Utilizing a Low-Cost, Laser-Driven Interactive System (LaDIS) to Improve Learning in Developing Rural Regions

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ABSTRACT

This study proposes an innovation Laser-Driven Interactive System (LaDIS), utilizing general IWBs (Interactive Whiteboard) didactics, to support student learning for rural and developing regions. LaDIS is a system made to support traditional classroom practices between an instructor and a group of students. This invention effectively transforms a general projection screen into an IWBs. Accompanied by a projector, laser emitter, screen, PC (Personal Computer) and web cam, LaDIS provides a viable, efficient and economical solution for e-learning in classrooms. Students in the classroom are connected to a single computer and a shared screen. LaDIS is an extensible device, for use in any IWBs and interactive teaching software. This study engages 92 first-grade students enrolled in a 5-Year Junior College; these individuals are from two classes at a college of Taoyuan County, in Taiwan. Each class consists of 46 students. Classes are twelve hours in length, for a total of six weeks in the experimental course with different didactics. One class is the control group, and it adopts ordinary didactics. The other one is an experimental group, which adopts the innovation LaDIS didactics in class. The results indicate positive impacts of the innovation LaDIS on student learning performances. Most students are highly satisfied with the system and willing to use LaDIS because of its naturally superior interactive performance in classes. LaDIS provides a low-cost classroom tool, for developing regions financially unable to afford general IWBs equipment and didactics.

Keywords

Learning, Interactive Whiteboard, Laser emitter, Web cam, Developing and rural regions, Low-Cost, Economical

Introduction

Interactive whiteboards (IWBs) are large touch-sensitive boards, which control a computer connected to a digital projector; they were originally developed for office settings. Lee & Boyle (2003) recently described the adoption of IWBs as virtually an overnight occurrence in some schools; and, that the introduction of IWBs into schools transformed the overall use of ICT (Information and Communications Technology). Smith (2005) reports, the benefits of using a graphics package to support younger pupils' handwriting skills, where gross motor movements on the IWBs helped students' handwriting on paper. Similarly, younger pupils in Goodison's study (2002a) report a preference for using the $IWB_{S,}$ as opposed to a computer, because they found the keyboard and mouse difficult to manipulate. As one teacher described (Austin, 2003, p. 2), 'I can see much more evidence of learning carried from one lesson to the next because of the ability for reinforcement on the fly'. Likewise, Walker (2002b, p.2) reports on a primary teacher, who finds the ability to 'flip back and review material', particularly beneficial for lower ability groups and pupils with special needs. Thus, it can be seen that the versatility of IWBs extends beyond the content of lessons and activities. In traditional teaching, the teacher talks more and there is less interactive teaching (Northcote et al., 2010). There is evidence to suggest that IWBs encourage teacher-led discussions in the form of dialogic teaching (Northcote et al., 2010). Reports also show that interactive teaching, supported by the use of IWBs, can lead to positive learning outcomes (Mercer et al., 2010). Teachers report finding IWBs a flexible and versatile teaching tool across age groups and settings (e.g., Austin, 2003; Jamerson, 2002), ranging from nursery (Wood, 2001; Lee & Boyle, 2003) to higher education (Malavet, 1998; Ekhaml, 2002) and even distance education (Abrams & Haefner, 1998 ; Bell,2002). Furthermore, teachers, report that IWBs extend possibilities when catering for a range of needs within a lesson. The facility to flip back and forth between pages on IWBs screen is reported as a useful technique in supporting a range of flexibly and spontaneous needs within a class (Latham, 2002; Walker, 2002b). Stallard describes the introduction of IWBs, in 29 nurseries across Birmingham, as having a profound effect on the number of pupils choosing ICT activities (Wood, 2001). She found pupils that would not normally choose to work on the computer were choosing to work on the IWBs, and observed that they could do the activities without needing the fine-motor skills required to operate a mouse. More recently, IWBs have been described as a technology hub (Miller

& Glover, 2010; Thomas & Schmid, 2010) where the teacher has access to videos, the web, animations, etc. through one device, enabling the teacher to offer a rich learning experience to students. When the IWB is set up as a technology hub, it has been proposed (Miller & Glover, 2010) that it can act as a trigger for pedagogic change (Miller & Glover, 2010). Nowadays, the traditional white board is being replaced by IWBs, which combine video/media systems. On-line IWBs use interactive vector based graphical websites to share annotations and drawings. Many schools use IWBs to connect to the Internet/district networks to develop digital video distribution systems for on-line/off-line study that can provide distance learning or e-learning courses. Although IWBs provide valuable assistance for teaching needs, its price is a major concern for many users; a common IWB, with basic functions, costs upwards of 1,500 US dollars. Therefore, how to make an economical solution for IWB_S is an attractive topic for many researchers. A noteworthy solution is the Wiimote Whiteboard, by Johnny Chung Lee (Lee, 2008). However, Wiimote is geared toward the main engine in the Wii video game controller, and it uses Bluetooth wireless transmissions. Consequently, Wiimote has function limitations because it is designed specifically for use with a video game controller and not for IWBs. Rather than altering the Wiimote sensor for a secondary use, in this paper, we develop a new installation and calibration method, utilizing tools regularly available in a standard classroom, such as projector, screen and pointer. Then, we propose a more viable, efficient and economical solution, specifically designed for IWBs.

