

Interactive Multimedia for Laboratory Session of Bright-Field Microscopy Technique

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Abstract—E-learning should be pedagogically-driven rather than technologically-driven. Technology that is applied in conjunction with pedagogical concepts can create an effective student-centered environment and enhance learning outcomes. The objective of this study is to develop an interactive multimedia in order to achieve the intended learning outcomes and to enhance self-regulated learning. An interactive multimedia on bright-field microscopy technique was developed in the CD-ROM which included various elements; text, images, animations, video, and audio. We conducted an experiment with thirty first-year biomedicine students in Universiti Sains Malaysia attended a 3-hour fixed laboratory session for conventional teaching and learning for bright-field microscopy technique. At the end of the session, all students were given the first set of questionnaires. After the conventional lab session, the same students were provided with multimedia teaching and learning materials and then were given the second set of questionnaires. These two set of questionnaires are used to measure their acceptance and satisfaction level on both approaches. Based on the results, it is anticipated that the interactive multimedia in bright-field microscopy technique would be suitable as a learning aid for the laboratory or practical session.

Keywords— e-learning, educational technology, interactive multimedia, teaching and learning, bright-field microscopy technique, computer-based, experiment and questionnaire.

I. INTRODUCTION

Conventional teaching and learning involve instructions, face-to-face traditional classrooms, together with lecture notes and text books for delivery of information to learners who have to attend classes based on a fixed schedule. The learner depends on text books or reference books containing information on certain subjects. There is a lecturer or instructor present in the classroom, and their role is to impart knowledge and academic skills necessary for the students [7]. There are various modes of teaching such as lecture, tutorial, group work and laboratory session. A laboratory or practical session is an essential component of undergraduate education in the field of life sciences. The laboratory provides one of the best opportunities for active learning as laboratory classes are designed to teach concepts through experiential learning [1]. In the conventional practical sessions, students have to attend

that session based on a fixed schedule [7] and students were provided with hands-on experiences of real tasks [9]. Students would refer to textbooks or any other reference books containing information on the particular subject.

However, in the conventional practice of teaching and learning, the students have insufficient class hours. Students only have about 3 hours of class per week, consisting of lectures, briefing sessions and performing laboratory experiments. All are time-consuming and yet there is insufficient time allocated for them. Acquisition of laboratory skills requires sufficient time, repetition to comprehend all theories and applications at each level of protocol [11]. Furthermore, the number of students in a class is very large. Such a high number of students in the classroom would generate more noise and, as a result, some activities such as listening are much less effective [2]. There is a lack of interaction between students and lecturer or instructor during practical sessions too due to the large number of students in a classroom [11]. In addition, large classes may cause several problems to the instructors. It is not easy for the instructor to ensure that all students are concentrating on the course materials. Instructors will also have a hard time dealing with students on an individual basis and interact with them, answer their queries, or evaluate their understanding. The chances to give quizzes, assignments, and any extra work to the students will also be reduced. As such, students need to enhance their regulated-self learning together with easy access to different materials or information resources.

Therefore, in our work, technology-assisted learning with the use of interactive multimedia was proposed to instruct students in the practical learning of bright-field microscopy technique. Here, we develop an interactive multimedia as a learning aid for the laboratory session. This interactive multimedia combines five basic elements of media into the learning environment; text, image, sound, animation and video. Our objective is to measure the acceptance and satisfaction level on an interactive tool that can significantly enhance the effectiveness of teaching and learning [12], particularly for laboratory session.

The remainder of this paper is organized as follows: Section II discusses some previous work in computer-based

teaching and learning. Section III introduces the design and implementation of the bright-field interactive multimedia application. Section IV discusses the experiment conducted. Statistical results and discussion are presented in Section V and VI respectively. Finally, Section VII presents some conclusions and suggestions for future work.

II. COMPUTER-BASED TEACHING AND LEARNING

In the 21st century, the application of multimedia in teaching and learning is growing, offering an alternative way to convey information. It has altered the way teachers teach and students learn. With the advancement of technology, learning has become interactive and electronically based such as e-learning. E-learning uses CD-ROMs, internet, Web Portal, E-book, video, audio, and animation to get the materials across to the students [7].

Any form of interface between the user and the medium may be considered interactive. Interactive media is not limited to electronic media or digital media. Interactive multimedia refers to products and services on digital computer-based system which responds to the user's actions by presenting content such as text, graphic, animation, video audio, etc. Many institutions have been using computer-based materials such as e-learning materials, which can be found in the companies, schools, and universities. E-learning initiatives in Malaysia are being undertaken mainly by higher educational institutions [10]. There is a trend to move towards blended learning application, where computer-based activities are collaborated with practical or lecture-based situations.

