

Active Learning in Fiber Optic Course Using Applied Education Game

N. Arsad^{a,b*}, S. Shaari^b, Mastang^b, A. A. A. Bakar^b, M. S. A. Rahman^b

^aEngineering Education Research Centre, , Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor DE, Malaysia

^bDepartment of Electrical, Electronics and System Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor DE, Malaysia

*Corresponding author: norhana@eng.ukm.my

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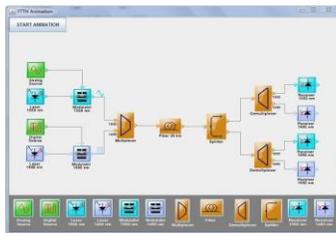
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Graphical abstract



Abstract

The strategy or method used in the learning process affect the result of learning. The wrong strategy will make students feel bored and lazy to attend class. In general, the learning method that is mostly used in universities around the world is center learning where the lecturer will give speak and the students will listen and take notes. This study was done in two classes i.e. a master's degree module and a bachelor degree course in the Department of Electrical, Electronics and System Engineering, National University of Malaysia. A total of 31 students were used as respondents (sample) that consists of 61.3% male and 38.7% female, where 41.9% of them are doing bachelor degrees and the other 58.1% doing master's degrees. This research show that 45% of respondents strongly agree and 55% of respondents agree that education games are more enjoyable than conventional lectures. 68% of respondents strongly agree and 29% of respondents agree that they like to study fiber optic using games. Furthermore, 58% of respondents strongly agree and 39% of respondents agree that they could remember fiber optic principles using the educational game.

Keywords: Learning process; education game; fiber optic

Abstrak

Strategi atau kaedah yang digunakan dalam proses pembelajaran mempengaruhi hasil belajar. Strategi yang salah akan membuat pelajar merasa bosan dan malas untuk menghadiri kelas. Secara umum, kaedah pembelajaran yang banyak digunakan di universiti seluruh dunia adalah pusat pembelajaran dimana pensyarah akan memberi kuliah dan pelajar akan mendengarkan dan mencatat. Metode ini memiliki banyak kelemahan seperti pelajar akan menjadi pasif semasa dalam kelas. Ketika pelajar hanya pasif, atau hanya menerima apa yang diberikan oleh pensyarah dimana pelajar mempunyai kecenderungan untuk melupakan apa yang mereka pelajari. Pembelajaran aktif kemudiannya menjadi salah satu cara yang efektif yang dapat digunakan untuk menerima dan menyimpan informasi kerana dalam proses pembelajaran aktif, para pelajar akan melakukan sesuatu untuk mendapatkan pelbagai jenis informasi dan pengetahuan. Dalam penelitian ini, pendidikan secara permainan telah dibangun untuk mencapai pembelajaran secara aktif. Pendidikan ini akan diterapkan dalam kursus serat optic dimana penelitian ini dilakukan dalam dua kelas iaitu pelajar sarjana dan prasiswazah di Jabatan Kejuruteraan Elektrik, Elektronik dan Sistem, Universiti Kebangsaan Malaysia. Sebanyak 31 mahasiswa yang digunakan sebagai responden (sampel) yang terdiri dari 61.3% laki-laki dan 38.7% perempuan, di mana 41.9% dari mereka adalah sarjana muda dan 58.1% adalah sarjana. Hasil tinjauan menunjukkan bahwa 45% responden sangat setuju dan 55% responden setuju bahwa pendidikan secara permainan ini lebih menyenangkan daripada kuliah konvensional. 68% responden sangat setuju dan 29% responden setuju bahwa mereka ingin belajar gentian optik menggunakan kaedah pembelajaran aktif ini. Selain itu, 58% responden sangat setuju dan 39% responden setuju bahwa mereka mudah mengingat prinsip-prinsip gentian optik menggunakan pendidikan secara permainan ini.

Kata kunci: Proses pembelajaran; pembelajaran aktif; pendidikan secara permainan; gentian optik

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1.0 INTRODUCTION

In general, the learning process in the classroom is dictating. This method has many disadvantages such as the student will become passive when studying in the class. When students are only passively gathering, or just accept what information is given by the lecturer, there is a tendency to forget what they received. Active learning then becomes one of the effective ways that can be used to receive and store information in the brain because in the active learning process, the students will do something to get many kinds information and knowledge. There are many ways to implement active learning in the classroom. One of the examples is learning using a game¹⁻³. The integration of the subject and a game can help students to learn the subjects actively². Games can engage students and stimulate their cognitive activities while they solve the problems portrayed in the game based environment.