Innovation laser-driven interactive system (LaDIS) design

LaDIS is a system made to support classrooms, unable to afford traditional IWBs equipment, but in need of a fully functional technology hub. LaDIS effectively and economical, transforms a general projector and a portable or stationary screen into an IWB. Via this invention, the classroom is connected to a single computer and a shared portable or stationary screen. LaDIS is an extensible device, and may be utilized in conjunction with any IWBs interactive teaching software. The system provides alternatives of both portable and stationary screen settings to satisfy various classroom needs. Basically, the laser spot, emitted by a laser emission unit and wireless control unit, allows the laser spot to synchronize and control the cursor and software on a projection screen. The concept behind the LaDIS design is shown in Figure 1(a). The illustration carefully indicates every component in the system but in real life, LaDIS, is not as complex as the classroom illustration shown in Figure 1(a). In reality, as shown in Figure 1(b), LaDIS is a very simple system.

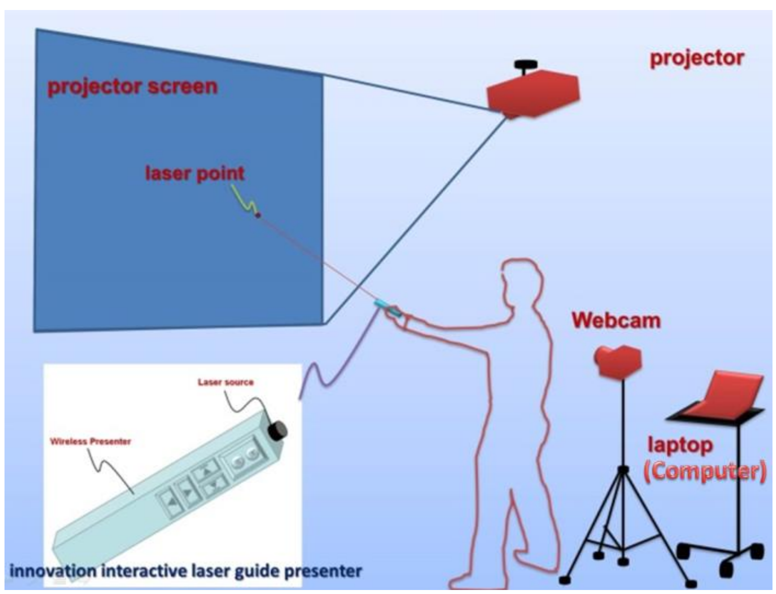

Figure 1(a). The concept of LaDIS design
(How to operate the LaDIS is shown in the following video link: http://youtu.be/cbE284_Bk7k)

Figure 1(b). Set-up of a real system: (1) the webcam can be fixed on a projector (2) the projector usually hangs from the ceiling of classroom (3) the computer usually is set up inside a lectern (4) wireless control technology can connect with LaDIS and a computer without any connecting lines

The variety of interactive functions provided by LaDIS duplicate the functions of traditional IWBs. The results from this study contribute both a novel system for synchronous distance education in an affordable manner and design insights for creators of related systems.

Image acquisition

The Laser emission unit is for emitting a laser spot on screen, and it coordinates the laser spot detected by a data processing unit through the image capture unit. The imaging is utilized to display the output image from the data processing unit. The key point of image acquisition technology, in this study, is the red visible-light filter. A light filter lens may effectively filter the Blue and Green visible light on the screen image. The wavelength of red laser spot is higher than any visible red color. This allows the optics photography-function to trace the laser emitter spot on the screen image. Utilizing this spot tracking can provide coordinates of laser spot precise

The internal coordinates with external coordinates converter operation

The laser emission unit is for emitting a laser spot imaging on a screen. Based on the coordinates of the laser spot, (detected through the image capture unit and the coordinate converter operation) the internal coordinates may be turned into external coordinates for the data processing unit. The location of the laser spot, through image acquisition calibration, as well as an internal and external coordinates converter operation, can guide the cursor output by the data processing unit, via on screen imaging to launch synchronous movement with laser spot as shown in Figure 2.

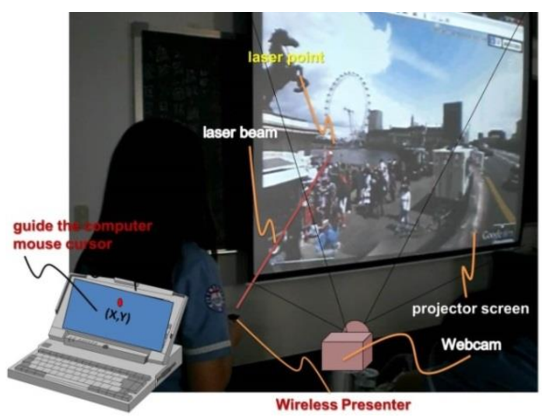

Figure 2. Via image acquisition and calibration, the external coordinate converter operation can guide the cursor to launch synchronous movement with laser spot

Calibration technology

The calibration utilizes an automatic four corner localization method to adjust the coordinates of the mouse cursor on the screen. This automatic calibration only takes a few seconds each time. The coordinate of the mouse cursor is followed by a defined sequence for completing the calibration. When corner is captured by the camera, the tracking process can be started; at this time, the cursor tracking is set up completely. Once the calibration stage is completed, the system starts its main loop. The main loop consists of a series of image manipulations that are performed on each frame and result in an array of coordinates pertaining to laser points on the screen. After image processing and computer software program operations, the movement of an image can be transformed by a cursor command to guide the laser point precisely as shown in Figure 3.

