Peer Reviewed Papers

GaMa Feedback Learning Model: Basic Concept and Design

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Ideally, in teaching and learning activity, there should be one teacher for one student, supported by sufficient instruments, and appropriate methods. Currently, a teacher assists a number of students. Teachers have limited time to monitor and help a student overcome their learning problems. This paper proposes a mastery learning model using e-learning that applies control mechanism to solve above problems. The model is applied in group learning, but the actual target is individual learning. Teachers have plenty of time to supervise, evaluate, and take necessary actions when finding a student with learning problems. The principles of control mechanism can be operated if it is already equipped with Learning Management System (LMS), in which it has been enriched with Intelligent Tutoring System (ITS) and appropriate instructional. The students will be more autonomous and the teachers serve more as monitors and assistants to promote a bigger number of students who can achieve mastery.

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1 Introduction

The key to mastery learning model is that every student is given individual opportunities to achieve the mastery level in a gradual and effective way (Ozden, 2008). Self-assessment is essential since it can be used for learning evaluation (Visentin *et al.*, 2013). Communication is also an important part of the learning process (Vui, 2008). Those requirements are difficult to fulfill due to some factors: (a) all students are given the same allocation of study time and type of activities, although they have different learning speeds; (b) learning is teacher-centered or teacher still dominates the activities; (c) students tend to be a passive learner; and (d) examinations are only twice in a semester and merely function as an assessment.

Achieving mastery needs an effort to help the students become continuously active. The lectures' roles are to monitor, to detect students' problems, and to provide proper treatment. This principle is similar to controlling principles using feedback in engineering; therefore, this learning model is designed using the principle of feedback mechanism in order that each student achieves mastery. This principle will properly work when e-learning is applied with an appropriate model. E-learning shows a potential to help accomplish an effective and efficient learning in mastery learning.

2 The Approach of Mastery Learning

Mastery learning is an instructional philosophy based on the belief that all students can achieve the learning objectives if they are given an amount of learning time and an appropriate instructional (Ozden, 2008). The mastery learning concept was introduced by Washburne in 1922 and then by Morrison in 1926, it was received as instructed in 1950, as a model of the school developed by Carroll in 1963, and as a working model by Bloom in 1968. In the middle of 1970's, mastery learning has been applied wider. Other important researches were done by Guskey and Piggot in 1988 and by Anderson in 1994. Of their works can be concluded that the essential elements of mastery learning are:

- The amount of time needed by learners to achieve mastery.
- The quality of learning resources and instruction.
- Student's motivation (willing to spend the time and to understand).

The mastery learning can be applied easily if it is supported by e-learning (Karrer, 2007). Learning process based on appropriate educational technology increases the possibility to realize the mastery learning goal (Liu & Yang, 2008). Learning Management System (LMS) is an important tool in e-learning (Davis, *et al.*, 2009) and it can be used for such purposes to manage and to monitor learning activities outside the classroom, LMS also can record learning activities and progresses (Simic *et al.*, 2009). LMS is useful in developing a learning process that uses student mastery learning approach (Yasuyuki, 2005). Due to LMS is not a teaching tool, it needs tutorial tools. Intelligent Tutoring System (ITS) is one of the online tutorials tools which can accommodate different learning characteristics. Combination of LMS and ITS can be used to encourage students to become more autonomous learner.

3 e-Learning

The definition of e-learning, according to Clark and Mayer (2008), its contents and instructional method. Mastery learning cannot be accomplished if the principles, such as motivation, are not well practiced since motivation is one among other factors which determines the success of e-learning implementation (Richter *et al.*, 2012). Mathews and Mitrovic (2007) proposed that it is necessary to conduct advanced research on ITS to accelerate the success of the mastery learning. Nevertheless, the implementation of e-learning for mastery learning should be employed appropriately (Knight, 2004; Huffaker, 2003; Berman, 2007).

