Effectiveness of Using SmartLITE as a Teaching Tool

Lemuel Ian C. Caparaz, Alan Charles R. Llorca, Luis Alfonso L. Mance, and Ellenita R. Red

***Abstract*—Many instructors in academic institutions rely on traditional media, like the mouse and keyboard, for controlling their multimedia presentations. This restricts the freedom of movement of the instructor during presentations thus affecting classroom management. This is also the case in Malayan Colleges Laguna. In this study, the researchers have developed SmartLITE, a tool that is able give the instructor control over the mouse using a *camera-tracked* laser while also giving freedom of movement during laboratory demonstrations. Using several Image Processing techniques, specifically in computer vision, the tool can track the laser and move the mouse cursor with it, as well as actuate mouse functionalities such as left, right, double click, and dragging. Put simply, it makes the traditional projection screen into an interactive laser-controlled interface. The researchers evaluated the effectiveness of SmartLITE as perceived by instructors and students in an IT laboratory setup. The two groups of respondents namely: the instructor-respondents and the student-respondents had different surveys to easily assess the data. To measure the tool effectively the researchers have identified a set of criteria to rate the tool, namely: *Freedom of Movement*, *Student Engagement*, and *Communication*. The questionnaires utilized Likert-scale type questions to determine the respondents' level of satisfaction or dissatisfaction toward each criterion. Results of the survey was tallied and summarized by computing for the weighted mean average of each item. To determine the score of each criterion, the arithmetic mean of the scores of each item in a particular criterion was computed. The scores are then interpreted and SmartLITE was found to have above average scores on all criteria. From the results of the survey, it can be said that SmartLITE is not only a viable teaching tool but also effective as perceived by instructors and students.**

***Index Terms*—Classroom management, computer vision, instructional system technology, teaching tool.**

I. Introduction

In this day and age, there are various innovations in instructional media like Smart Boards, wireless networked tablets, interactive wall systems, interactive projectors, and wireless clickers and mice [1]. But for most institutions, these systems and devices are costly, if not overpriced [2]. Fortunately, there are various ways of developing scaled-down versions of these commercial instructional media. In this study, the researchers developed SmartLITE (Smart Laser-controlled Interaction for Teaching and Education) as an alternative to commercial wireless presentation control devices (i.e. wireless clickers, wireless mice, and interactive projector screens).

But the real goal of this study is not only to provide an alternative means of controlling laboratory presentations/demonstrations, but also to determine if it is an effective alternative. This research titled "Effectiveness of Using SmartLITE as a Teaching Tool" answers the question: Is SmartLITE a suitable teaching tool for laboratory demonstrations in Malayan Colleges Laguna as perceived by students and instructors? The researchers conducted a quantitative descriptive research to properly determine the effectiveness of the tool. Specifically, the researchers employed survey research to easily collect and interpret data.

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The authors are with Computer Science in Malayan Colleges Laguna, Philippines (e-mail: lem_ian@yahoo.com, alanllorca@yahoo.com, mance.luis@gmail.com, erred@mcl.edu.ph)

A. Overview of the Current State of Technology

During laboratory demonstrations, instructors are dependent on the mouse and keyboard to control their laboratory demonstrations/presentations. Because of this they are tethered to the terminal while discussion or demonstration is ongoing. Fig. 1 depicts the current setup of *IT Laboratories* in Malayan Colleges Laguna.

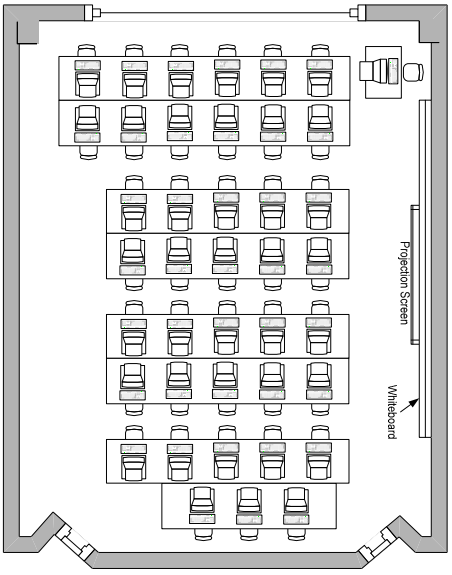

Fig. 1. IT Laboratory Setup

B. The Concern

The instructor's terminal is located in the upper right corner of Fig. 1. In this setup, an instructor does not have a balanced presence in the room while performing a demonstration. The instructors' verbal instructions are also disproportionate inside the laboratory which makes it relatively harder to communicate to students that are farther away from the instructor. In addition, an initial survey conducted by the researchers showed that *all* instructors of the College of Information Technology experienced disruptions caused by students, and observed student inattentiveness during classes.