Applying game in teaching subjects in university can increase the performance of students to learn in classroom⁴. It can also make them more focused⁵⁻⁷. Designing a game for educational purpose is however not easy, but it is one of many effective ways to a successful learning in university. Some researchers already found that the effectiveness of learning mathematics and physics can be increased through the education game method⁸⁻⁹. Using computer, the complex models can be simulated and animated so that learning in the classroom can be fun¹⁰⁻¹⁵.

Playing the game is not the main goal of this method. It is just a strategy to attract and compel students to learn actively. When the students were given a full color animation in computer display and nice sound effects, they will be excited. Researchers has applied the education game in various subjects^{2,16-17}. For example, “Re-Mission” was used to help students understand cancer in human¹⁸, “Chief Knowledge Officer (CKO)” was used to train students about knowledge management¹⁹ and “River City” was used to teach water architecture²⁰.

Lecturers in engineering are always faced with teaching complex theories. Some subjects such as fiber optic are just difficult to teach. This is because fiber optics use rays as the main entity to transfer and receive data whereas the ray cannot be seen by eyes. The integration of computers and new information technologies offers a large number of possibilities to help students learn fiber optic. New media helps in illustrating the structure of complex systems; virtual and remote laboratories help in gaining practical experience anytime and anywhere²¹⁻²².

The work reported in this paper is based on such research. This study experiments with the use of games as a teaching aid in the fiber optic course taught to juniors in the Department of Electrical, Electronic and System Engineering, National University of Malaysia (UKM). The purpose of this study is to implement active learning through educational games, thereby helping students to achieve better learning outcomes. These are only a few reasons why we think that computer games are suitable in enhancing the active learning and motivation of students. This paper will show how a computer game has exemplarily been integrated in a fiber optic course at the undergraduate and graduate university levels. In this course, students learn to analyze and design fiber optic communication system actively.

2.0 FIBER OPTIC AT NATIONAL UNIVERSITY MALAYSIA

The fiber optic game presented in this paper is used in our Fiber Optic Communication course at the National University of Malaysia. It is part of the curriculum of several study programs such as engineering communication, electrical engineering, and

computer engineering. The 31 attendees are undergraduate and master’s students. The course consists of 26 hours of lectures and 6 hours of exercises in one semester, i.e., 2 hours per week over a period of 16 weeks. In the lectures, new materials are introduced to the students, while during the exercises, common control problems and typical solution strategies are demonstrated.

This course covers the basics of fiber optic communication such as FTTH (Fiber To The Home). FTTH is a network created using the fiber optic so that broadband service that integrates voice, data and video can be transmitted directly to the users’ homes with low maintenance cost. FTTH capabilities in transmitting these three types of data has been demonstrated and implemented in Malaysia. FTTH is a Point-to-Multipoint (P2MP) network in which all the components between the Central Office and the users use only passive components. Thus maintenance costs can be reduced and damage can be minimized. Since there is no active component, the use of power supply and hot components can be avoided. More details on the course material can be found in any standard textbook. Therefore, we consider it to be typical for many theoretical courses in other fields of engineering. Thus, our experience in applying educational games to motivate students and improve their learning process should be transferable and would be of help to other lecturers.

3.0 DESIGN OF GAME

This fiber optic game was created using Java Eclipse Software. This software was chosen due to its many advantages compared with others, such as it can run on any operating system, is an executable file, support Object Oriented Programming (OOP) and consist of Standard Widget Toolkit (SWT).

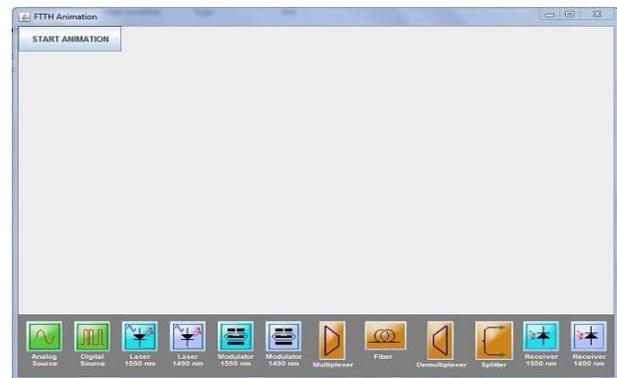


Figure 1 Layout of fiber optic game

Figure 1 shows the layout of the fiber optic game that is divided into two sections. The lower part lists the fiber optic components that will be used to form a network. The upper part is the space for creating the fiber optic network. Students can drag these components and connect them. If the components are correctly connected, students can then run the simulation.

Figure 2 shows a custom fiber optic network that has been created. The signals will move from one component to another component and transform based on the function of that component. For example, when a signal goes through a splitter, that signal will be duplicated and sent to all output ports of the splitter. When a component does not emit a signal, this means that there is something wrong in that network. The students can fix or recreate the network until successful. It can be very interesting and the students will enjoy it.