The principles of mastery learning are learning time, learning techniques, feedback, challenges, strong connection to the real world, monitoring; communication, and assessment (Barrett, 2005). Learning tools must be able to accommodate the principles of student differences, also should have assessment features and communication media as well. In addition, the features should be effective (Godwin *et al.*, 2010). The evaluation process will be better and more useful for the improvement of learning when using technology (Richter *et al.*, 2012).

4 The Feedback Control System

Control is the use of algorithms and feedback in engineering systems (Murray & Amstrom, 2008), the objective is to make the process run as desired. The feedback control system (Figure 1) consists of: input, output, comparator, controller element, actuators, plant, as well as feedback elements. Input or set point is a variable to reach in, while output is the result variable aimed by the controlling system (Dunn, 2005). Control process starts with measuring the output using the sensor to get feedback signal. Then, the feedback signal is compared with the input to get the error signal using a comparator. Furthermore, the error signal is processed by the controller to set the manipulating variable. The actuator will manipulate the process to reduce errors. This process runs continuously to minimize the error. This process becomes a cycle of feedback control which runs continuously to minimize errors and get the stability in a quick and proper way. If the controlled variable is close to set point value for an infinite period of time, it can be said that the system reaches stability.

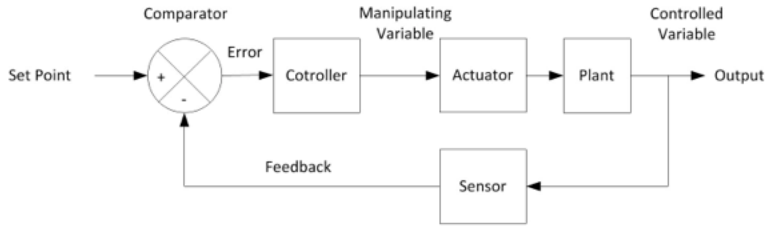

Fig. 1 - The Model of Feedback Controlling System (Dunn, 2005)

5 Formulation of The Model

The mastery is highly possible when students are continuously active to learn under the teachers' supervision (Kazu *et al.*, 2005). Regarding to mastery learning practice, Clark and Mayer (2008) suggested to: (a) plan and carry out the instructions well; (b) give sufficient time to students; (c) regularly monitor. If a learning problem appears, immediately a teacher should provide actions for learning improvement. This method is similar to the principles of a feedback controlling system. This model adapts the principles of feedback controlling system to help learners achieve their mastery learning. The model can be described as follows: input is the learning objective; the process is the learning activity; and output is the students' learning achievements. The adaptation of the control system requires a humanity factor since this model will be applied to humans who have different characteristics of tools or machines. To develop the model, the e-learning definition proposed by Clark and Mayer (2008) is chosen because it contains engineering and education elements.

Any research under the theme of e-learning mostly observed the technology; and, e-learning, in fact contains the elements of technology and education, even the future research direction of educational technology is mobile learning, ubiquitous learning, and game-based learning (Kinshuk *et al.*, 2013). The trends in the development of e-learning have been still dominated by the discussions of LMS in terms of the user's personalization, access, integration with other systems, interactions, display designs, reporting systems, activity records, assessment programs, business requirements, technology requirements, competency, and learning management. This model directs how to combine elements of modern learning in such a way that the LMS, online tutorials device (ITS), teachers, and students have a clear function to bring all students to reach the competency. This model can be described as arrange the pieces to form a unity puzzle have full meaning. Accordingly, this study carries novelty and state-of-the-art principles, those that can be taken into responsibility. Furthermore, this model's title is GaMa Feedback Learning Model (GFLM). The paper closely to this model was written by Guskey (2005) which explains that to help the students achieve their mastery level; their activities should be monitored by using assessments and also be controlled, but it did not provide further explanations about the controlling process in an e-learning. Figure 2 shows the basic design of GFLM as adapting of feedback control system.