C. The Resolution

According to several experts [3]-[4], these are the most

common ways of preventing misbehavior in a learning environment: 1) Scan the classroom – see if any students are having difficulties and support them in resuming working quickly. 2) Circulate – go around the room and ask students about their progress. This uncovers problems which otherwise would not be obvious. Also, making your presence known in the room will help students maintain focus. 3) Use Proximity – moving towards students who are talking indicates awareness of th*eir conduct. Standing by pupils keeps them on-task.*

In light of this, the researchers developed SmartLITE. SmartLITE is an alternative presentation tool that controls the mouse cursor while giving an instructor freedom of movement during laboratory demonstrations. Using image processing techniques (i.e. image warping, luminance detection, image resizing, etc.) SmartLITE can track the laser in most viewable angles - even if the camera is not facing the projection screen directly, it can adjust to different environmental luminance (see Fig. 2), and can adjust tracking accuracy to cope with the hardware components of the terminal being used. SmartLITE utilizes a camera-tracked laser to move the mouse cursor and actuate its functionalities as seen in Fig. 3.

D. Mechanics of SmartLITE

SmartLITE allows instructors to use a laser as an alternative to the mouse. In a nutshell, a webcam monitors the projection screen while the presentation is ongoing and sends a video feed back to the instructor's terminal. Utilizing several Image Processing techniques, specifically in computer vision, SmartLITE is able to track the laser and move the mouse cursor with it. SmartLITE tracks the laser's position in the projection screen and maps it to the computer screen; basically it moves the mouse cursor to the location of the laser point. It can also actuate the basic mouse functionalities namely: dragging, left, right, and double click.

II. Related Works

Several related literatures and studies that helped in the development of SmartLITE are as follows: first SmartLITE needed to track the brightest pixel in the video feed being captured by the webcam. The researchers based the brightness calculation on the ITU-R BT.601 standard brightness model [5], which is:

$$Y' = 0.299r + 0.587g + 0.114b$$

where *r*, *g*, and *b* are stimulus sRGB coordinates. The ITU-R BT.601 standard assigns a brightness value to each pixel in every frame captured by the webcam. To define which pixel is the brightest, the researchers implemented a brightness threshold with values ranging from 0 to 255, with 255 being the highest value. SmartLITE tracks any pixel with a brightness-value higher than the threshold's.

Another problem the researchers faced was that the camera could not always face the projection screen directly, which was the optimal position for the camera. This causes a problem in the tracking and mapping of the laser since the projection area captured in each frame is not a regular rectangle. The researchers tackled this problem by implementing a Quadrilateral Transformation algorithm [6], where a quadrilateral selected by the user of SmartLITE is cropped and transformed into a regular rectangular image. This is done by calibrating the captured feed of the camera by selecting four points that will be the corners of the desired cropped video feed. Below is a sample screen shot of SmartLITE's screen calibration.

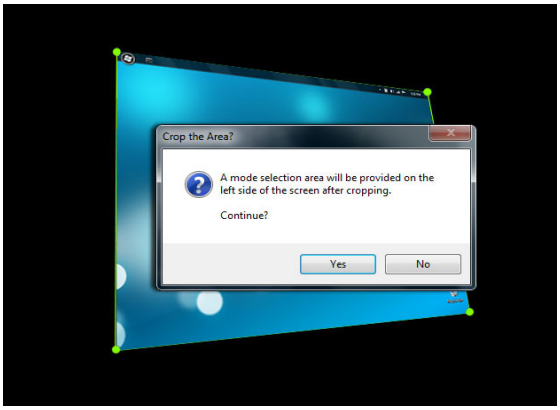

Fig. 2. Camera's view before screen calibration

The resulting video feed is then cropped according to the dimensions set by the four points. After quadrilateral transformation, the resulting screen is seen in Fig. 3.