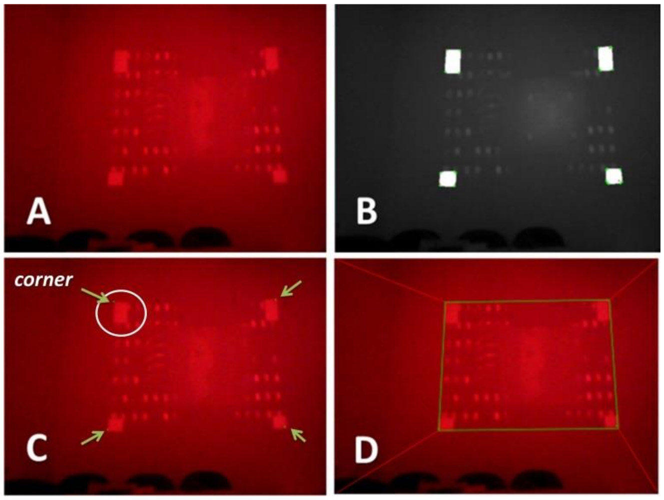

Figure 3. (A) A red visible-light filter lens transforms the whole image (and the background) into a full red view (B) The four white corners are captured by the camera (C) The calibration comes from an automatic four corner localization method (D) Utilizing a four corner localization method, the control cursor can launch precise and synchronous movement with the laser spot

Wireless control technology

LaDIS also installs a wireless control electron circuit which can directly execute each kind of interactive control function completely by wireless control technology. We explored laser guided and wireless control multi-technology for their interactions and applications. The wireless control switch is used to control the function of many buttons, such as Previous, PgUp, Next, PgDn Playback, End, Esc, Black Screen, and it can, likewise, set the countdown timer, vibration alert, and other functions, as shown in Figure 4, below. This proposed system can be operated wirelessly for presentations, including multi-media interactions. LaDIS can control and interact with any software image presented on a screen.

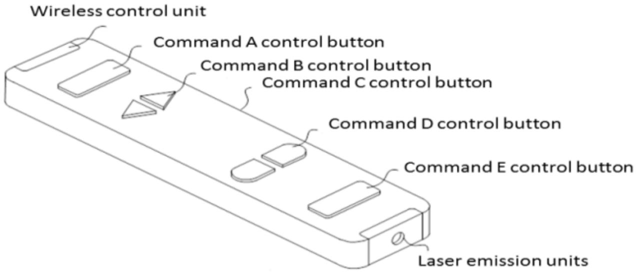

Figure 4. LaDIS: Utilizes a wireless control electron circuit to execute multiple interactive controls

Innovation laser-driven interactive system (LaDIS) solution

Potential benefits of LaDIS

Expenses

While IWBs offer support for teaching needs, they are not an economical solution for many users; for example, a common IWBs, costs range from 1,500 to 5000 US dollars (Lee, 2008). Back lit IWBs, such as back lit LCD (Liquid Crystal Display) or even back lit projectors are more expensive and less commonly utilized in classrooms than general projectors and screens (Richard ,2006 Park, 2010). Due to financial limitations, IWB_S still cannot be effectively implemented into every classroom worldwide; this is especially the case in developing country and rural regions. As proposed by Johnny Chung Lee (Lee, 2008), the Wiimote whiteboard is an example of a cost-effective solution to replicate high-cost IWBs. Wii is the official main engine of a video game system created by Nintendo in 2007. Wiimote is the Wii's standard controller, and it uses the Bluetooth wireless transmission with main engine's segment. However, Wiimote has function limitations because it is designed specifically for use with a video game controller and not for IWBs. The main limitations of Wiimote whiteboard are its setup, and calibrations are difficult. For example, the users must connect a Bluetooth between computer and Wiimote, and then use an infrared pen to calibrate each corner on the screen each time. Using a Wiimote whiteboard, try to connect Bluetooth between computer and Wiimote and calibrate by infrared pen is inconvenient and limited as the Wii was never designed specifically to function as an IWB. Rather than altering the Wiimote sensor for a secondary use, in this paper, we develop a new installation and calibration method, by using the facilities in a classroom, such as projector, screen and pointer. LaDIS propose a more viable, efficient and economical solution, specifically for IWBs. Generally speaking, LaDIS provides automatically calibration and without any complicated connecting procedure. Classrooms can be set up with LaDIS for around $50 USD. The main parts of a LaDIS device are simply a wireless presenter and a laser diode, which cost approximately $30 USD and other hardware components of the LaDIS, such as a webcam cost $10 to $20 USD. The developed software is freely downloadable at the following website: http://webcam-whiteboard.apponic.com/download/link-1/. In comparison to the thousands of dollars that a fully operational IWB_S would cost to install, LaDIS is very well suited for rural and developing regions, to cultivate interaction and information didactics, as shown in table 1. In table 1, we don't only compare the cost of the LaDIS, Interactive Whiteboard (IWB_S) and Wiimote Whiteboard but also the Manipulating, Set up and function of those systems. The results are a summary from the survey of ten professional teachers in this study. They all have experience in using LaDIS, Interactive Whiteboard (IWB_S) and Wiimote Whiteboard in their classes.

Table 1. Comparison of the LaDIS, Interactive Whiteboard (IWB_S) and Wiimote Whiteboard (Lee, 2008)

	LaDIS (This work)	Interactive Whiteboard (IWB_S)	Wiimote Whiteboard
Cost	$50.00	$1500.00	$50.00
Manipulating	Good	Excellent	Good
Set up	Moderate	Easy	Difficult
IWB_S function	◎	◎	◎
Interactive function	◎	◎	◎
Presenter function	◎		
Without direct control distance limitation	◎		
Without Screen Size limit	◎		
Air mouse function	◎		
Extensive control& MBWA in classroom	◎		
The user can stand a safe and comfortable distance from the projection light or associated equipment and wires	◎		

Note. The results are a summary from the survey of ten professional teachers in this study.

