The Effectiveness of Form Four Stem-Based Physics Interactive Laboratory (I-Lab) By Employing Isman Instructional Design Model

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ABSTRACT
The study examines the effectiveness of the Form Four STEM-Based Physics Interactive Laboratory (i-Lab) to enhance form four students' achievements in Physics. It describes the design process by employing the Isman Instructional Design Model. A quantitative study was carried out using an experimental method. The instruments used were pretest and posttest for form four students' achievements in Physics. The sample of this study consists of three groups: a Traditional Physics Laboratory (T-Lab); Form Four STEM-Based Physics Interactive Laboratory with explanation feedback (i-LabP); and Form Four STEM-Based Physics Interactive Laboratory with knowledge of results (i-LabK). In this study, T-Lab is control groups while i-LabP and i-LabK are treatment group. Each group had 20 participants. Statistical analysis in the form of One Way Anova was used to compare the achievements of students in each group (T-Lab, i-LabP & i-LabK). The findings show that i-LabP had highest score mean at 64.70, followed by i-LabK at 56.90 and T-Lab at 52.65. The findings from this study suggest that the Isman Instructional Design Model is suitable in the development of Form Four STEM-Based Physics Interactive Laboratory (i-Lab) to enhance form four students' achievements in Physics.

INTRODUCTION
Teaching and learning Science must be based on today's Science and Technology development. Students are now more exposed to an explosion of information technology in their daily lives. In that regard, from the very beginning of the 19th century, educators, policy makers and the general public have focused on science teaching and learning. In the twenty-first century, science teaching requires an efficient approach to help students deepen and master their understanding of Science. One of the reforms in Science teaching is through the STEM (Science, Technology, Engineering & Mathematics) approach known as "Integrated STEM". STEM based physics teaching and learning embraces creative and engaging activities for students. In addition to producing innovative learning, the STEM Based Physics Interactive Laboratory (i Lab) is an innovation in physics laboratory modules which incorporates Science, Technology, Engineering and Mathematical elements to develop critical thinking and problem solving (Wan Ab Kadir, Abdullah, & Mustapha, 2019). Additionally, integrating technology in education will enhance the transformation of wisdom and thinking and learning for students (Gopalan, Bakar, & Zulkifli, 2017).

Labs are places where students can practice hands-on theoretical learning. The laboratory is known as a Science teaching place that involves students in concrete experience with science equipment and concepts (Ganiel & Hofstein, 1981). In laboratories, students will gain training and practical skills. Laboratory studies in Science (Physics / Chemistry / Biology) are very important for students to prove the theory learned in the classroom is true and proven. A theory can be demonstrated when students practice in laboratories. It is a common term for explaining activities related to the observation, testing and experiment or practice conducted by students (Kamarudin, & Halim, 2014 ; Trumper, 2003).

BACKGROUND
Modules are a form of interactive learning media that can be used for self-learning. Along with the development of information and communication technology or ICT, modules now appear not only in print, but also in the form of interactive modules based on the use of computers. An Interactive Module is an innovation of teaching aid, whether the teaching and learning process is run in the classroom or in the laboratory. Interactive modules can be implemented using internet applications either "online" or "offline" without internet applications. Many

early researchers have developed interactive modules to enhance the effectiveness of learning (Alias et al., 2014 ; Lee, & Osman, 2012 ; Penispaningam et al., 2014). In addition, interactive lab learning can have a good impact student learning as well as attracting students (Wan Ab Kadir, Abdullah, & Mustapha, 2019 ; Abdullah, & Yaakob, 2019).

In this study, Form Four STEM-Based Physics Interactive Laboratory (i-Lab) refers to a module of interactive learning comprised of Form Four Physics notes, procedures of Form Four Physics experiments, videos of Form Four Physics experiments, and quizzes. Form Four STEM-Based Physics Interactive Laboratory with explanation feedback is known as (i-LabP). Explanation feedback is a feedback form that describes the student as to why the answer given is correct or incorrect (Clariana, Ross, & Morrison, 1991). Form Four STEM-Based Physics Interactive Laboratory with knowledge of results is known as (i-LabK). Decision-making feedback is a fairly simple response which simply states whether the response given is right or wrong, without giving the user a real answer (Clariana, Ross, & Morrison, 1991).

