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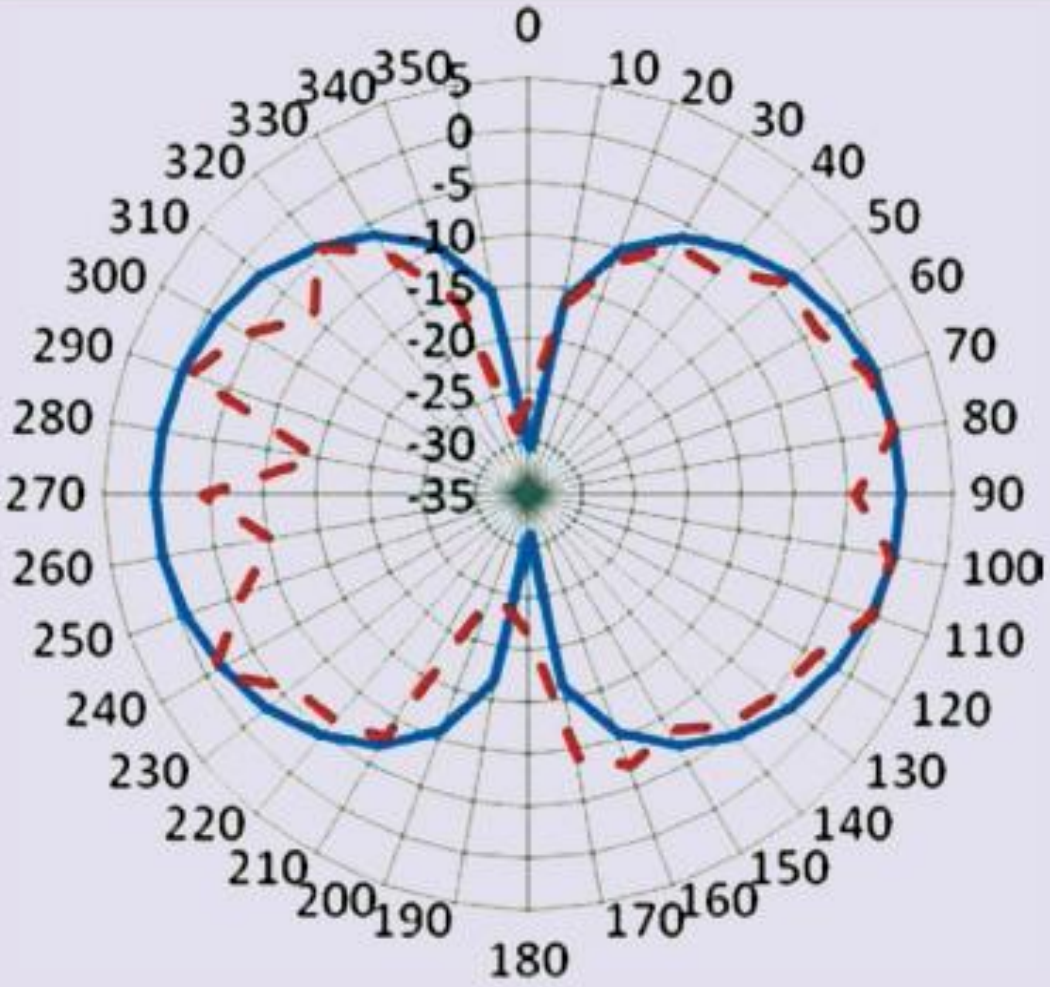

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Intelligent Tutoring System for Mastery Learning: Development Method for Extensive Use