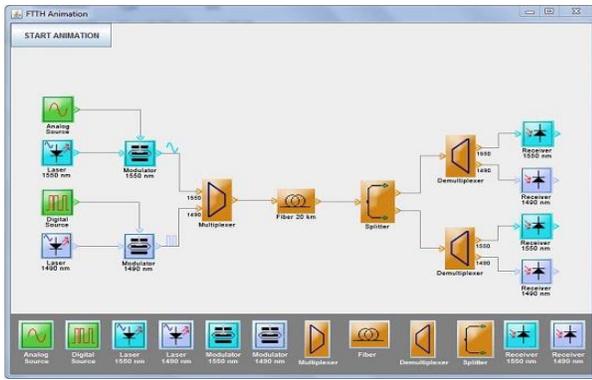


Figure 2 Running the fiber optic game

There are two lasers used in this game, namely laser 1550 nm and laser 1490 nm. The laser with wavelength of 1550 nm will be used to carry video signal (analog signal) while the laser with wavelength of 1490 nm will be used to carry audio and internet data (digital signal). Modulators 1550 nm and 1490 nm function to modulate electrical signal with laser 1550 nm and 1490 nm. Inside of this modulator, there is a carrier generator that functions to produce video, audio and internet carrier using RF frequency with certain channels.

The difference between frequency channel carriers is named frequency spacing. These channels will be modulated with laser 1550 nm and 1490 nm using the Mach-Zender modulator. For long distances, it needs an optical amplifier such as an Erbium Doped Fiber Amplifier (EDFA) to amplify the optical signal so that the receiver (also called Optical Network Unit or ONU) will display quality video signal.

Transmitting data through the optical fiber using single mode fiber (SMF) is typically divided into two parts e.g. 18 km for feeder region (Central Office to Optical Splitter) and 2 km for drop region (Optical Splitter to ONU). So the overall distance represented in the example is 20 km.

A Wavelength Division Multiplexer (WDM) functions to multiplex a number of optical carrier signals onto a single optical fiber by using different wavelengths of the laser light. In fiber optic network, this WDM is used to multiplex optical signals with wavelength 1550 nm and 1490 nm. This allowed the transmission of both signals to users using only one optical cable.

The role of the optical splitter is to distribute the optical signal to more than one customer. This optical splitter is passive and does not need a power supply. There are many kinds of optical splitter based on the number of its outputs such as 1x2 that means the number of outputs is two ports, 1x4 likewise means the splitter has 4 output ports and et cetera. The maximum number of ports of an optical splitter is 64.

The more ports a splitter has, the higher will be its loss. The WDM Demultiplexer's task is to separate the optical signals based on their wavelengths. This is needed because the photo detector (inside of receiver) can only detect one wavelength. For example, photo detector 1550 nm can only detect optical signals with wavelength of 1550 nm. Photo detector 1490 nm can only detect and convert optical signals to electrical signals with wavelength of 1490 nm. In a fiber optic network, the receiver is usually called the Optical Network Unit (ONU).

To ensure all students are able to grasp demo this animation and all of them have deep understanding to step and process that occurred inside FTTH using java animation software. A questionnaire distributed to get feedback from all students enrolled in the course. This questionnaire later analyzed and the

analysis result will be the key of indicator to student to understand obviously FTTH as shown in Table 1 below.

Table 1 Questionnaire

1. I can understand FTTH component very well using animation.
 - a. Strongly agree
 - b. Agree
 - c. Somewhat agree
 - d. Somewhat disagree
 - e. Disagree
 - f. Strongly disagree

2. I like study FTTH using animation.
 - a. Strongly agree
 - b. Agree
 - c. Somewhat agree
 - d. Somewhat disagree
 - e. Disagree
 - f. Strongly disagree

3. I can remember the network of FTTH because animation.
 - a. Strongly agree
 - b. Agree
 - c. Somewhat agree
 - d. Somewhat disagree
 - e. Disagree
 - f. Strongly disagree

4.0 RESULTS AND DISCUSSION

We introduced the presented educational game in our fiber optic lecture with the intention of increasing students' general motivation and improving learning performance. In order to study the effectiveness of the game, an evaluation was made with 31 students used as respondents (sample) that consists of 61.3% male and 38.7% female which are 19 and 12 students respectively, where 41.9% of them are doing bachelor degrees and the other 58.1% doing master's degrees which are there 13 bachelor's degree and 18 master's degree students involved. The details on gender and degree are shown in Table 2 and Table 3.

