pen and IR fingertip snapshots.

Table 1. IR Devices' characteristics

IR pen	IR fingertip
Activate by keep pressing on momentary switch	Activate by pressing/ touching directly to the screen
Hold the pen while writing on the screen.	Wearable device : wearin fingers
Easy to pick and drop when it is not being used.	Need to take off when it is not being used.
Cost around 3$ (~MYR10)	Cost around 4$ (~MYR15)

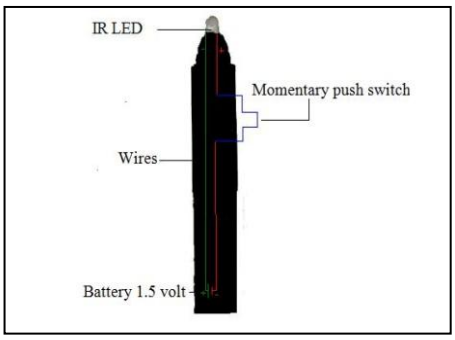

Fig 2. Sketch of IR pen's components

Fig 3. IR pen

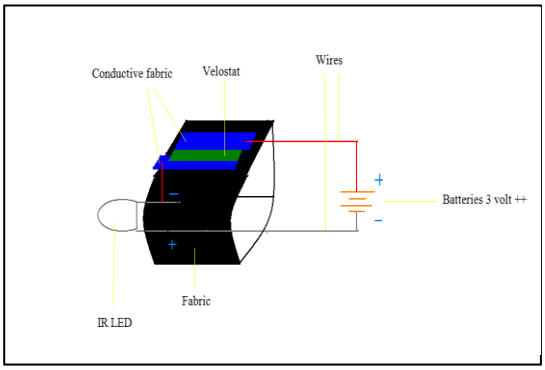

Fig 4. Sketch of IR fingertip's components

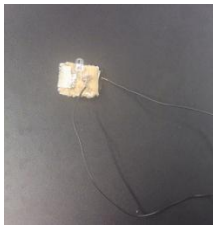

Fig 5. IR fingertip

4. Study 1: Investigating on IR pen vs. IR fingertips with various users

This study intended to evaluate the efficiency usage of IR pen comparing to IR fingertip in different tasks/issues. It took twenty users with diverse genders to evaluate on this technology. Each of them required to have training on both IR devices for five minutes. Then they were requested to use IR pen/IR fingertip interacting with tabletop for tasks/issues given. The feedbacks from users were analyzed after the experiment was done. Figure 6 and Figure 7 were captured during

experiment when users using IR pen and IR fingertip.

Fig 6. Students using IR pen

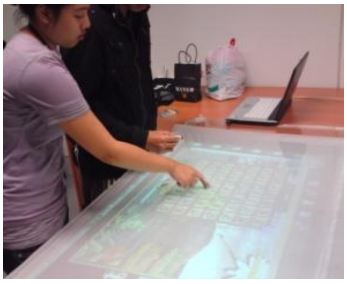

Fig 7. Student using IR fingertip

Result: Table 2 shows the results of the Questionnaire for User Satisfaction and Usability of IR devices. The responses from users are collected from the marks in different tasks/issues. The table has shown that the first category of writing purpose of IR pen has higher of mean (m= 0.9) which exposed that users preferred to use IR pen to write on the screen rather than using IR fingertip. In the same time, mean(m = 0.85) of IR fingertip for playing game purpose is much higher than IR pen, it seems that users satisfied with IR fingertip when they were playing game applications with tabletop. However, some users who had experiences on both IR devices reported less satisfaction with ease of use at first because it needs to take some time for them to get used to with the devices and it was frustrated for them when they activated IR devices and it was not working as it supposed to be.

Table 2. IR devices analysis description

Tasks/Issues	**IR pen**	**IR fingertip**
	Mean	**Mean**
Writing	0.9	0.2
Drawing	0.7	0.65
Scrolling up/down	0.4	0.6
Clicking icon	0.65	0.55
Moving Item	0.6	0.7
Playing games	0.25	0.85
Preparing document (e.g.presentation slide)	0.75	0.6

5. Study 2: Investigating collaborative settings impact to students' interaction

This study involved three pairs of foundation students in various genders. They were required to play MagikWord game;MagikWord game is a fast-paced addictive word game that similarly to scrabble.