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A personal learning tool, Intelligent Tutoring System (ITS), can be made with a variety of technology options and a variety of methods. The main challenge is how ITS can be used for a variety of subjects and how ITS can be developed by teachers to assist their instructional activities. ITS can be used widely in schools if there is cooperation between the programmer and lecturer. A programmer has a responsibility to develop ITS master module, while a teacher plan and prepares what to teach and how to order. Because, ITS will be widely used in schools, the method of its manufacture should consider the habits and skills of teachers in using information technology for teaching. In addition, the technology that used to develop the ITS modules should be cheap and also easy to publish. PowerPoint and Learning Management System are e-learning tools that are most widely used by teachers around the world. Teachers have experience of how to prepare a good learning material, create questions, sort them in a particular manner, and put them in a PowerPoint template. Habits and skills of teachers in using information technology tools are the main consideration in developing this approach. This paper describes a method for developing ITS modules that are intended for teachers so that they can make the ITS modules despite having no knowledge of programming. They also will be able to create a module with low cost and a short time. Master ITS modules are created using the Authoring Tools to shorten the creating time; it also uses SCORM (Sharable Content Object Reference Model) standard which make it compatible with many LMSs. The teacher creates ITS module like creating PowerPoint slides; at the beginning of the project, teachers' success creates English modules that delivered using LMS and tested to the students.

Keywords: ITS master module, teacher habits and skill, authoring tools.

1. INTRODUCTION

Today's Intelligent Tutoring System (ITS) is an interactive e-learning tool to help students learn independently, and it is proven to accelerate and increase students' cognitive understanding. Develop web-based intelligent tutoring systems have many advantages over stand-alone tutoring systems, such as it can reach more students, it can be accessed at any time, it can recognize the knowledge level of each student, and it gives multimedia support[1].

The basic assumption of measuring an indicator through diagnostic test is the amount of the right answer shows the level of instructional objective achievement[2]. The students are considered in the mastery learning if their correct answers are at least 70% of total questions[3]. The approach of mastery learning performed when the learning is working properly and all students learn well. It means that, mastery learning happens when students are taught by an appropriate method, giving enough learning time and additional learning specially for students who meet problems in learning. This method is difficult to implement by using conventional means or face-to-face, especially in the study group with big number of students[4]. Improving the students who have difficulties one by one is difficult for a teacher, i.e., the faculty who has a problem in understanding students emotional expressions[5].

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It needs for alternative learning experiences, such as the use of interactive software mentioned in several previous studies[6,7].

1.1 Why does a teacher need an ITS?

Ideally, in learning, one teacher is for one student, and support adequate equipment and appropriate methods. Today, the ratio of the teacher compared to student is getting smaller, means that a teacher should manage learning groups with a growing number of students. This condition causes the teacher to be careful to manage teaching and learning activities like one student one lecturer; as a result, the possibility of students to achieve mastery reduced. ITS can be used to solve this problem because it can be developed and be integrated with the Web Based Learning Management System (LMS) to handle many of the students but it is also able to provide individual treatment

1.2 Problem statements

In this research, the ITS module uses for increasing the learning outcomes using the drill-practice method. In the real world, the teaching method use by the teacher until today is face-to-face. Teachers, who have long experience of teaching, have experience how to teach and measure the learning outcomes of their students; they called as experienced teachers. From the explanation, it shows that, the teacher needs ITS modules for improving their teaching and learning. The teacher is not a software developer and vice versa. ITS consists of two parts: technology and education. Teachers have the experience; the technology is already available, and software developer have the capability to develop ITS. There are several challenges in ITS module development:

- ITS is developed mostly by programmers, but less involves education experts. In fact, the experience of teachers is crucial in the development of ITS, especially for real-world applications[8]
- Creating ITS modules for extensive application is still hard to make[9]
- The duration to create an ITS Module is very long, about 200-300 hours[10] or 200-1000 hours for the duration of a one-hour ITS[9]

Refers to the above explanation, for extensive use, teachers should be the main part in ITS developing. The teacher's experience is an important consideration for ITS modules design.

1.3 Research contribution

This research is dedicated to teachers who want to use information technology for helping student mastery in learning. The main goal of ITS authoring system is to make the process of creating ITS module easier, cheaper, and faster. The other main goal is also to decrease in the skill threshold of potential ITS module developer; teachers can develop ITS module without any programming capabilities. Teachers only need experiences in teaching using PowerPoint and understand how to order the teaching material in a certain sequence. Until today, ITS software only developed by software engineer due to the algorithm on it. The ITS module can help the teacher to speed up the student's mastery; thus, if the teachers with various backgrounds of knowledge can develop their ITS module, the more students will achieve learning goals. The result of this research is the new development method so that ITS can be used more widely, because the teacher can create ITS modules by themselves and include their teaching experience. Besides that, students can easily use the ITS at any time and from anywhere using the internet environment. If the ITS easy implement in the general teaching and learning, more student can learn independently without or less teacher intervention.