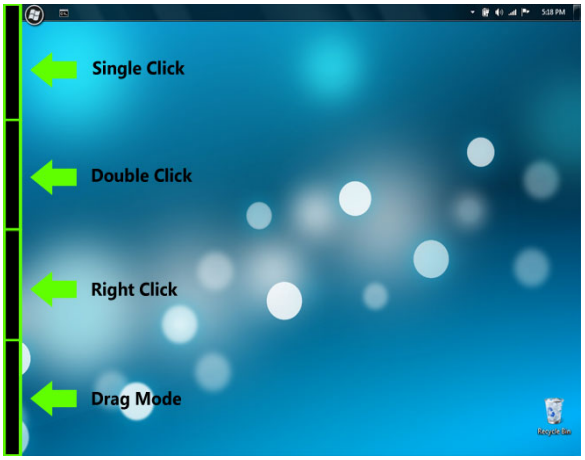

Fig. 3. Screen after quadrilateral Transformation

III. Methodology

To determine the effectiveness of SmartLITE, the researchers have determined a set of criteria that SmartLITE needs to answer, namely: *Freedom of Movement of Instructors*, *Enhance Student Engagement*, and *Improve Student-Instructor Communication*. These criteria were based from the findings of Cao, X., Ofek E., and Vronay D. in their study [7]. These criteria define the overall effectiveness of SmartLITE as perceived by instructors and students. Also, each criterion was comprised of a set of statements that was evaluated by the respondents based on how they perceived SmartLITE. These criteria were integrated in the questionnaires for the respective respondents of the study.

There are two groups of respondents to this study – the instructors and their students. According to Louis Gay, there are different acceptable sample sizes for different types of research. For Descriptive Research, a minimum of 20% may be required [8].

There were a total of 12 instructors in the College of Information Technology, so a total of 3 instructors were randomly selected as instructor-respondents of the study. The student-respondents were comprised of students from randomly selected laboratory classes of the instructor-respondents. The researchers randomly chose a laboratory class having more than 30 students for each instructor.

Separate questionnaires were used for instructors and students. Both questionnaires gathered information about the demographics and the effectiveness of SmartLITE.

The Freedom of Movement criteria, which can only be sensibly answered by the instructors, was not made available to the students' questionnaires. The instructors had an additional survey about the usability of SmartLITE. There were 4 criteria for the usability survey of SmartLITE; namely: *Physical/Safety concerns*, *Usability Concerns*, *Pleasing and Enjoyable Attributes*, and *Usefulness Attributes*.

Both the survey for the effectiveness of SmartLITE and its usability used 5-point Likert scales to measure the level of agreement of the respondents for every Likert item for each criterion. The respondents would evaluate each criterion by rating a set of statements that is associated to that particular criterion. Put simply, each respondent gave each statement a score of 1 to 5. Later on, the weighted mean for each statement was computed. To finally compute for the final score of each criterion, the weighted mean of each statement under a particular criterion was used to get the arithmetic mean of said criterion.

IV. Interpretation of Results

Using questionnaires, the researchers collected data from selected instructors from the College of Information Technology and their students. Implementation of the study was conducted in a span of one week, this meant that SmartLITE was used only once by each instructor. Each instructor used SmartLITE in one of their laboratory classes which had a minimum of 30 students. In addition, instructors were not trained prior to the actual implementation of SmartLITE. In total, the respondents comprised of 3 instructors and 92 students.

A. Data Collected

Data collected from the respondents were divided into two general groups; 1) the instructors; and 2) the students. Demographic profiles of both groups were taken and summarized. The demographic profiles of instructors are shown in Table I and II while Table IV and V show the demographic profile of students.

1) Instructors

TABLE I: Age Range Of Instructors

Age	Frequency	Percentage
21-25	1	33.33%
31-35	1	33.33%
41-45	1	33.34%
Total	3	100%

TABLE II: Gender Tally of Instructors

Gender	Frequency	Percentage
Male	3	100%
Female	0	0%
Total	3	100%

TABLE III: Comfortable With Laser Pointer?

Comfortable?	Frequency	Percentage
Yes	3	100%
No	0	0%
Total	3	100%

2) Students

TABLE IV: Age Range of Students

Age	Frequency	Percentage
16-20	89	96.74%
21-25	3	3.26%
Total	92	100%

TABLE V: Gender Tally of Students

Gender	Frequency	Percentage
Male	60	65.22%
Female	32	34.78%
Total	92	100%

According to the data, the instructors are all male and the male population dominated the student-respondents' group. Almost 2/3 of the students' population is male. With regards to age, 16-20 year old students dominate the student-respondents population. Also, instructors were asked if they were comfortable using a laser pointer for presentations/demonstrations. It is important to know if the instructors are comfortable with the presentation medium (laser pointer) because it may affect the results of the implementation. In our case, as shown in Table III, all three instructors answered 'yes'.