Engagement for the students

The main problem with any IWBS, including Back-lit IWBs, such as back-lit LCD (Liquid Crystal Display) or even back-lit projectors is that whoever is using it usually has their back to the class as shown in Figure 5. In general (left), teacher's eyes may be strained by standing close to a high luminance projector light or screen. In this study (right), a teacher can utilize the LaDIS system to stand at a comfortable distance away from the projection light or screen, and still interact fully with the screen. If there is more than one person trying to use the board, they physically block the board from the rest of the class, or they cast a shadow over it **(**Bell, 2002; Walker, 2003b). This often causes an instant breakdown in engagement for the students in their seats who can no longer see what is happening on the board. Once there are two or more people writing on an IWB_S, other students cannot see the board. The LaDIS system can provide an economical solution, to the problems stated above, via a laser emission unit and fully wireless control functions. By utilizing a hand-held LaDIS device, a class may keep their view of the screen unhindered, even as a student or teacher interacts with the viewing screen itself. That is to say, LaDIS allows for a touch-less interactive method between teacher and student without a breakdown in engagement for any student as shown in Figure 6. In general (as seen in the left picture), when two or more students are interacting with an IWB_S; the class becomes very un-interactive as the other students cannot see the board. In this study (as seen in the right picture), every student may interact with display in the classroom from their seat: in order to answer questions and remain interactive alongside each-other, without a breakdown in engagement between students, teachers and the screen. The laser emission unit is for emitting a laser spot on a screen to launch a synchronous cursor movement with the laser spot. The laser is a direct light source and has no distance limitations within a standard classroom. Employment of wireless control technology, allows every student to interact with the display from their seats. In this way, students may answer questions and stay interactive while remaining physically alongside to each-other. This touch-less function allows for student, teacher and screen interaction without a breakdown in engagement between these parties.

In general, cognitive learning can be divided into cognitive structure learning theory and information-processing theory of learning. Cognitive structure learning theory considers how the individual learner understands things, in terms of developmental stages and learning styles. Information-processing theory of learning explores how the input of sensory information starts at the top, goes through sensory memory or a sensory buffer into short-term memory (STM), and hence to long-term memory (LTM) (Brown, 2007). In this study, we try to demonstrate the potential of LaDIS system on cognitive learning. Based on LaDIS system, student can engage intuitive thinking and feedback learning by discussion with teacher and classmate during class. For example, a student can point out any question/problem and operate/interactive teaching material/software, by themselves, in classroom setting, from their individual seats. A teacher can easily display cognitive representations such as enactive representation, iconic representation and symbolic representation via the LaDIS system. For example, teacher can mark, paint note, maps and zoom in any teaching material/software. Students can also participate in any learning activity in class through the LaDIS system. Teachers may, likewise, design an activity allowing students to use the LaDIS system in completing guided discovery learning. The LaDIS system can increase student's learning motivation via diversification learning activity and more easily turns short-term memory (STM) into long-term memory (LTM). In other words, the LaDIS system is a powerful tool for engaging the cognitive learning process.

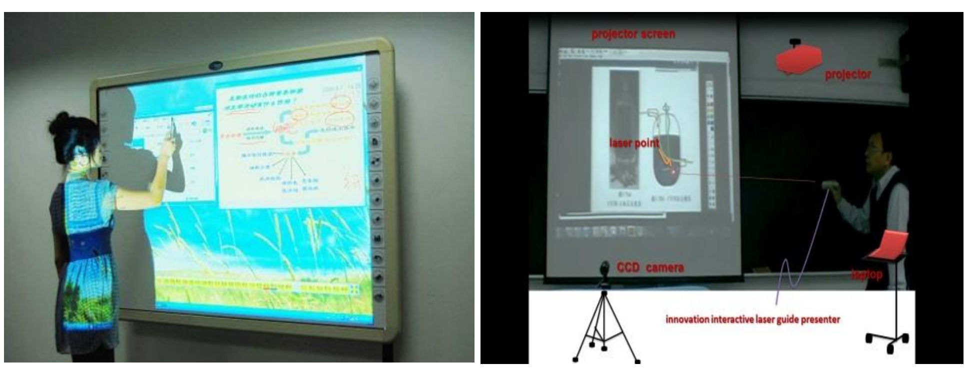

Figure 5. In general (left), In this study (right)

Health and safety

In general, as a teacher or student uses an IWB, their eyes may be strained by being in close proximity to a high luminance light source (Mark 2009). There is a concern often expressed regarding the health and safety implications of the multitude of wires required for IWBs and associated equipment (Bell, 2002; Smith, 2005; Cogill, 2003). Teachers also report that they need to stand to the side of the board or a shadow is cast over the screen as the light shines on them (Bell, 2002; Walker, 2003b), a difficulty, likewise, experienced by pupils (Smith, 2005). Another virtue of the LaDIS system is that the laser emission is a directed and focused light source pointed away from the users, to the board. It provides a touch-less interactive method of use. Therefore, the user can stand a safe and comfortable distance from the projection light or associated equipment and wires while still being fully interactive with screen.

Figure 6. In general(left), In this study (right)

Time wasted

Another major disadvantage of the IWB$_S$ is the amount of time wasted as each student, one at a time, walks out to the front of the screen, selects their answer then hands the pen to the next student who walks out to the front to answer their question. This turn-taking delay and slow pace of the lesson can be very frustrating for students, especially those who do not get a go up to the front of the class due to time constraints (Smith, 2005). In this study, students can select their answer or interact with screen from their seats by LaDIS without walking up to the front of the class. In the other words, teachers can save time and avoid the slow pace of students taking turns to walk up to the screen, as shown in Figure 7. Students, one at a time, walk out the front, select their answer then hand the pen to the next student who then walks out to the front to answer their question. In this study (right), students can select their answer or interactive with screen from their seats via LaDIS without walks out to the front of the classroom.