2. ITS MODEL DESIGN

2.1. Learning States

Every subject has learning goal or objective and learning outcome. Learning outcomes that describe significant and essential learning, the students have achieved it. Learning outcome can be reliably demonstrated at the end of the course. Learning outcomes affect the content, methods to teach, and assessment on an analysis of the knowledge[11]. A student can achieve learning outcomes after mastery in every learning objective[12]. Mastery in each objective is the most central in each instruction. There are three types of learning objectives: cognitive, affective, and behavioral. This paper deals with cognitive learning objective; there are three learning states, namely less, good, or excellent. In each state, it has a particular action, remedial for less state, mastery of good state, and enrichment for the excellent state. The student can move from one state to another state if they pass or fail, repeat in the same state, and jump to finish. Mastery is the main activity for all students, remedial for a slow learner and enrichment for a fast learner.

2.2. Intelligent Part of the System

The fundamental principle of ITS is a decision what the next learning after a set of learning activity undertaken. The next learning is known by looking at the answers and score positions that obtained. Students, with the same score and answering questions with the same answer, have different training for next learning. It depends on the calculation of the next position. More, the Witheley's algorithm has been modified as described as follows:

2.2.1. Learning transition

State Sn is a condition arising from an action taken by the previous decision. State written by n = 1, 2, 3 ... The set of all states is denoted by state code like shown Table 1. If S_0 is the student's current state, then there are three possible subsequent actions and two states, namely:

• Learning state L with a correct answer of state C

• Learning state L with an incorrect answer state IC

S_n is a state where *n* is the number of lessons that the state code is nearest to the current grade.

2.2.2. Expectation Immediate Reward

Expectation Immediate Reward (EIR) is an award granted before moving from one state to the next, current position will be updated by Eq. (1):

$$Grade = Grade + EIR \quad (1)$$

The EIR value depends on the answer and the current position. If the answer is correct using Eq. (2):

$$EIR = V^{\pi}* \quad (2)$$

If the answer is incorrect using Eq. (3):

$$EIR=-1*EIR_{max} \quad (3)$$

2.2.3. Learning transition opportunities

Learning transition opportunities are probabilities of transitions in a state S_n was written by notation P_n, where n = 1, 2, 3.... The probability of a question P^{π} is the discriminant index of a question. The best learning activities are a pair of lesson and appropriate question with probability P_n.

2.2.4. The next activities

Next activities or alternative decisions of ITS are all possible actions taken to a state. The next activity runs after checking the position using current grade after updated; it can be in the same category. This activity uses the next step of the algorithm and reward calculation. All the next activity always uses the position or level grade; it may be selected such as:

- Moving to a lower level
- Repeating the same topic on the same level
- Repeating a new topic on the same level
- Continuing to the higher level

2.2.5. Markov Decision Process (MDP)

To determine the next state using a Markov's chain algorithm is shown in Fig. 1.

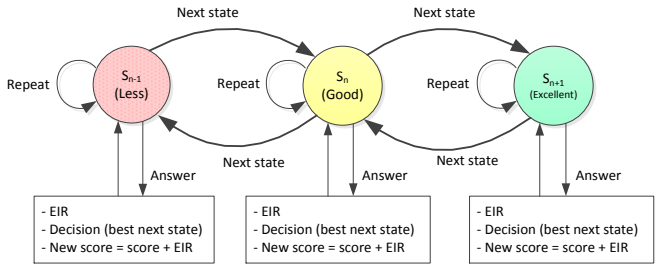

Figure 1 Markov's chain in the ITS

IF-THEN decision is also used to follow the flow of learning move in the same state or move to another state while the computational decision uses to find the best lesson and its quiz. Computational decision is used to calculate *EIR*, new reward and a new grade by solving the Bellman's equation (Eq. 4). Markov's algorithm used to find the best of the next state and EIR value:

$$V^{\pi^*}(s)=EIR+max_{a\epsilon A}.\gamma\Sigma P_{s\pi}(s)(s')V^*(s') \quad (4)$$

Which $V^{\pi}*$ is a constant 0 to EIR_{max}, γ is a constant 0 to 1, and $P_{s\pi}$ is the next state with the best learning probability. The best solution is when the error solution minimum, which $EIR = V^{\pi}*$. The best next state is a set of tutorial, and question which has probability $P_{s\pi}$.