Three collaborative settings were investigated: Figure 8: a paper-based version where each student had their own pens; Figure 9: computer-based version where two mice are available for students and Figure 10: interactive table-based version where two IR pens are available for students.

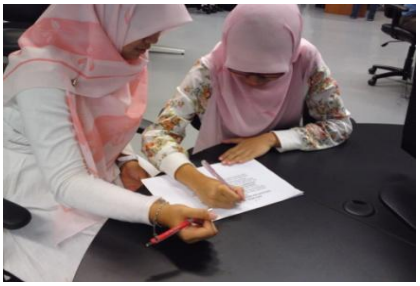

Fig 8. Paper-based setting

Fig 9. Computer-based setting

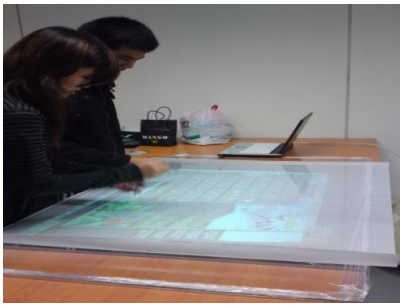

Fig 10. Interactive table-based setting

Starting with all pairs played a game in the paper-based setting first which the paper-based version of the game was used as a training session to help students get to know with the game. Since the students have been used interactive table when they were doing experiment on IR devices then it was not necessary to have a training section again. After that, students played game for fifteen minutes in each collaborative setting. Finally, students were required to complete post-experiment questionnaires to determine the overall satisfaction of the game and feedback on the collaborative settings.

Result: The results from video camera record, observations and post-questionnaires were analyzed. The data from paper-based version setting was not considered since the students used it as a training session. This experiment provided valuable data on how students engaged given a new technological medium that support collaborative interactions, against which the interaction in the computer-based setting.

Overall, six students preferred interactive table-based rather than computer setting, that is because the new technology given which they have never been experienced on it and a large colorful display screen gave more attraction than computer's screen.

Students' engagement in collaborative activity was determined by the amount of off-task behaviors that they expressed, the data gathered from the videotapes and observations. Off-task behaviors were considered from nongame-related actions (e.g. literature message, looking around, frustration behavior from difficult game and stop holding mouse and IR device)

Students appeared to participate more actively at the beginning of game and the last 5-8 minutes they appeared to get frustrated easily from difficulty of higher game's levels and in computer-based setting, students got more annoyance when they had to share a cursor with their partner.

The result of analysis has shown in Table 3 illustrates that students exhibited more off-tasks-behavior during computer-based setting (m= 60.833 seconds, std. = 15.328 seconds) than in interactive table setting (m= 42.166 seconds, std. = 14.148 seconds).

Table 3. Collaborative analysis description

Issue	Collaborative Settings	Mean(sec)	Std.(sec)
Off-task behaviors	Computer-based	60.833	15.328
	Interactive table-based	42.166	14.148

Students appeared to participate more actively in interactive table setting. They were frequently active 71.9% during in interactive table-based setting rather than computer-based setting which they were less active for 59.4% during time session.

An important informal observation should take into account was the limited used of traditional computer and interactive table which is not efficiency supported collaborative activities in term of synchronous interaction. It was noticeable that even thought two mice were provided to allow students interacting with computer at the same time but they preferred to do it sequentially. The same as in interactive table-based setting since computer OS generally supported only a single cursor at a time, the students would be able use multiple IR pens. But they have to be used in sequence which makes it inefficient for collaborative activities.

However, most of students were satisfied and enjoyed the experience of working with a technology that supports collaborative activity. Surprisingly, some students showed their impression by asking more time to play with interactive table.

6. Conclusion

This research aimed to explore how new technology of interactive table affects student's interactions in collaborative activity comparing to computer-based setting. The findings indicate that technology of interactive table was taking more attention from students rather than traditional computer. It appears that a big screen of interactive table provides large space for two students and more working collaboratively in activities. When students can interact directly to the screen, it gives more fun and builds interactively environment. The overall feedback from students was positive overwhelming and students enjoy working with the technology.