Figure 7. In general (left), In this study (right)

Screen size limitation

The height at which an IWBS is placed can be an issue, particularly where boards are permanently fixed and if pupils are to use them (Cogill, 2003). If the board is placed too low (or made small) on the wall, the screen may not be seen by pupils at the back of the class, and some functions of the board may be difficult to operate (Cogill, 2003). If the board is placed too high (or made large), then, teachers may have difficulty reaching the top. The size of the screen is a related factor to consider (Smith, 2005). The Wiimote IWBS uses coordinate tracking and guides the computer mouse cursor by detecting the IR spot. However, Wiimote IWBS has a detection distance limitation, and the screen size is also confined within a certain short range (Lee, 2008); the designer proposed a design to utilize a web cam (optical camera) and a special light filter lens to detect the laser spot on the screen effectively. LaDIS system provides a total solution by using the facilities in a classroom, such as projector, screen, and a LaDIS device. As shown in Figure 8, the direct laser light source, allows teachers to reach the top of the screen utilizing the LaDIS system, easily. The screens, presented in the Figure 8 are the standardized size for schools, of all levels, in Taiwan. The reason why they need a large-size screen is in order to allow everyone a clear-view. In most Asian countries, including Taiwan, each class has more than 30 students. Based on this reason, LaDIS is designed to suit large-screen sizes, Asia teachers and their classes. With a projector, screen, PC equipment, already in classrooms, schools barely need to invest any extra funding for LaDIS to provide them with a viable, efficient interactive system.

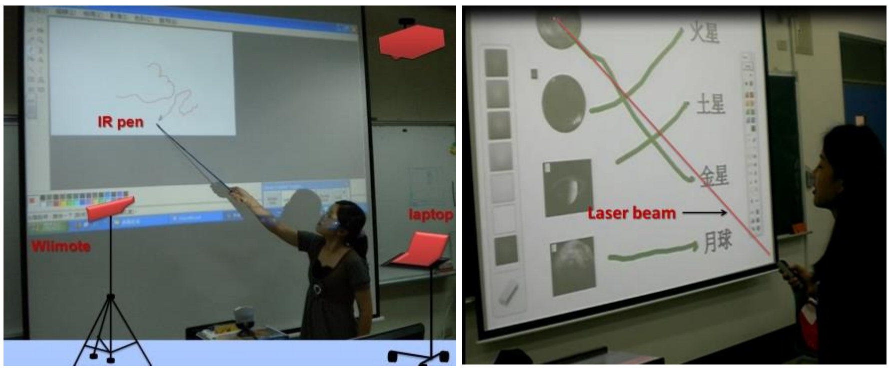

Figure 8. If the screen is placed too high (or is too large), then teachers may have difficulty reaching the top of the display. In this study (right), a teacher utilizing the LaDIS system may easily point to the top of the screen

Management in classroom

Some studies indicate that Management by Walking around (MWBA) in a classroom positively affects instructional practices and student achievement (Todd, 2005). However, in order to control the interaction teaching material on the screen more effective, the teacher is restricted to stay in front of the white board. The result is that they cannot execute MWBA in a classroom by using IWB_S. On contrary, owing to a touch-less and wireless interactive control device, a teacher can easily accomplish MWBA in a classroom by means of the LaDIS system. By utilizing a focused laser light source, a teacher can remain interactive with the screen and execute MWBA from any place within a classroom as shown in Figure 9(a). In general, the teacher is physically limited to staying in front of the white broad while using it. The result is that they cannot execute MWBA in a classroom while using IWB_S. In this study (right), teacher can interact with the screen and execute MWBA from any part of a classroom by utilizing the LaDIS system.

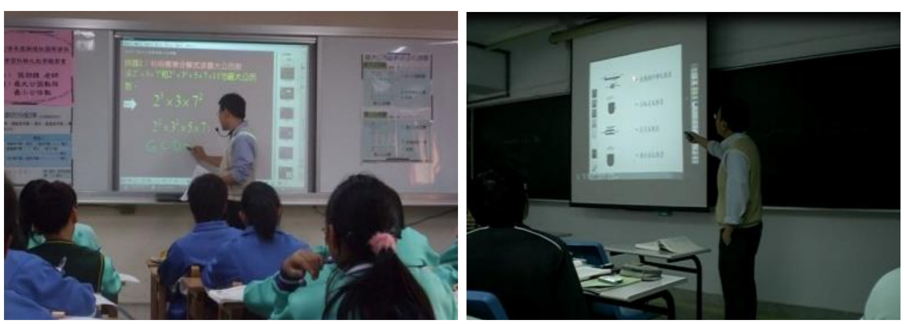

Figure 9(a). In general (left), In this study (right)

LaDIS is a multi-function system. Every student may interact with display in the classroom from their seat to answer questions and remain interactive alongside each-other, without a breakdown in engagement for any student via its touch-less function; but LaDIS may also perform utilizing a touch sensitivity function as if the user were operating an IWB. This study provides teachers with alternative function options. A teacher can select different function modes depending on their teaching needs as shown in Figure 9(b). From their seat, every student may interact with the display in the classroom, allowing them to answer questions and remain interactive alongside each-other. By utilizing LaDIS' touch-less function (left picture) this interaction occurs without a breakdown in engagement. Users may also operate LaDIS' touch sensitivity function as an IWB (right picture).

Figure 9(b). LaDIS' touch-less function (left picture) and touch sensitivity function as an IWB (right picture).