Results for the effectiveness of SmartLITE were also divided into two groups: effectiveness of SmartLITE in the instructors' perspective and in the students' perspective. Although the instructors are the users of the tool, the perspective of the students is important because they would affirm if SmartLITE have improved the demonstrations in the IT Laboratories.

B. Results of Testing

After tallying the results of the survey on SmartLITE's effectiveness and usability, the researchers computed for the weighted mean of each item (statement) in every criterion. The weights assigned for the scale are as follows: Strongly Disagree – 1, Disagree – 2, Neither – 3, Agree – 4, Strongly Agree – 5. Computation of each item is as follows:

$$S = \frac{\left[\left(1\times n_1\right)+\left(2\times n_2\right)+\left(3\times n_3\right)+\left(4\times n_4\right)+\left(5\times n_5\right)\right]}{n_{total}}$$

The variable n_i being observed here is the total number of respondents answering for that particular option. With n_1 for the Strongly Disagree option, n_2 for the Disagree option, and so on. The variable n_{total} is the total number of respondents per respondent-group, meaning 3 for the instructor-respondents and 92 for the student-respondents.

Next, the researchers solved for the final score of each criterion by computing for the arithmetic mean of all the scores (weighted means) of the items (statements) in those criterion.

A table of interpretation was constructed, via computing for the weighted mean, to easily show the results of the study.

TABLE VI: LIKERT SCALE INTERPRETATION

Range	Interpretation
4.20 – 5.00	Excellent
3.40 – 4.19	Very Satisfactory
2.60 – 3.39	Satisfactory
1.80 – 2.59	Fair
1.00 – 1.79	Poor

Using Table VI, the researchers interpreted each criterion in the Usability Survey and the survey on the Effectiveness of SmartLITE as perceived by students and instructors. To compute for the score of a particular criterion, the researchers used the result of each item in that particular criterion to compute for the arithmetic mean. The result of which will be the score for that particular criterion. The data found in the computation column is the weighted mean of all items in that particular criterion. Computation for the score of criteria is shown in Table VII.

TABLE VII: SUMMARY OF RESULTS FOR USABILITY SURVEY

Criteria	Computation	Result	Interpretation
Physical Concerns	(4 + 3.33 + 3.33)/3	3.55	Very Satisfactory
Usability Concerns	(4.33 + 4 + 3.67 + 4)/4	4.00	Very Satisfactory
Pleasing Attributes	(2 + 4.33 + 4)/3	3.44	Very Satisfactory
Usefulness Attributes	(4.33 + 4.33)/2	4.33	Excellent

First - for the usability survey, instructors found SmartLITE very effective to use as a teaching tool and this was shown in the last criterion of the survey. The lowest rating of 3.44 in the Pleasing Attributes criteria still yields Very Satisfactory but still it can be considered that SmartLITE has proven itself as an effective teaching tool.

TABLE VIII: SUMMARY OF RESULTS FOR THE EFFECTIVENESS OF SMARTLITE AS PERCEIVED BY INSTRUCTORS

Criteria	Computation	Result	Interpretation
Freedom of Movement	(5 + 4 + 4)/3	4.33	Excellent
Student Engagement	(4.67 + 4.33 + 4)/3	4.33	Excellent
Communication	(4.67 + 4.67 + 4)/3	4.45	Excellent

Next is the summary of results of the effectiveness of SmartLITE (see Table VIII) as perceived by instructors, in response to the objectives of the study which involves rating SmartLITE according to the following criteria: Freedom of Movement, Student Engagement, and Communication. Clearly, the instructors considered SmartLITE effective in all criteria involved in answering the objectives of the study.

TABLE IX: SUMMARY OF RESULTS FOR THE EFFECTIVENESS OF SMARTLITE AS PERCEIVED BY STUDENTS

Criteria	Computation	Result	Interpretation
Student Engagement	(3.80 + 3.30 + 3.69)/3	3.60	Very Satisfactory
Communication	(3.78 + 3.63 + 3.95)/3	3.79	Very Satisfactory

Lastly, the summary of results of the effectiveness of SmartLITE as perceived by students was taken into account. As for the students, it is clearly shown in Table IX that SmartLITE yielded positive, although lower results as compared to the instructors' results. This may be attributed to the small amount of exposure to SmartLITE during implementation. Rating SmartLITE based on their first-time experience with it may have made the students perceive SmartLITE poorly.