In every state, student guided to understand a concept or procedure than is given the questions to measure the level of understanding. This system can work if the teacher prior to designing the learning workflow scenarios using taxonomy table. The teacher also should collect the lesson and its alternative questions and then put on the Table 1. A specific objective is achieved through sub-topics to follow the scenario designed by the teacher. Scenario between topics is different, depending on the purpose and objectives. The ability of students to understand a topic is measured using an appropriate question; the next step determined by using the accuracy of answering the questions.

3. METHOD

There are seven main stages in module research and development (Fig. 2):

1. Describe the ITS requirement and specification
2. ITS template design and development
3. ITS module development
4. Publish the modules on LMS
5. Implement the ITS in real-world teaching and learning
6. Analysis the result
7. Concluded

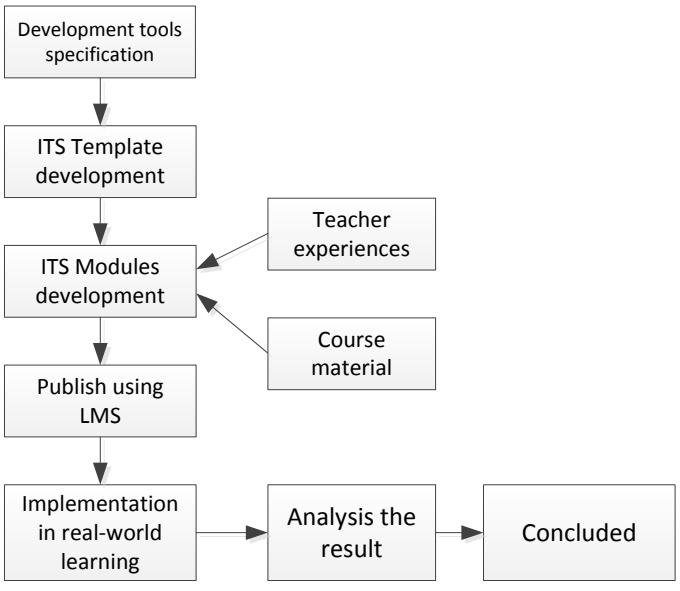

Figure 2. Research Method

3.1 Development tools specification

The E-learning authoring tool is an advanced, easy to use for creating online course content. It is also a powerful tool and easy for creating an online course content. Today authoring tool supports SCORM (Sharable Content Object Reference Model) standard[12]. In the beginning of study select 101 Authoring Tools. CourseLab is chosen because it has qualified specification for building ITS module, low cost, and easy to use. CourseLab is like power point and has basic features needed to build ITS including multimedia support, animation support, less programming, navigation, quiz modules, text editor, modular templates, and feedback tools. CourseLab is an authoring tool to create e-learning content which is very handy, easy to use, offers free programming facilities for creating interactive and ready-published on the internet through an LMS.

3.2. Template design

CourseLab structure has hundreds of slides, and each slide can contain 40 of the frames for reasonable access speed. The slide consists of three parts: the remedial, mastery, and enrichment. The intelligent part of ITS are written by using JavaScript to enter the MDP and order of learning based on position, tutorials probability, weight of questions, and answers. ITS modules perform a maximum duration of 20 minutes.

