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Learning Management Using the Geometer's Sketchpad to Construct the Understanding of Mathematical Concepts for Eleventh Grade Students

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ABSTRACT

The purposes of this action research were to investigate the efficiencies of learning management (E_1 / E_2) using the Geometer's Sketchpad (GSP) in the topic of limit and continuity of functions, to examine student understandings of mathematical concepts, and to evaluate the student satisfaction towards learning with GSP. Participants in this study were consisted of 34 grade-11 students studying in the second semester, academic year 2014, Samsenwittayalai School, Bangkok, Thailand. The instruments used in this study were learning management plans, achievement tests, and a questionnaire. Activity worksheets and quizzes were used to assess efficiency of the learning process (E_1). The posttest was used to assess efficiency of the learning outcomes (E_2) and to examine student achievement. A questionnaire was used to evaluate student satisfaction. The researcher found that the proposed learning management integrated with GSP had efficiencies at E_1 / E_2 = 85.12/85.93 which were greater than the expected criterion at 70/70. The achievement test results had the average score at 85.93% which showed the positive effect of the proposed strategy on student understandings of mathematical concepts. Student satisfaction towards this learning management was at high level (average 4.24/5.00).

Keywords: Geometer's Sketchpad, Understanding of Mathematical Concepts, Student Satisfaction

1. Rationale and Significance of the Problem

Traditional teaching styles relied on direct instruction. Most of instructions had been given through static media such as whiteboard and paper works. These traditional teaching methods did not attract student attentions and obstructed student motivation and improvement.

Teaching and learning mathematics in 21st century, the National Council of Teachers of Mathematics (NCTM) plays a role in determining the direction of teaching and learning mathematics. NCTM determined that technology is an essential tool for learning mathematics in the 21st century. Effective teachers maximize the potential of technology to develop student understandings, stimulate their interests, and increase their proficiency in mathematics. When technology is used strategically, it can provide access to mathematics for all students (NCTM, 2000). Technology can help students to furnish visual image of mathematics ideas, facilitate organizing and analyzing data, and compute efficiently. Students can investigate characteristics of shapes using dynamics software and also focus on decision making, reflection, reasoning, and problem solving.

Calculus is one of the most difficult aspects of undergraduate mathematics. Difficulties exist in the teaching and learning as many topics in calculus involve with a large number of functions and equation systems. Such these math problems were solved by using pen and paper. However, it was difficult to develop student understanding with this traditional method. Meyer (2001) explains that students bridge the gap between concrete and increasingly abstract level through their creation and use of models, drawings, diagrams, tables or symbolic notations.

The Geometer's Sketchpad (GSP) is one of dynamic software that used in many secondary mathematics classrooms in more than 60 countries and was translated into 16 different languages. NCTM had identified one of its six principles as a technology principle and the Geometer's Sketchpad is one of those.

GSP provides teacher and students to with convenient, accurate, and precise construction, graph, measurement, and computation allowing students to encounter to mathematical ideas. The Geometer's Sketchpad gives students at all level a tangible and visual way to learn mathematics with the increasing of engagement, understanding, and achievement. Many research which use the GSP as a part of learning activities presented that it has positive effects on student learning achievement and satisfaction (Ames, 2011, Noom-on, 2011, Lekwongmanipun, 2011, Chulert, 2010, and Myles, 2006)

From the above reasons the researcher was interested in improving teaching and learning mathematics by including the Geometer's Sketchpad in the learning management.

2. Research Objectives

This research aims to develop the learning management with the use of the Geometer's Sketchpad. Objectives of the study are as follows:

1) To investigate the learning management efficiency using the Geometer's Sketchpad (GSP).
2) To examine student understanding of mathematical concepts.
3) To evaluate student satisfaction towards learning with GSP.

The framework of this research is illustrated in Figure 1.