Additional with the experiment of IR devices in order to verify the valuable of the new wearable IR fingertip which it was working effectively. Even though the use of wearable device is not sophisticated comparing to a natural hand but it was worth to apply this technology to schools or universities where the price of technology is quite cheap and affordable. For that reason, this research paper will be potential benefits to schools and universities for future smart and interactive classroom.

References:

[1] Raja Maznah RajaHussain, "A Collaborative Learning Experience of Evaluating aWeb-Based Learning Tool", *Journal of Instructional Technology (MOJIT),*Vol. 1, No. 2, pp 67-72, December2004,Available:http://pppjj.usm.my/mojit/articles/pdf/12A%Collaborative%20Learning%20Experience%20of%20Evaluating.pdf

[2] National Centre for Technology in Education.

Nov2008. Interactivewhiteboard. Available: http:// www.neilstoolbox.com /bibliographycreator/reference-journal.htm#. Last access: 15 Dec 2009.

[3] Do Huy Thinh and M. V. T. Dung. "Interactive Teaching & LearningwithLow-cost Interactive Smart Boards. "Availableat" http://www.unescobkk.org/fileadmin/user_upload/apeid/Conference/13th_Conference/Papers/3.E.2_Interactive_teaching_and_learning__Vo_Tan_Dung_.pdf " Last accessed 20 May 2010.

[4] Zhixuan Wang Louey, J, "Economical Solution for an Easy UseInteractive Whiteboard",Frontier of Computer Science and Technology, FCST '08. Japan-China Joint Workshop on 27-28 Dec. 2008 IEEE Page(s):197 - 203.

[5] Admin. (2008). Wiimote Whiteboard in action. Available: http://ilearntechnology.com/?p=390. Last accessed 16 Dec 2009.

[6] Johnny Chung Lee.2007, Low-Cost Multi-point Interactive Whiteboards Using the Wiimote. Available: http:// johnnylee.net /projects/wii/. Last accessed 15 Dec 2009.

[7] Donata Francescatoa, Rita Porcellia, Minou Mebanea, Marcella Cuddettaa, Jane Klobasb, Paolo Renzia, "Evaluation of the efficacy of collaborative learning in face-to-face and computer-supported university context," *Journal of Computers in Human Behavior*,Volume 22, Issue 2, pp. 163-176, March 2006

[8] Barbara Leigh Smith, Jean T. MacGregor, "What is CollaborativeLearning", Washington Center for Improving the Qualityof UndergraduateEducation. ,Available:http://learningcommons.evergreen.edu/pdf/collab.pdf.

[9] Heerwagen, J.H., Kampschroer, K., Powell, K.M. and Loftness, V. for the U.S. General Service Administration, Building Research and Information, Spoon Press, November-December 2004, 32(6), 510-528.

[10] César A. Collazos, Luis A. Guerrero, José A. Pino, Sergio F. Ochoa, "Evaluating Collaborative Learning Processes," Groupware: Design, ImplementationandUse,Lecture Notes in Computer Science, 2002, Volume 2440/2002, 173-194, DOI: 10.1007/3-540-46124-8_14

[11] Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historicalperspective. In R. K. Sawyer (Ed.), Cambridge handbook of the learning sciences (pp. 409-426). Cambridge, UK:Cambridge University Press.Available at http://GerryStahl.net/cscl/C SCL _English.pdf

[12] Stacey D. Scott, Regan L. Mandryk, Kori M. Inkpen, "Understanding children's interactions in synchronous shared environments," in the preceeding of the Conference on Computer Support for Collaborative Learning: Foundations for a CSCL Community, 2002.

[13] Anita Cassapu,Ben Gurion, "Introducing the Interactive Whiteboard in Computer Science Teaching A High School Experience"Annu. Joint Con.Integrating Technology into Computer Science Education,2009 in Proc 14th Annu. Conf. on Innovation and technology in computer science education ACM SIGCSE.

[14] Stephen Brown, "Interactive Whiteboards in Education", TechLearn service of the JISC-funded Technologies Centre.

[15] Inc., S. T. (2004). Interactive Whiteboards and Learning: A Review of Classroom Case Studies and Research Literature.