PROBLEMS ARISING IN PHYSICS LEARNING

Student achievement in Physics shows that a lack of student understanding of Physics concepts and Physics experiments may be linked to students' interest in Physics Kamaruddin, & Halim, 2014 ; Phang et al., 2014 ; Zakaria et al., 2017). In addition, students are also less interested in the subject of Physics. They find that physics is a very difficult subject to study because it covers abstract concepts and concepts that students need to understand, as well as solving problems that require mathematical calculation applications [13]. In addition, a students' lack of interest in Physics is due to their perceptions of Physics and conventional teaching approaches by teachers (Phang et al., 2014 ; Zakaria et al., 2017).

OVERVIEW OF MODULE LEARNING

Many Physics modules that have been run by previous researchers who integrate ICT in teaching and learning and need to be accessed online such as (Alias, & Siraj, 2012 ; Alias et al., 2013a). In addition, most of the Physics modules that have been developed are physics modules to enhance students' understanding of abstract physics concepts more easily and to enhance student achievement as practiced by researchers (Alias, & Siraj, 2012 ; Alias et al., 2013a ; Alias et al., 2013b). However, few practical modules that use STEM approaches and are accessible offline have been developed to overcome the obstacles faced by students and teachers in physics labs. Development of Physics Interactive Labs (i-Lab) is STEM based to enhance students' knowledge and skills in STEM so that they can pursue higher education while continuing their lifelong learning. In addition, students will be able to apply STEM knowledge, skills and values through inquiry, daily solutions, environment and local and global community (Shahili, Ismail, & Halim, 2017).

OBJECTIVES

1. Evaluate the effectiveness of the Form Four STEM-Based Physics Interactive Laboratory (i-Lab) based on traditional laboratory (T-Lab), interactive laboratory with decision knowledge feedback (i-LabK) and interactive laboratory with explanation feedback (i-LabP) on student achievement in Physics by pre and posttest design.

2. Describe the design and development of Form Four STEM-Based Physics Interactive Laboratory (i-Lab) to enhance form four students' achievements in Physics by employing the Isman instructional design model on expert agreement.

METHODOLOGY

In this study, 60 form four students who take Physics in the state of Perak were randomly selected. The samples were divided into three groups: T-Lab, i-LabP and i-LabK. T-Lab was a control group using traditional laboratory learning, while the i-LabP and i-LabK were treatment group. In this research, the form four students' achievements in Physics refer to the difference between pre- and post-test scores.

The first instrument was pretest for identifying student's prior knowledge. The second instrument was posttest for identifying student's achievement. Both instruments pretest and posttest were the same questions which different arrangement. Student achievement in this study refers to post-test scores by controlling for pre-test score factors. Pre and post test instruments were validated by three Physics Lecturer and have Cronbach alpha 0.918.

EMPLOYING ISMAN INSTRUCTIONAL DESIGN MODEL IN THE DEVELOPMENT OF FORM FOUR STEM-BASED PHYDSICS INTERACTIVE LABORATORY (i-LAB)

Teaching is a process of planning teaching and learning activities. Teaching models are implemented to motivate students to learn [18]. In a learning model, several factors need to be considered. There are also factors that need to be included in the steps of developing a teaching (Isman 2011 ; Isman 2005). In other words, the learning model is very important for developing a lesson and an activity to be carried out. This study is based on Isman's Teaching Design Model (2011).