Table 2 Frequency statistic for gender

	Gender			
	Frequency	Percent	Valid Percent	Cumulative Percent
Male	19	61.3	61.3	61.3
Female	12	38.7	38.7	100.0
Total	31	100.0	100.0	

Table 3 Frequency statistic for degree

	Degree			
	Frequency	Percent	Valid Percent	Cumulative Percent
Bachelor	13	41.9	41.9	41.9
Master	18	58.1	58.1	100.0
Total	31	100.0	100.0	

The results of this research are divided into 5 categories i.e. the understanding of students in learning fiber optic, the motivation of students to learn the fiber optic course, the capability of students to keep the knowledge in their memory, the interest of students in the learning method, and the reliability of the students on the learning method. Table 4 shows the response of the students toward understanding of fiber optic course using the game method. 45% (14 students) of the students strongly agree and 55% (17 students) agree that learning fiber optic course using a game is easier to understand compared to the conventional method.

Table 4 The response of students to the understanding of fiber optic course using an educational game

Valid	Understanding			
	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	17	55	55	55
Strongly Agree	14	45	45	100.0
Total	31	100.0	100.0	

Table 5 shows the response of students toward their motivation to learn the fiber optic course. 68% (22 students) of them strongly agree and 29% (9) of them agree that learning the fiber optic course using the educational game method is more interesting and exciting compared to the conventional method using only text books that consists of static images and texts.

Table 5 The response of students toward their motivation to learn the fiber optic course

valid	Motivation			
	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	9	29	29	29
Strongly Agree	22	68	68	100.0
Total	31	100.0	100.0	

Table 6 shows the response of students toward their capability to keep the knowledge in their memory. 58% (18 students) of them strongly agree, 39% (12 students) of them agree and 3% (1 student) somewhat agree that after learning fiber optic course using the educational game method, they are able to remember very well the principle working of fiber optic and its components afterwards.

Table 6 The response of students toward their capability to keep the knowledge in their memory

Valid	Capability			
	Frequency	Percent	Valid Percent	Cumulative Percent
Somewhat Agree	1	3	3	3
Agree	12	39	39	42
Strongly Agree	18	58	58	100.0
Total	31	100.0	100.0	

Table 7 shows the interest of students in the learning method to learn the fiber optics course. 80.6% (25 students) of them strongly agree, 19.4% (6 students) of them agree that they are more interested to learn the subject with gaming method instead of the traditional book method.

Table 7 The interest of the students in the learning method to learn the fiber optics course

	Interest			
	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	6	19.4	19.4	19.4
Strongly Agree	25	80.6	80.6	100.0
Total	31	100.0	100.0	

Table 8 shows the reliability of the students towards the learning method to learn fiber optics. 80.6% (25 students) of them strongly agree, 19.4% (6 students) of them agree that they are more interested to learn the subject with gaming method instead of the traditional book method.

Table 8 The reliability of the students towards the learning method to learn fiber optics

	Reliability			
	Frequency	Percent	Valid Percent	Cumulative Percent
Agree	11	35.5	35.5	35.5
Strongly Agree	20	64.5	64.5	100.0
Total	31	100.0	100.0	

All the tables show that learning the fiber optic course using a game can be an effective tool in university. It can deliver knowledge and information to students in an interesting way and not mind-numbing since the method used suits the young students. Besides that, they are more familiar with the games and their understanding on fiber optics can be utilized. This method can be considered in curriculum design of fiber optic teaching. It can support students that possessed different skills and learning styles.

On top of that, it can help students to understand science topics and complex courses. Another important plus is this game can give students a chance to do some experiments in creating fiber optic communication without cost and risk. The hand on experience and application are able to enhance the students' memory better and thus, increase their knowledge on fiber optics and make them more interested in the subject. Moreover, the students are relying on the gaming methods to help them understand the subject better since the methods helps them in

understanding and grew their interest to know more about the fiber optics.

Based on these results, the students prefer to learn fiber optic using a game compared to reading text books. The methods helps not only in increasing the students interest on the subject but also motivate the students and increase their knowledge and understanding regarding on fiber optics. Even though this will be an additional burden for the teachers and lecturers to provide and design game systems, in reality, this method can be more effective and efficient to be used in both university and school. The development of this fiber optic game must therefore be expanded to cover more fiber optic topics.

4.0 CONCLUSIONS

Active learning is a cornerstone for learning at any level of education. In university-level engineering education, the gap between the application-oriented expectations of the learner and the theory-focused lecture content may cause considerable demotivation of a number of students. Educational games are one way to close this gap. In this paper, we have shown how a fiber optic game has effectively been introduced in a fiber optic communication course at the National University of Malaysia. Besides that, the students can learn actively by a practical example, which shows them the difficulties of designing a fiber optic system and the principles of fiber optic components. In the future, we want to introduce a course-wide high-score list in order to further increase the learning process of our students.

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