The red color shows the category of remedial, yellow for completion, and green for enrichment (Fig. 1). The red color shows the category of remedial, yellow for completion, and green for enrichment. Intelligence algorithms are written using JavaScript that is used to process inputs include pre-test score, the value of a penalty for wrong answers, and reward for correct answers. The ITS requirements currently are easy to develop, easy to use, inexpensive, easily disseminated[8], well accepted by teachers[14], and refer to instructional design. ITS modules create using the Authoring Tools CourseLab that supports most of the LMS based on SCORM are meeting these requirements. CourseLab is easy to use because it resembles the use of power point[15]. CourseLab also supports SCORM 2.4 which is easy published on LMS.

4. RESULT AND DISCUSSION

The experiment consists of two main stages: ITS module developing (ITS template and module development) and ITS module implementation of real learning process (publish the module through LMS). ITS module template created for developing any subject modules, in this experiment the template used for English subject. There are three teachers create the modules; each of them creates at least ten modules. Of the experiment, the average time to make ITS module on English subjects was 12 hours, and the calculus course was 48 hours. The duration to create a calculus module was longer than to create an English module because the teachers should write formulas. In the beginning, the teachers also feel less familiar with Authoring tools. Overall, they feel glad, and the teachers interested to use the ITS module for their teaching activities. The first study using true experimental research to prove that the experimental group had a significant increase in student achievement compared to the control group, based on Bloom's criteria, at least 95% of the experimental group students achieve mastery[16].

The ITS modules applied to English subject which has three specific instructional objectives, namely: grammar, pronunciation, and fluency. The main objective is skills to communicate effectively using English. The instruction includes practicing for pronunciation and fluency in the classroom, combine with self-directed learning out of the classroom using the ITS modules. In order to eliminate the problem outside the context of the study, students were given the freedom to use the ITS module whenever they need. ITS modules published through an LMS for facilitating the researchers, teachers, and students. There was no limitation on how many times students should use it. The research population consisted of students participating in English subject level one. The total number of participants was 100 students.

To measure the successfulness of the ITS modules requires the data of pretest and post test. All students have a chance to use the ITS modules. The experiment conducted without advance notification to the faculty and the students; this is to avoid a change in the attitude of both them if they knew that they were being studied. The participants divided into an experimental group and a control group. The experimental group was students whose scores were at least 40% of tutorials, and the rest included in the control group. It is obtained that 76 students included in the control group and 24 students included in the experimental group. Successfulness test is done by using the data of pretest and posttest. Successfulness test will be declared through the ability of ITS modules to make significant differences between the experimental group and the control group.

In a successful test, preliminary analysis is done toward the homogeneity of pre-test and post-test data in terms of grammatical skills in both the experimental group and the control group. Correlation analysis of grammatical knowledge on the pre-test and post-test using 2 Independent Samples T-test with a significance level of 5% ($\alpha = 0.05$). There is no significant difference between two groups before use the ITS modules (homogeneous). After using the ITS module, there were 24 students included in the experimental group and all of them achieve mastery (100%). Associated with significant differences in post-test between the control and experimental, it can state that the ITS module impact to the learning. From the explanation above, the experimental group had a significant increase in

achievement compared to the control group and there is 100% students of the experimental group achieved mastery, it is greater than 95% (Bloom criteria).

5. CONCLUSIONS

Drill-practice learning model appropriate with the concept of widely-use ITS module. ITS drill-practice designed using the model to align with the student must be actively repeating the online tutorial to achieve mastery in learning objectives. Learning strategies use a modified drill method to provide an element of "intelligence" that can reduce the number of repetitions. Drill method was chosen for the method because it is easy to understand by the teachers. ITS model is easily constructed using appropriate authoring tools. CourseLab is chosen because the usage is similar to PowerPoint, so it is easier to understand by the teacher. Besides that, teachers are easy to pour their experience to draw up the learning sequence. The selection of drill method also considers the advantages of CourseLab that accommodate to handle the slide and frame using JavaScript; so that an intelligent system to decide the best next tutorial can use an algorithm. An ITS module has the potential to spread due to: the experience and skills of teachers in development, authoring tools freely available, the characteristics of intelligence can implement, and the ITS modules can distribute using the LMS. The model tested the extent of the English course; it means that for the purposes of generalization, in future, the model should be tested in other subjects, other goals, in various different places, and with a bigger number of samples. Those for measuring the consistency of the result.

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