Interactive multimedia can enhance a student's competency in laboratory techniques and can also solve the problem which has arisen in conventional learning method; the difficulty to standardize techniques across multiple lab sessions. It also promotes successful learning outcomes [8]. Interactive multimedia learning allows students to use resources that are difficult to implement through conventional learning methods, such as simulations, virtual laboratories, tutorials, assignments, quizzes, and other multimedia content [11].

One of the interactive multimedia products which have been developed in teaching and learning is known as a Moodle [14]. This product has revolutionized the learning process in most of university subjects such as Microbiology course, by offering an advanced and user-friendly solution for encouraging the collaborative work of students and lecturers. It comes with a toolbox full of online teaching techniques that facilitate and enhance the proven teaching principles and traditional classroom activities. They stated that through a rich interactive multimedia content, students get better motivated to engage themselves in the learning process. The student can use many images, videos, animation and etc.

As a medium for learning laboratory technique, tutorials based on interactive multimedia programs offer a number of potential advantages by comparison with conventional microscope-based classes. However, given a choice between computer-based tutorials, microscope-based practical classes, or a combination of both, the majority of students prefer the combined learning [6]. Therefore, it is important to carefully

construct and design the content of teaching and learning materials in order to meet the requirement for teaching and learning in higher education.

Most of developed interactive multimedia systems were very useful and can be applied the teaching and learning process but there is a certain lack of teaching and learning component such as the interaction between students and lecturer or instructor. Interaction with the instructor and other students is important in learning. In current interactive multimedia, it has lack of interaction between student and instructor. However, the disadvantages of interactive multimedia have been solved through the use of message boards, chat rooms and emails to enable learners (students) to communicate with others (students and lecturers). The best interactive multimedia should consist of the main components of teaching and learning as illustrated in Figure 1.

Based on [6], the best approach was considered to be using interactive multimedia to provide basic information, followed by conventional practical class. In our work, we measure the acceptance and satisfaction level on both approaches i.e., using conventional teaching and learning and using interactive multimedia as learning aid for the laboratory session of bright-field microscopy technique.

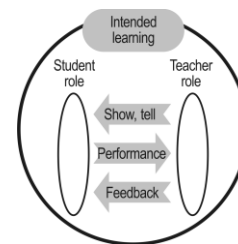


Figure 1. Model of teaching and learning [5].

III. BRIGHT-FIELD INTERACTIVE MULTIMEDIA

Bright-field interactive multimedia application was developed according to specific features and having graphical user interface. Contents were organized around four topics: the introduction, components, principles, and the application and functions of microscopy technique. In the bright-field interactive multimedia application, the students need to login into the system by clicking the 'enter' button. After entering the system, students will view the overall sections in the system and learning outcomes of each section in the module. The system will show the content and students will get the information from the system. After the students have finished the first section, an assessment will take place and then they can view the feedback. After the evaluation, students will view the reward and then can go to the next section of the module.

Text was the main mode of presenting information in bright-field application. Texts on the screens were read slowly by students, and their comprehensions were lower when

compared to reading from a text page. Each screen was incorporated with back and next button. According to this figure, there was a small graphical diagram on the top-right side of each screen which displays each section in the system.

The use of carefully selected colour scheme was effective for attracting attention and motivating learning. It is recommended to use neutral greys or pastel colours for the background since they recede optically, or cool colours such as blue as they create a calm feeling. Dark colour fonts on light backgrounds or vice versa were used as shown in all figures. This colour choice needs to be consistent within the program. Basically white, blue, black and occasionally red colours were used for the text. It was comfortable to the eyes and user-friendly in progressing through the lessons.

The animations and videos were included to teach facts or concepts and demonstrate principles. Animations and videos as graphical images were expected to help students to visualize a dynamic process that was difficult or impossible for them to visualize on their own, and would thus facilitate learning tasks. It could also capture attention and provide dynamic explanations and demonstrations. Animations and videos were incorporated with play, pause, stop, repeat and also the speed of change buttons. Students were expected to perform well when auditory explanations were combined with visual instructions. In order to measure student understanding, the quiz was provided. It was prepared to provide feedback for each question and at the end of the quiz, there will be a display of the results. The quiz consisted of five questions.