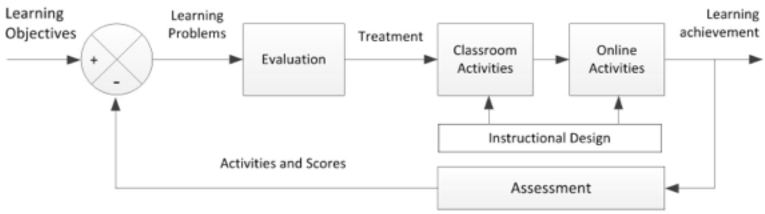

Fig. 2 - The Basic Design of GFLM

GFLM model also considers the mastery learning principles where students are given freedom to learn, monitored, helped to find their problems in the learning process, and provided with proper treatments for solutions. GFLM provide solutions for the learning success regarding the mastery..

TABLE 1
Feedback Control and GFLM Comparison

Parameter	Feedback Control	GFLM
Input	Set point	Learning objective(s)
Output	Controlled Variable	Learning achievements
Feedback	Measured Variable	Activities and score
Feed forward	Manipulating Variable	Learning treatment
Comparator output	Error	Learning problems
Feedback element	Using sensor	Using assessment tools
Object	Process	Classroom and online activities
Error finder	Using comparator	Using evaluation process
Goal	Stability	Mastery

Table 1 shows the comparison between the feedback control system and its adaptation in the GFLM. Motivation can serve as the driving force for GFLM since it creates enthusiasm in doing activities. The students' willingness to continuously use the facility is the key factor. The motivation can be from internal or external sources. William and William (2011) described learning interest and motivation through five components: student, teacher, content, method/process, and environment. A learning strategy by using interesting media can be used to draw learners' attention. To improve self-confidence, a positive comment to encourage learners also can be used as one of the strategies.

6 Discussion

GFLM is divided into three levels: (a) tools level consists of LMS and ITS. LMS types can be used in a wide range; the most important is the LMS must be able to present the data for assessment. ITS can use a variety of technologies and approaches; the important thing is how the ITS module can be integrated with the LMS and can be used effectively and independently by students, (b) teaching and learning level, can use a hybrid model with a variety of learning methods, as long as the teacher is still possible to treat the learning process either on a group or individual. The control characteristics on GFLM are at (c) the management level which refers to the interactive four-step management P-D-C-A. In this model, "Plan" means the design of instructional planning and teaching material, "Do" means implementing an appropriate learning, "Check" includes assessment, evaluation, and improvement plans, and the "Action" means conducting discussion and giving motivation, assignments, or additional tutorial.

Two major issues related to ITSs development are "what to teach" and "how to teach" (Santhi *et al.*, 2013). The typical ITS architecture consists of the knowledge-based model, student model, teaching model, and expert model. The main part is teaching model because it deals with the uncertainty of reasoning. It is associated with the decision-making process, that is to determine the most appropriate learning material to be given and the best kind of teaching method for students. There are many approaches in Artificial Intelligence that have been proposed for uncertainty reasoning, including: rule-based systems, Markov decision processing, fuzzy logic, Bayesian networks, Kohonen map networks, and neural networks. GFLM can be developed by using ITS which uses many approaches as long as it is an effective learning manner to the student. The web is at today's learning environment which makes it possible to construct an ITS that support the student to learn through free discovery (hypermedia), instructed system, or combination of both (Saleh & Papy, 2001). GFLM can be developed by any technology as long as it meets the instructional needs.

The implementation design consists of 3 activities: teaching-learning, assessment, and evaluation for improvement (Figure 3). It also consists of 5 variables: learning objective as input, learning achievements as output, learning problem as a trigger or a driver for teaching and learning activities, and treatment. An appropriate instructional design is important, because teaching and learning are core activities in GFLM. Giving assignment is surely required since motivation serves as the most essential point in the GFLM and it affects the student's activity.