Multimedia teaching method needs

The proposed work wisely offers a viable solution to challenges faced by IWB_S. The user can operate via far distance control didactics. IWB_S provides an interactive, precise and multimedia teaching method in front of the screen. For a conventional IWB_S, the user has limited functions in presentation work by using an infrared detector and infra LED, like Wiimote. This proposed study provides a full solution for presentation needs, such as an air mouse, air presenter and air writing function as shown in Figure 10. Due to the property of far distance control, the proposed study can operate in a large classroom as well as on a large screen for more attractive didactics. Thus, we can say that it is a distance free (touch-less) detector. The trajectories of mouse movement, such as the trajectory path, icon pattern, and writing symbol, are all made possible via LaDIS, allowing for diverse computer commands and superior interaction with multimedia, multi-functional and touch-less behavior. This study also proposes a practical application on general multimedia didactics methods.

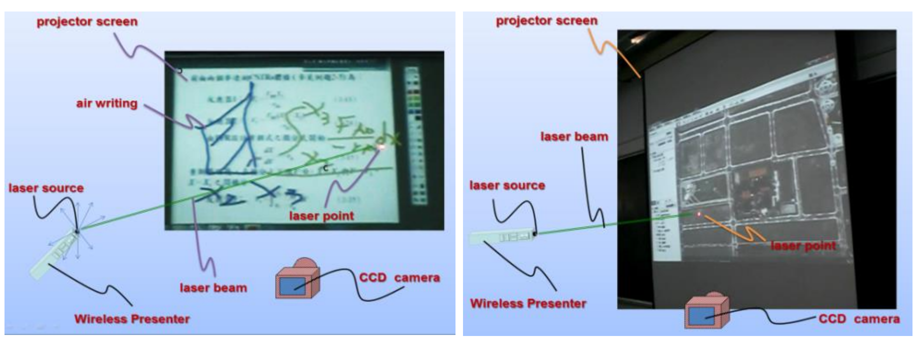

Figure 10. The proposed design performs air writing (left), air mouse and air presenter functions (right).

Drawbacks in LaDIS

Laser safety is the use and implementation of lasers to minimize the risk of laser accidents, especially those involving eye injuries. Since even relatively small amounts of laser light can lead to permanent eye injuries, the sale and usage of lasers are typically subject to government regulations. A Class-2 laser is safe because the blink reflex of the human eye will limit the exposure to no more than 0.25 seconds. It only applies to visible-light lasers (400–700 nm). Class-2 lasers are limited to 1 mW continuous wave, or more if the emission time is less than 0.25 seconds or if the light is not spatially coherent. Intentional suppression of the blink reflex could lead to an eye injury. Many laser pointers and measuring instruments are class 2. For class 2 laser pointers, the blink reflex of the human eye (aversion response) will prevent eye damage, unless the person deliberately stares into the beam for an extended period. Output power may be up to 1 mW. This class includes only lasers that emit visible light. Most laser pointers are in this category. In this study, our LaDIS is designed as Class-2 laser and its output power is only 1 mW. General speaking, LaDIS is a safe device for teachers and students. However, laser beams still have potential risks if teacher or student deliberately stares into the beam for an extended period of time. Mainster et al. (2003) provides one case, an 11-year-old child who temporarily damaged her eyesight by holding an approximately 5 mW red laser pointer close to the eye and staring into the beam for 10 seconds, she experienced scotoma (a blind spot) but fully recovered after 3 months. Luttrull & Hallisey (1999) describe a similar case, a 34-year-old male who stared into the beam of a class-3, 5 mW red laser for 30 to 60 seconds, causing temporary central scotoma and visual field loss; his eyesight fully recovered within 2 days. Therefore, teacher must remind students not to stare at, or direct laser beams, at themselves or other students, as these are inherent risks and drawbacks in the LaDIS design.

Attentive student, enriched learning

Impact of LaDIS on students' cognitive learning outcomes

Background

The samples of this study include 92 first-grade students enrolled in a 5-Year Junior College; these individuals were from two classes at a college of Taoyuan County, in Taiwan. The college, in this study, has experienced tight budgeting problems for a number of years and has no capability to afford IWB_S in any classroom. Its financial situation is, likewise, similar to many schools in developing or rural regions worldwide. However, most teachers in this College have the ability, education and need to adopt IWBs didactics into their classes to improve student learning motivation, increase efficiency of teaching as well as outcomes of learning.

Participants

In this study, each class consists of 46 students, and they are assigned by normal college assignment procedures. Classes are twelve hours in length, for a total of six weeks in the experimental course with different didactics. The instructor for each group is addressed the same content and only didactics differences are: "with or without" the innovation of LaDIS in the class. One class is the control group, and it adopts ordinary didactics. The other one is an experimental group, which adopts the innovation LaDIS didactics in class. The instructor in the control group is the same as in the experimental group. It should be noted that only tradition mouse didactics are used in the control group. "Cooperative Learning" and "Enquiry Learning" activities are arranged in every class.

Data collection

Before the course, both classes took part in a pre-test of living science course achievement. After completing the course, the two groups took a post-test of living science course achievement and Student Satisfaction Index (SSI) to explore the students' learning attitudes towards the innovation LaDIS on didactics application.

Statistical analysis

As shown in Figure 11, the mean level of two classes students' prior domain knowledge was low (M = 42.9, SD = 9.8) & (M = 42.7, SD = 8.5). After receiving the ordinary and the innovation LaDIS, two kinds of different didactics, almost all experimental group students make remarkable progress on their post-test score in the class (M = 81.8, SD = 12.2). The post-test score for the control group (M = 72, SD = 14) was modest compared to the gains of the experimental group (independent-samples t-test analysis on control and experimental group students' pre-test (t = -.08, p > 0.5), post-test (t = 3.567, p < .001) scores). The results of the univariate ANCOVA analysis (covariance on the post-test scores, with students' pre-test scores as the covariate) reveal that students taught using the innovation LaDIS didactics scored significantly higher than did students within the control group.