Isman's Teaching Design Model has a primary purpose of how to effectively plan, develop, implement and carry out learning activities (Isman, 2011). This model was developed based on the views of several key learning theories such as behaviorism, cognitive and constructivism (Alias et al ., 2013a ; Siraj, Alias, & Dewitt, 2013). Isman's Teaching Design Model (2011) used the relationship between stimulus and response, reinforcement factor, and their environment as behaviorism theory to motivate students. The model also focuses on how to preserve knowledge in the long term memory and each planned activity must have that purpose (Siraj et al., 2013)

Isman's model was implemented on 100 graduates from the faculty of education at the University of Eastern Mediterranean to determine the effectiveness of the model on student achievement. It was found that the Isman Model can work effectively and has a positive impact on the achievement of the graduates (Isman, 2005). In addition, the Isman Model is widely used to see the effectiveness of a teaching on high school students as previously conducted by researchers (Alias, & Siraj, 2012 ; Alias et al., 2013a ; Alias et al., 2013b). Isman's model was used in the Design & Development Research method (DDR) (Alias, & Siraj, 2012 ; Alias et al., 2013a ; Alias et al., 2013b) in her study to test the effectiveness of a learning. Therefore, Isman's Teaching Design Model (2011) can be applied in the DDR method. The model consists of five systematic plans: input, process, output, feedback and learning. Figure 1 shows the Isman Teaching Design Model 2011.

Teaching is a process of planning teaching and learning activities. Teaching models are implemented to motivate students to learn (Isman, 2011). In a learning model, several factors need to be taken into account. There are also factors that need to be included in the developmental steps of a teaching (Isman 2011 ; Isman, 2005). In instructional design, the steps are interrelated with each other. It is very important to arrange the steps in a logical way and relate to the other steps. In other words, instructional design is a big responsibility for planning teaching and learning activities. In other words, learning modules are very important to develop a lesson and activities that will be carried out. This study was developed based on Isman’s (2011) Instructional Design Model. The Isman Instructional Design Model has a main purpose which is how to plan, develop, implement and carry out learning activities effectively (Isman, 2011).

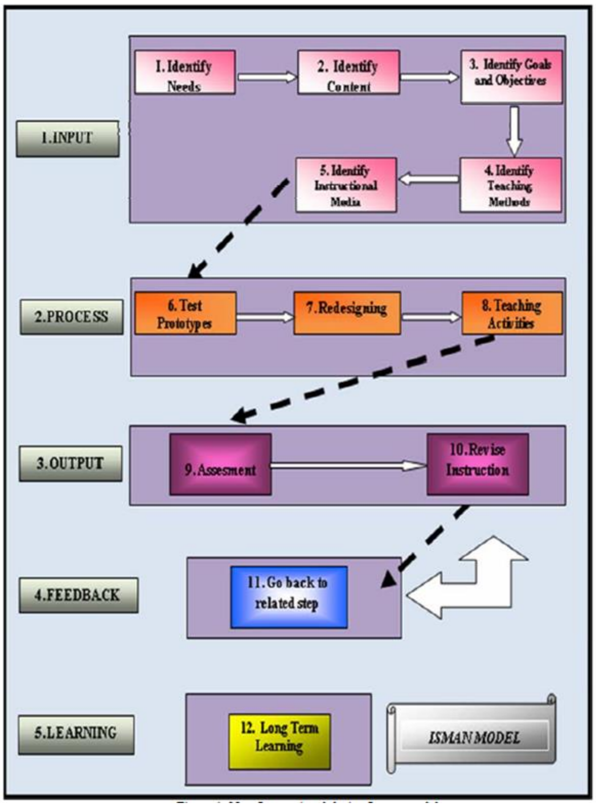

Figure 1: New Instructional design Isman model (Isman, 2011)

DATA COLLECTION

Isman model with a new instructional design based on active learning. During teaching and learning activities, students are active and use cognitive learning to build new knowledge. To create new knowledge, technological tools in education are used. The Isman model with the new instructional design (Figure 1) has five phases namely input phase, process phase, output phase, feedback phase and learning phase (Isman, 2011). Figure 2 showed the Isman Model applications in this study:

Phase	Steps	Explanation
INPUT	Identify needs • Identify content • Identify goals and objectives • Identify teaching methods • Identify teaching media	• Plan the construction of i-Lab modules through needs analysis to find out the needs for Physics modules as well as problems encountered in Physics subjects as well as Physics practice. • Content, teaching methods and pursuit media are determined based on expert agreement.
PROCESS	• Testing prototypes • Updating instructional design • Teaching and learning activities	• Prototypes (i-Lab modules) are tested for effectiveness with students • Rearrange teaching activities • Pre -tests are conducted on students • Teachers begin teaching activities through content, teaching methods, goals and objectives with appropriate teaching media.
OUTPUT	• Assessment • Review teaching	• Teachers to perform assessment on students to find out the learning objectives achieved/not (Post Test) • The teaching process is reviewed if problems are encountered during the learning
FEEDBACK	• Return to the relevant steps	• Teachers can return to any problematic step
LEARNING	• Long -term learning	• Long -term learning is certified by the teacher (as required by the learning objectives)

Figure 2: Applications of Isman Models in the Development of Form Four STEM-Based Physics Interactive Laboratory (i-Lab). Addapted (Isman, 2011)

FINDINGS

From table 1, I-LABP have the highest mean score (64.70), followed by I-LABK (56.90) and the lowest mean score is T-LAB (52.65). This results shows that I-LABP & I-LABK have more effective for students' achievement in Physics more than T-LAB.

Table 1: Descriptive Analysis of Mean Score Between i-LabK, i-LabP & T-Lab

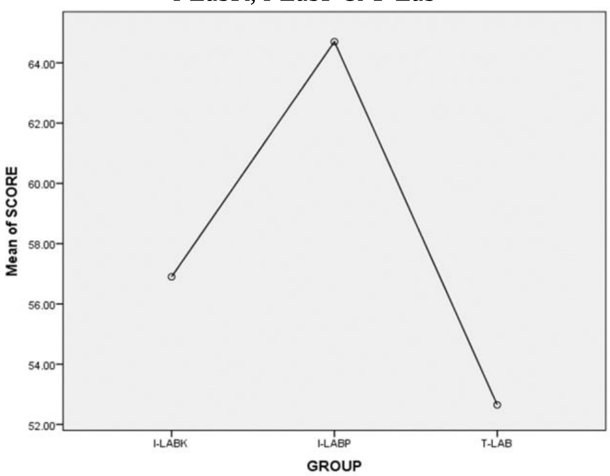

Table 2 indicates that there is a significant difference in students' achievement levels based after treatment through teaching and learning using I-LAB module. This is clearly being shown when the mean between group for posttest is 747.017 and the mean within group is 114.255 with test $F(2,57) = 6.538$, $p < .05$. Therefore, there is a significant difference in students' achievement in the treatment group posttest.

Table 2: One way ANOVA Students Achievement Between Group

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1494.033	2	747.017	6.538	.003
Within Groups	6512.550	57	114.255		
Total	8006.583	59			

Figure 3 shows that I-LABP have highest mean score compare with I-LABK and T-LAB. It can be concluded as I-LABP is most effective for students followed by I-LABK and T-LAB.

Group	Sample	Mean	Std. Deviation	Std. Error
I-LABK	20	56.9000	9.35780	2.09247
I-LABP	20	64.7000	11.54442	2.58141
T-LAB	20	52.6500	11.04191	2.46905
Total	60	58.0833	11.64924	1.50391

Figure 3: Means of Score Students Achievement between Groups

CONCLUSIONS

The findings show that Form Four STEM-Based Physics Interactive Laboratory with explanation feedback (i-LabP) and Form Four STEM-Based Physics Interactive Laboratory with knowledge of results (i-LabK) give positive effectiveness of form four student's achievement in Physics. The results show that treatment group which is I-LABP and I-LABK have greater mean score than control group, Traditional Physics Laboratory (T-Lab).

RESEARCH IMPLICATION

The development of i-Lab has many implications for education. For students, the development of i-Lab can attract students and facilitate student learning. For teachers, i-Lab can be used as a teaching tool to replace existing practical books, in addition to helping teachers carry out the teaching and learning process at the school. Development of i-Lab is able to produce unique modules, as each component is developed based on a specialist agreement in the field of Physics education, which is an advantage to the Ministry of Education Malaysia. Additionally, i-Lab is a very suitable teaching and learning medium for teachers and students especially during movement control order (MCO) where students can learn by their own and teachers as facilitators.

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