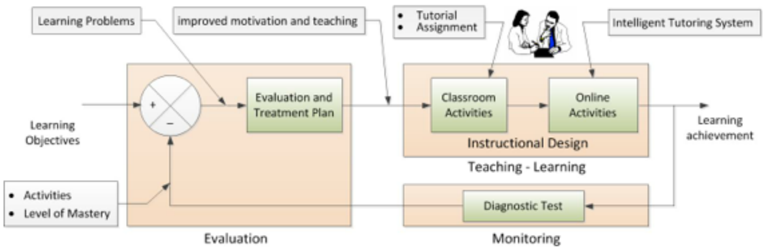

Fig. 3 - The Implementation Design of GFLM

6.1 Learning Objectives and Learning achievement

Learning objectives showed the learner's already-acquired competency that can be measured using a diagnostic test. When the measured area is only within the cognitive domain, the basic assumption is that the number of the correct answers should indicate the level of the learning achievement (Whiteley, 2008). The learners are considered to have achieved the mastery of learning, if they can answer minimal 70% of the diagnostic test (Leonard, 2008).

6.2 Learning problems

A learning problem is any difficulty experienced by a learner to achieve an intended mastery. Two groups of students undergo this problem. First, they are students who nearly achieved mastery but encountered difficulties in a particular topic, and the second group, it is comprised of students who have not achieved mastery because they do not master the basic concepts.

6.3 Evaluation and Improvement Plan

Improvement plan is carried out after finding out the learning problems and its evaluation. One of the learning improvements is giving motivation to the student and it is highly important in GFLM. If students are motivated, they are willing to participate in activities such as instructional design. Other learning improvement is conducting a discussion or repeating the tutorial.

6.4 Classroom-based teaching

GFLM is not to replace face-to-face learning model, but to combine classroom activities with online activities (hybrid models). The classroom-based meeting model has been there forever for any level of schooling, from the elementary to the university level. Consequently, indeed it is difficult to thoroughly replace it with a new model. Besides, a mixed model is the best to help employ e-learning (Moodie & Kunz, 2005).

6.5 Out-of-classroom learning (online activity)

Intelligent Tutoring System (ITS) can help increase the time allotment of student's self-learning. LMS and ITS can work together to serve the students so that they can learn outside of class through an online environment.

6.6 Instructional Design

The instructional design is created in such a way to ensure that the learning process complies with the e-learning model (Clark & Mayer, 2008). The core concept of GFLM is to provide a closed-cyclical process (Picture 3) and an instructional design should help students get a chance to gradually achieve a learning objective and also to provide a reliable monitoring system.

7 Implementation

The experiment was conducted at a nursing department of health science. GFLM applied in the English course which instructional objectives are mastery of grammar. The course consists of 15 themes. Each theme consists of 1 hour of watching the video tutorial and using ITS, 2 hours of practicing and collaborating in the classroom, and 2 hours of explanation by the lecturer. This model is similar to flipping classroom in which the typical lecture and homework elements of a course are reversed (Johnson & Renner, 2012).

The total number of participants is 109. The results are very significant, the students in the experimental group who achieved mastery are 100%, and it is greater than Bloom's criteria (95%). Students in the control group who achieved mastery are 40%. The experimental group had a significant increase in achievement compared to the control group. The pre-test between those two groups was homogeneous because grammatical knowledge showed no significant differences, while the post-test after using the model shows significant difference. The experimental group had a significant increase in achievement compared to the control group. The effect size of GFLM in this experiment is 2.3.

8 Conclusion

The ratio of the numbers of teachers and students is getting smaller. As a result, the contribution of a group based learning model to help achieve mastery is also getting lesser. GFLM is designed for group-based learning model but it provides the monitoring and improvement for every student independently. GFLM adapt the concept of a feedback control system to manage the learning process and its improvement. GFLM process control consists of the measurement of learning achievements through giving assessment to get scores and activity, comparing the learning objectives with learning achievements, finding learning problems, evaluating the learning problem to select improvement strategies, and providing motivation and improvement actions. The principles of control mechanism with GFLM can be operated if it is already equipped with LMS, ITS, and an appropriate instructional designs. By using GFLM, the teachers act as a learning partner to help more students achieve mastery in all objectives. It means that, mastery can be achieved because each student has a flexible learning time, followed the continuous learning process, accompanied by a teacher, and is always being motivated.

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