C. Interpretation of Results

Results for the effectiveness of SmartLITE were also divided into two groups: effectiveness of SmartLITE in the instructors' perspective and in the students' perspective. Although the instructors are the users of the tool, the perspective of the students is important because they would affirm if SmartLITE have improved the laboratory demonstrations. All criteria for the effectiveness of SmartLITE were rated by both students and instructors except for 'Freedom of Movement', which can only be sensibly answered by the instructors who used the tool during the implementation. According to the data collected, the students score on the effectiveness of SmartLITE in terms of 'Student Engagement' and 'Communication' is notably lower than the score of the instructors. This can be attributed to the little amount of training the instructors had with using SmartLITE. Since the instructors had little time to get used to SmartLITE, it may have affected their performance during the implementation of the study, thus giving a detrimental influence on how the students perceived SmartLITE - it removes both the mere-exposure and contrast effects out of the study, which is detrimental to the results of the study.

Put simply, the mere-exposure effect or familiarity principle states that: *people that are more exposed to a certain stimulus develop a certain preference toward that stimulus as compared to other unfamiliar stimuli* [9]. This could affect the results of the study because the respondents evaluated SmartLITE based only on their first-time experience with it. While the contrast effect states that a person can more effectively evaluate or assess a certain phenomenon if he/she has more experience with it. The formal definition of the contrast effect is as follows: an immediate negative experience will lead the person to view a phenomenon as bad and an immediate positive experience will lead the person to view a phenomenon as good. Successive exposure to a phenomenon for a period of time will absolutely result in the person having a better judgment of the said phenomenon [10]. Considering this, the respondents of the study could have more effectively evaluated SmartLITE if they were more exposed during the implementation phase of the study, especially if the instructors were formally trained to use SmartLITE prior to the implementation of the study.

V. Conclusion

The results of the study show that SmartLITE can be used as a teaching tool in the laboratory setup. It also means that SmartLITE is an effective teaching tool as it gained a standing of Excellent in all criterions for the instructors and a standing of Very Satisfactory in all criterions for the students. It can therefore be concluded that SmartLITE is not only a viable teaching tool for the current laboratory setup but also effective for it can improve classroom management by allowing instructors to circulate the laboratory while performing their presentations.

Although SmartLITE was initially intended to be used in an IT laboratory, the researchers have made SmartLITE's role flexible - applying it in auditoriums to accommodate for a larger crowd demonstration. Although, the application of SmartLITE is mainly to interact with a large display medium from a distance, it is not limited to just being a tool to help with demonstrations. The researchers are looking into how SmartLITE could be incorporated into the field of video games.

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Lemuel Ian C. Caparaz is a BSCS graduating student from Malayan Colleges Laguna, Philippines. He loves computer applications, video games, photo/video/audio editing software, operating systems, antivirus systems, and cracking tools have drawn his attention to software development at the age of 15. His skills in programming include C#, C++, Java, SQL, PHP, Android and HTML.

He is a member of Information Technology Society and Junior Philippine Computer Society – MCL Chapter.

Alan Charles R. Llorca is a BSCS graduating student from Malayan Colleges Laguna, Philippines. Adhering to the philosophy of randomness and discordianism eventually led this gent to pursue a degree in Computer Science. During this undertaking, he adapted to the life and routine of a programmer. In which he fell in love with the concept of a programmers' routine-life. He finds that although it is always fulfilling to finish a project, the art involved and the experiences he shared with his colleagues during the development of the software is much more valuable.

He has also gained a solid understanding of genetic algorithms during his final year in college. He is an officer of Junior Philippine Computer Society – MCL Chapter. This became a conduit of many new experiences that made him adapt characteristics of a community leader.

Luis Alfonso L. Mance is a BSCS graduating student from Malayan Colleges Laguna, Philippines. His skills in programming include C#, C++, Java, SQL, PHP, and HTML.

He is a member and officer of various student organizations like: Information Technology Society (Education Committee Head), Junior Philippine Computer Society – MCL Chapter (Public Relations Officer), Malayan Colleges Laguna Spinners (President), and Community Leaders Circle (President). In these organizations, he learned many different skills and adapted traits such as leadership, team cooperation, and time management.

Ellenita R. Red is an assistant professor of the College of Information Technology at Malayan Colleges Laguna, Philippines. Other tasks assigned to her are Course Syllabi Chair, eLearning Facilitator, and Thesis Coordinator.

She finished Bachelor of Science in Computer Engineering, Master in College Teaching and Master in Information Technology. She is currently pursuing PhD in Information Technology Management. She is a member of International Association of Computer Science and Information Technology (IACSIT), International Innovative Scientific & Research Organization (IISRO) and Philippine Society of Information Technology Educators (PSITE).