IV. EXPERIMENT

A. Participants

All first-year students in Biomedicine Program of the academic session 2011/2012 in the School of Health Sciences, Universiti Sains Malaysia (USM) participated in this study. All students attended a 3-hour fixed laboratory session of bright-field microscopy technique with a conventional teaching and learning method in the first semester, academic session 2011/2012.

B. Sample Size

The required number of participants to be recruited for given effect sizes, alpha levels, and power values is calculated by using G*Power software [4]. The effect size expresses whether the difference observed is a difference that matters. The larger the effect size, the easier it to see there is a difference between the two means being compared. Effect sizes from 1 to 2 are typical for exploratory study. For this study, the effect size was set to 1.5. The value of alpha (α) was 0.05, and the required power was 0.8. The program calculated the expected sample size as $n = 18$. Therefore, the minimum number of subjects needed for this study to detect an effect size of 1.5 with 80% power was 18.

C. Instruments

A 5-point Likert-type scale questionnaire was used as a data collection instrument in order to obtain the feedback of

students toward satisfaction obtained before and after using the interactive multimedia in bright-field microscopic technique. The questionnaires were divided into two parts; part 1 consisted of five point Likert-type scales and closed-ended questions while part 2 contained one open-ended questions requesting students to express their views in full statements or to write comments. In part 1, the Likert-scale scores from 1 to 5 were Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), and Strongly Agree (5). We refer to the set of questionnaires from the Centre for Innovative Education (CINE), Multimedia University, Malaysia and we evaluate the validity and reliability of the questionnaires to suit the study based on the results in [13].

In this study, each student was also provided with the developed interactive multimedia on bright-field microscopic technique in the form of CD-ROM. The activity was carried out in a computer laboratory in School of Health Sciences, USM.

D. Experimental Procedure

All of the students had attended a fixed laboratory session of bright-field microscopy technique for 3 hours using the conventional teaching and learning method. During a class break, the students involved were explained on the nature of the study and the survey that were going to be performed. It was emphasized that student participation was voluntary and their responses would be kept unanimous and confidential. The students were given the instruction of this experiment.

The students were invited to answer each question in the first set of questionnaire form regarding satisfaction level on previous (conventional) method of teaching and learning. After completing the questionnaires, the students were provided a CD-ROM and a guideline on how to play and use the interactive multimedia. They were instructed to start the lesson using the interactive multimedia tool. After they have finished studying the contents of the interactive multimedia, they were invited again to answer another set of similar questionnaires to evaluate on their satisfaction of using the interactive multimedia learning activity.

V. RESULTS

Table I shows the analysis of students' responses on each questionnaire in part 1. The results were expressed in mean and SD based on agreement level to the given statement as well the percentage of students who agreed and strongly agreed with the statements. Table II and Table III illustrate the list of comment and suggestions (unedited) that students had written in Part B of the questionnaire to improve the effectiveness of both teaching and learning methods.

TABLE I. THE ANALYSIS OF QUESTIONNAIRE A AND B

| No | Question | Method (*C/IM) | Agreement Level | | |
|----|------------------------------|-------------------|------------------|---------|----|
| | | | Mean \pm SD | P Value | % |
| 1. | I found the learning session | C | 3.93 \pm 0.740 | 0.133 | 77 |

| | | | | | |
|-----|--|----|--------------|-------|----|
| | interesting and engaging. | IM | 4.20 ± 0.610 | 0.133 | 83 |
| 2. | I found the session useful for learning. | C | 4.17 ± 0.648 | 0.673 | 93 |
| | | IM | 4.23 ± 0.568 | 0.673 | 87 |
| 3. | From the start it was clear what I was going to do in the practical session. | C | 3.57 ± 0.679 | 0.003 | 93 |
| | | IM | 4.07 ± 0.583 | 0.003 | 80 |
| 4. | From the start it was clear what the learning outcomes of the session were. | C | 3.63 ± 0.765 | 0.081 | 60 |
| | | IM | 3.93 ± 0.521 | 0.082 | 77 |
| 5. | I know better about the subject after the session. | C | 3.90 ± 0.662 | 0.362 | 87 |
| | | IM | 4.07 ± 0.740 | 0.362 | 77 |
| 6. | Generally there was just the right amount of information obtained. | C | 3.43 ± 0.728 | 0.059 | 60 |
| | | IM | 3.83 ± 0.874 | 0.059 | 63 |
| 7. | Important information or key concepts were easy to identify. | C | 3.80 ± 0.805 | 0.006 | 73 |
| | | IM | 4.30 ± 0.535 | 0.007 | 90 |
| 8. | Generally the content was clear and logically organized. | C | 3.80 ± 0.761 | 0.010 | 77 |
| | | IM | 4.27 ± 0.583 | 0.010 | 90 |
| 9. | I found the contents clear, structured and appealing. | C | 3.73 ± 0.691 | 0.015 | 67 |
| | | IM | 4.17 ± 0.648 | 0.015 | 87 |
| 10. | I knew what to do next during the learning session. | C | 3.70 ± 0.750 | 0.215 | 77 |
| | | IM | 3.93 ± 0.691 | 0.215 | 70 |
| 11. | The instructions were easy to understand. | C | 3.90 ± 0.845 | 0.026 | 83 |
| | | IM | 4.33 ± 0.606 | 0.027 | 87 |
| 12. | I found the information delivered in the session useful in | C | 3.80 ± 0.761 | 0.011 | 77 |
| | | IM | 4.30 ± 0.702 | 0.011 | 80 |