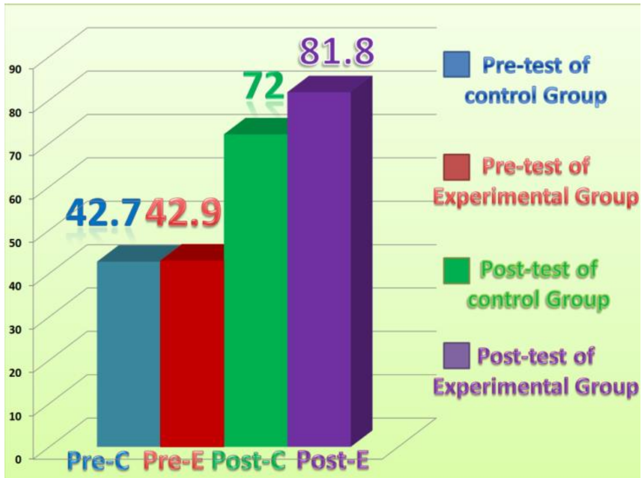

Figure 11. Experimental and control group student' mean score on pre-, post tests

Main findings

According to Bloom, cognitive objectives are concerned with intellectual outcomes. The classification system ranges from lower-level knowledge outcomes to higher-level intellectual abilities and skills. In this study, we focus on understanding, including comprehension, understanding relationships, meaningful learning, remember paraphrased, defined concept and concrete concept. As shown in the Table 2, F(1, 90) = 82.15, $\eta^2 = 0.480$, $f = 0.96$ (very large effect size) (Cohen, 1988), this result shows the positive impacts on their achievement in living science course. The results demonstrate that "Cooperative Learning" and "Enquiry Learning" benefit from the adoption of the LaDIS interactive system. It is shown that, there is better interaction between student and student & student and teacher in the classroom due to the use of this form of interactive system, as shown in Figure 12. The aim of this study is to show how LaDIS works in a classroom, as well as to demonstrate how its performance positively impacts student's achievement in a course. We have no intention of comparing LaDIS and IWBs, in terms of which one is better. The positive effects of IWBs application in education, is not in question. However, the cost of an IWB is 100 times that of LaDIS. The intention of this study is to provide another choice, in regard to IWBs, and solution for schools with economic concerns, especially those in rural and developing regions.

Table 2. Univariate ANCOVA analysis of covariance for student achievement

Univariate ANCOVA							
Dependent	Hypoth.	Error	Hypoth.	Error	F	Sig.of F	f
variables	SS	SS	MS	MS	(1, 90)		
achievement	2261.49	2450.07	2261.49	27.52	82.15***	0.000	0.96

Student 's SSI

As shown in Figure 12, Evaluation results for the Student Satisfaction Index (SSI) are separated into four dimensions, including: Satisfaction: meaning, whether (or not) students are satisfied with LaDIS in class; Willingness to use: indicating whether (or not) students are willingness to use LaDIS in class; Interaction: meaning, whether (or not) LaDIS increases the interactivity in class; and Learning, indicating, whether (or not) LaDIS improves learning in class. Between each two dimensions are also included two sub-items: (1) between satisfaction and learning is "motive and effect": indicating whether (or not) LaDIS increases the motive of a student and/or effect on a student; (2) between satisfaction and willingness to use is "better than traditional and usability": meaning, whether (or not) LaDIS better than a traditional device and LaDIS' usability; (3) between willingness to use and interaction is "perceptive and participation": meaning whether (or not) LaDIS increases the perceptive and participation of student; 4) between learning and interaction is "interaction with teacher and interaction with classmates": indicating whether (or not) LaDIS increases the interaction with teachers and classmates. The results show each dimension as follows: satisfaction (90%), willingness to use (93%), interaction (95%), learning and sub-items such as motive (91%), effect

(90%), interaction with teacher (96%), interaction with classmates (93%), perceptive (93%), participation (93%), usability (91%), better than traditional devices (94%). All the above results obtain over 90% ratings on the satisfaction index. These findings demonstrate a large improvement between student's learning and interaction in the classroom due to the use of the LaDIS interactive system. Most students are highly satisfied with, the system and willing to use the Laser-Driven Interactive System (LaDIS) because of its naturally superior interactive performance, in classes.

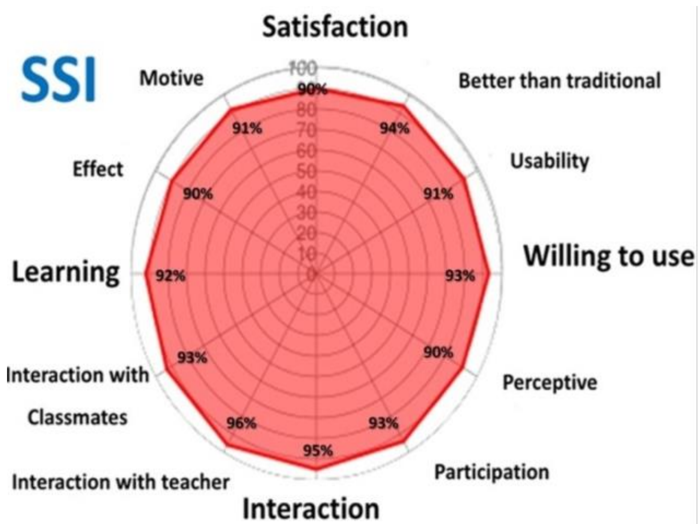

Figure 12. Evaluation results for the Student and Teacher Satisfaction Index (SSI)
(URL :http://www.mysurvey.tw/hm4zYGES)

Results and discussion

Reports show that interactive teaching, supported by the use of IWBs, can lead to positive learning outcomes (Mercer et al., 2010). When the IWBs is set up as a technology hub, it has been proposed (Miller & Glover, 2010) that it can act as a trigger for pedagogic change (Miller & Glover, 2010). However, the main shortcoming of IWB_S is its costs. The other disadvantages of IWB_S include:

- When two or more students are interacting with an IWB_S; the class becomes very un-interactive as the other students cannot see the board.
- The teacher's eyes may be strained by standing close to a high luminance projector light or screen.
- Students usually walk out the front of the class, one at a time, selecting their answer then handing the pen to the next student who then walks out to the front to answer their question.
- If the screen is placed too high (or is too large), then teachers may have difficulty reaching the top.
- The teacher is physically limited to staying in front of the white-broad while using it.