| | | | | | |
|-----|---|----|--------------|-------|----|
| | visualizing the concepts. | | | | |
| 13. | The information provided was meaningful to me. | C | 3.83 ± 0.747 | 0.019 | 77 |
| | | IM | 4.30 ± 0.750 | 0.019 | 80 |
| 14. | The contents assisted me to achieve my learning goal. | C | 3.73 ± 0.868 | 0.065 | 73 |
| | | IM | 4.13 ± 0.776 | 0.065 | 77 |
| 15. | Multimedia increased my motivation to learn. | C | 3.93 ± 0.868 | 0.163 | 80 |
| | | IM | 4.23 ± 0.774 | 0.163 | 80 |

*C-Conventional, IM- Interactive Multimedia

TABLE II. COMMENTS AND SUGGESTIONS FOR CONVENTIONAL PRACTICAL SESSION

| No | Comments/Suggestions |
|----|---|
| 1 | Divide the learning group into smaller groups and each group has their own microscope, which will help us to understand about the bright-field microscopy technique much more clearly. |
| 2 | I think the practical session on the microscope was not enough with only being learnt in one or two sessions. Need extra lesson to make sure the theory and the practical lesson become easier to understand. |
| 3 | The practical session on bright-field microscopy technique was interesting and easy to understand. |
| 4 | There are once only we exposure to this practical session. I think need more time or day to understand about microscopy. |
| 5 | Interesting and meaningful. Should improve in explaining more briefly about it during practical session. Give more guidelines. |
| 6 | Need more visual instruction. |
| 7 | Do a step-by-step demonstration with given hands-out to each student. |
| 8 | Most microscopes are not in good conditions, the lens was infected. |
| 9 | For the students who do not know how to use the microscope and will learn how to use it, the instructions need to be followed by pictures to make the learning session easier. |
| 10 | The laboratory instructor should encourage students to involve themselves in the experiments |

TABLE III. COMMENTS AND SUGGESTIONS FOR MULTIMEDIA SESSION

| No | Comments/Suggestions |
|----|---|
| 1 | Learning through the interactive multimedia is interesting and helpful to students. |
| 2 | The presentation was simple yet meaningful. |
| 3 | This is a great module to study bright-field microscopy technique. This should be applied in the teaching and learning activities in the practical session. |
| 4 | I can repeatedly learn from the module to get more understanding about microscopy. |
| 5 | The module is really easy and for me; it was an interesting way to study science. |
| 6 | It can reduce the study time to achieve the learning goal. |
| 7 | Should provide more method or show us how to handle one sample, for example on gram staining. |
| 8 | Put more interesting pictures and information into this software. |
| 9 | The quiz should provide more variety by giving a lot of exercises or answering parts of the questions only. |
| 10 | Put more interesting videos and sound effects. |

VI. DISCUSSION EXPERIMENT

This study has indicated that interactive teaching material can be developed in order to achieve learning outcomes. Students with different learning abilities can learn at their own place, time and pace; interactively and perform self-assessment. Thus it makes learning a highly personalized, independent, and a rewarding experience. This study can be an initial move towards improvement of the methodology used in the teaching and learning process.

The students' satisfactions on the use of interactive multimedia were very positive. Students agreed that the instructions were easy to understand, at the same time they found that the important information or key concepts were easy to identify. According to Table I, the highest mean for the agreement response is 4.33 with 87% of the students agreeing with the statement which is "the multimedia increased my motivation to learn". Some of the favourable comments were derived from examples in Table I, "I can repeatedly learn from the module to understand more about microscopy" and "It is better than to study manually because this is much more interesting and meaningful".