The effect of the proposed interactive system that incorporates LaDIS into a course may be summarized as the follows: (1) With a projector, laser emitter, screen, PC and web cam, it is easy to show a viable, efficient interactive system in any classroom. (2) The proposed LaDIS system provides an economic educational system for developing and rural regions. (3) Most students are highly satisfied with, the system and willing to use the Laser-Driven Interactive System (LaDIS) because of its naturally superior interactive performance in classes. (4) This study demonstrates how LaDIS excellent performance, positively impacts students' achievement.

LaDIS provides a new and innovative, economically effective, interactive software and presentation technique for general multimedia didactics. The proposed design utilizes a laser point which comes from a common laser pointer to emit a red spot onto a screen. It cooperates with a web cam (optic camera) and a laser point image tracing software. After some imaging and software program operations, the movement of laser point images can be transformed into a command signal to control the mouse's cursor on the screen. In association with multimedia presentation software, the proposed design can efficiently present a superior performance with said multimedia, being multi-functional and touch-less in nature, via controlling the mouse's locus.

The results indicate positive impacts of the innovation LaDIS on students' learning performances. Most students are highly satisfied with, the system and willing to use LaDIS because of its superior interactive nature, compared to the traditional classroom. Preliminary results suggest that the innovation of LaDIS is promising in facilitating students' cognitive learning outcomes in didactics applications. The results demonstrate that "Cooperative Learning" and "Enquiry Learning" are fit to adopt the innovation of the LaDIS interactive system. Simply put, LaDIS improves interaction between student and student & student and teacher in the classroom. The main pedagogical advantages of LaDIS appear to be:

- Write-ability: allowing drawing, annotating and writing on a screen.
- Point-ability: allowing learners and teachers to point, physically, to interesting features on the board, rather than using a mouse pointer which can be hard to see and manipulate.
- Size: in promoting group working allowing learners and teachers to work collaboratively with software around a large, shared work area.
- Talk-ability: allowing learners and teachers to talk more directly to the audience from the front, freeing them from the PC, the keyboard and the mouse.
- Familiarity: encouraging both learners and teachers to engage with technology more comfortably through a more familiar interface.

Why LaDIS is particularly suitable for developing and rural learning settings:

- Infrastructure: 1. The key parts of a LaDIS device cost about $30USD. (The main parts of this device include a wireless presenter and a laser diode). 2. The price of a webcam ranges from $10 to $20 USD. However, a webcam is already a standard device in most laptops, so if the classroom has a laptop, then this cost can be discounted. 3. Even in developing and rural areas, a computer or Easy Personal Computer (EPC, low-cost laptop) usually part of the standard equipment available in classrooms in most countries. 4. In a standard classroom, a projector usually hangs from the ceiling of classroom. In the other words, based on the basic infrastructures existing in most schools and classrooms, such as an Easy Personal Computer and a projector, it is easy to establish an interactive classroom via LaDIS; this is the main reason why LaDIS is particularly suitable for developing and rural learning settings.

- Student needs: Student can point out, mark, maps and zoom, in or out, and operate/interactive teaching material/software by themselves, in a classroom, from their seats. Therefore, student can engage intuitive thinking and feedback learning by discussion with teacher and classmate during class. Student also can feel free to participate in any learning activity in class through the LaDIS system. Through an activity, student can complete guided discovery learning by using a LaDIS system. Without a low-cost LaDIS system, most developing country and rural area would have no chances to bring about IWBs type interactive learning into their class.

- Teacher's learning style: Most teachers today are trained to be adept in utilizing computers. They are, likewise, trained to create various teaching materials by using computers. With information technology aids, teacher can increase student's learning motivation and attract students' attention (Masalela 2001). Combining computers and interactive teaching aids is a popular teaching and learning style for teachers (Abowd, 2000). However, a lot of developing country and rural area don't have adequate budgets to support this brand-new teaching and learning style in their classes. The low-cost of the LaDIS system can be the solution, to the problem of the high costs of IWBs, in any developing country or rural area.

The aim of this study is to show how LaDIS may function in classrooms as an economical solution to IWBs. IWBs costs ($5000-$1500) almost 100 times more than LaDIS ($50-$25). Based on this study, we have the intention of providing an economical solution for schools with financial limitations, as those found in rural and developing regions. As a teacher said in our study," If I can do the same thing with a tablet that costs $50 rather than the hefty $1500 to $5000 price tag that some IWBs cost, then that is the direction I think I would want my classroom and school to head".

There is still more research that needs to be done. Comprehensive studies to uncover potential problems in LaDIS are being undertaken. Further studies must be conducted to explore what subjects and teaching & learning mode are suitable to adopt the innovation of the LaDIS interactive system. As we know, LaDIS is a brand-new system, for use in any IWBs and interactive teaching software. In fact, schools barely need to invest any extra funding to acquire a LaDIS. LaDIS is well suited for rural and developing regions due to its low cost. As we look to the future, we are starting by providing LaDIS to schools, in underdeveloped areas, which can easily add this innovation, with a projector, screen and PC equipment, already found in most classrooms.

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