According to Table I, there was a significant difference ($p < 0.05$) in the student satisfaction level between a conventional practical session compared to interactive multimedia session on bright-field microscopy technique (Question 3, 7, 8, 9, 11, 12, and 13).

For question 3, students were informed clearly what they were going to do in the module from the start. For question 7, students found that important information or key concepts were easy to identify in the module. For question 8, students

felt that generally the content was clear and logically organized. For question 9, students found the content clear, structured and appealing. For question 11, students felt the instructions were easy to understand. For question 12, students found the information delivered in the module useful in visualizing the concepts.

The highest percentage of satisfaction level in conventional practical learning session was obtained for questions 2 and 3 (93.3%). The highest percentage of satisfaction level after the use of interactive multimedia on bright-field microscopy technique was obtained for Questions 8 and 9 (90.0%). Students found that the important information or key concepts were easy to identify and generally the content was clear and logically organized.

According to Table II, most students suggested an increase in the frequency of practical session. They thought the practical session on bright-field microscopy was not enough to benefit from in just one or two sessions. Extra lessons are needed to make sure the theory and the practical lessons become easier to understand. Students also need a step-by-step demonstration with hand-outs given to each student.

The practical session should be held more than once and more guidance to each student is needed so that there will be no students who are left behind during the practical session. More laboratory assistants must be added to guide students because of the large number of students per class. More practical sessions should be done and students should be given a microscope each for activities involving observing specimens on the slide. This will help students to acquire the expertise and know how to use it correctly. Students also commented that the instructions needed to be complemented by pictures to facilitate the learning session.

According to Table III, all positive comments indicate that the students were satisfied with this interactive multimedia. Besides, some suggestions were given in order to improve the effectiveness of interactive multimedia in bright-field microscopy technique.

Students were satisfied with the interactive multimedia and hoped it will be applied in the teaching and learning during the practical session. Students thought that the presentation of the module was simple yet meaningful and helpful to students because they can repeatedly learn from the module to get more understanding about microscopy. The module can reduce the study time to achieve the learning goal. They suggested the inclusion of more interesting pictures into this module. Other than that, a few students requested an increase in the number of questions in the quiz.

Overall, the results show that many students prefer to learn the bright-field microscopy technique with an interactive multimedia module that provides a challenging quiz and video demonstration than the conventional practical session. Interactive multimedia increases motivation for students to learn. It can help students in their self-learning and can be an aid in teaching and learning. Baharuddin, et al., 2006 [3] pointed out that lecturers or laboratory instructors should indeed become facilitators to guide and help students to access, organise and obtain information to seek solutions to

problems. Their support is essential for students in using an interactive multimedia.

VII. CONCLUSION

From the results and discussion of this research, it can be concluded that an interactive multimedia in bright-field microscopy technique is suitable as a supporting learning aid for students. Students perceive that an interactive multimedia is capable of enhancing learning of the subject.

Multimedia applications are becoming more prevalent in teaching and learning. The advances in multimedia technology allow information to be presented in an unlimited variety of choices, as well as provide interactivity for the students. The introduction of multimedia technology alone is not enough to improve teaching and learning; multimedia design is also important. The most effective media combinations should be used to convey information.

This study has indicated that interactive teaching material can be developed in order to achieve learning outcomes. Students with different learning abilities can learn at their own place, time and pace; interactively and perform self-assessment. Thus it makes learning a highly personalized, independent, and a rewarding experience. This study can be an initial move towards improvement of the methodology used in teaching and learning process.

It is important to ensure multimedia systems work effectively in terms of transferring knowledge to the user. This is especially true if the multimedia applications were to replace existing forms of conventional practical sessions. There is a challenge with the task of selecting content, appropriate screen designs, commonly accepted user-interfaces, clear directions for access and system and application software that are appropriate for courseware development, as well as appropriate digital multimedia elements [3]. Interactive multimedia can provide a very useful alternative for teaching and learning about laboratory technique especially in cases where it is not applicable to teach students through conventional practical sessions.

In future, a field study will be conducted on students of the School of Health Sciences to assess the effectiveness of using multimedia interacting systems with larger study or experimental groups. The results from the study will be investigated to see the strengths and weaknesses with the newly-proposed multimedia system. Future improvements will be re-evaluated using the same or different groups of study. Eventually interactive multimedia as teaching and learning materials will be proposed for certain courses or parts of courses.

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