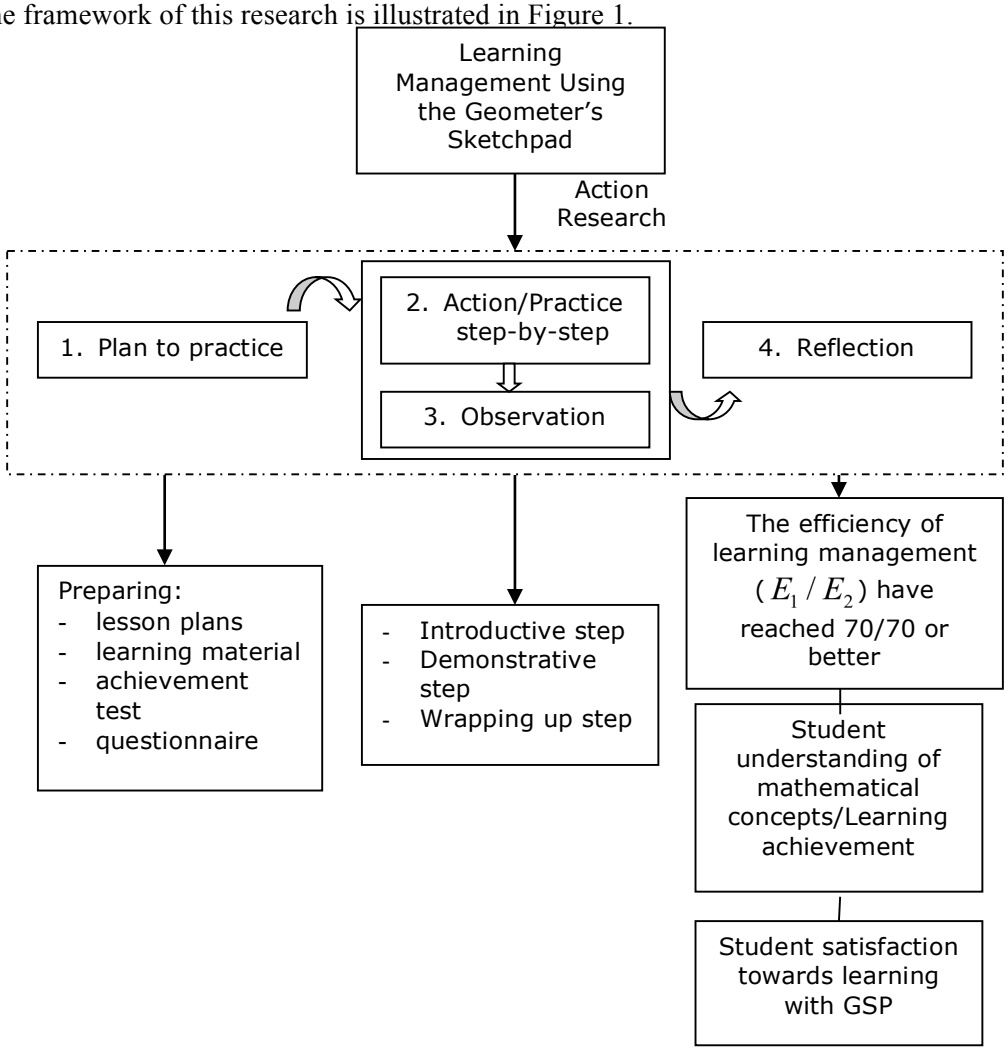

Figure 1
The framework of the study

3. Research Methodology

This research was design as a classroom action research. Participants of this study will be explained, followed by the explanation of research instruments, data collection, and data analysis.

3.1 Participants

Participants in this study were consisted of 34 grade-11 students studying in the second semester, academic year 2014, Samsenwittayalai School, Bangkok, Thailand. This research was done as a part of a pre-calculus course in the topic of limit and continuity of functions.

3.2 Research Instruments

Instruments used for collecting data are divided into three parts as follows:

1) Experiment tools which are consisted of 11 lesson plans involving exercises and quizzes in the topic of "limit and continuity of functions" in a pre-calculus course.
2) Achievement test (post-test) is consisted of 25 multiple-choice questions and 5 essay questions.
3) The questionnaire aimed to investigate the satisfaction of students after learning using the Geometer's Sketchpad.

3.3 Data Collection

Implementation of data collection, the researcher was conducted and collected the data in the second Semester of academic year 2014. The duration is October to November, 2014. The instruction has 12 periods with 11 lesson plans, as shown in Table 1. The data collection process is described as follows:

1) Prepared lesson plans, course contents, and research instruments. All instruments had been verified by three experts in the mathematics education field for content validity. Instruments Item-Objective Congruence (IOC) index value is higher than 0.5.
2) Taught the participants by using the prepared 11 lesson plans. The estimate time for each period is 50 minutes. Exercises were given during the instruction and student scores were collected. Student behaviors and participation in the classroom were also observed and recorded.
3) Test the participants by using the achievement test (post-test) in the final period.
4) The participants responded to the questionnaire to investigate their satisfaction towards learning using the Geometer's Sketchpad.

3.4 Data Analysis

The researcher analyzed both quantitative and qualitative data as follows:

1) Quantitative Data:
   - Use the data collected from exercises and the achievement test to calculate the percentage of mean value and to calculate for the learning efficiency (E_1 / E_2) (Promwong, 1977). Formulas are displayed in (1) and (2).
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$$E_1 = \frac{\frac{\sum x}{N}}{A} \times 100 \qquad (1)$$

where

E_1 means the percentage of the average scores of all formative tests of all learners,

$\sum x$ means the total scores of the formative tests the subjects have got,

N means the number of learners,

A means the total score of the formative test.

$$E_2 = \frac{\frac{\sum F}{N}}{B} \times 100 \qquad (2)$$

where

E_2 means the percentage of the average scores of all formative tests of all learners,
$\sum F$ means the total scores of the formative tests the subjects have got,
N means the number of learners,
B means the total score of the summative post-test.

- Find the arithmetic mean and the standard deviation of the achievement tests to determine student understandings. The same analysis was applied to the questionnaire results to evaluate student satisfaction which are categorized into four aspects consisting contents, learning management, learning materials, evaluation and assessment.

2) Qualitative Data:
   - Use the data gathered from the classroom observation to determine student learning behaviors.

4. Results of the Study

Activity worksheets were given in each period and students were asked to complete an exercise at the end of each period. Table 1 shows the average score on each unit. In the final period, students had to complete an achievement test (post-test). The results are displayed in Table 2. Data from these two tables are used to calculate learning efficiency (E_1 / E_2) as mentioned before. Experimental results yield the learning process efficiency (E_1) at 85.12 and the learning outcome efficiency E_2 at 85.93. Analysis of student satisfaction gave the results as shown in Table 3.

Table 1
Exercise and quiz scores

Lesson plan /Content	Mean (%)	S.D.
1. Finding Limits Numerically	83.43	2.48
2. Finding Limits Graphically	98.28	0.41
3. Finding Limits of Polynomial Function	94.61	0.81
4. Finding Limits of Indeterminate Forms	87.45	3.55
5. Finding Limits whose piece-wise defined functions	92.21	0.72
6. Finding Limits of functions whose absolute values	86.67	1.93
7. Finding Infinite Limits	78.04	4.23
8. Finding Limits of functions approaching infinity	70.49	3.75
9. Continuity of Polynomial Functions by Definition	81.23	3.64
10. Continuity of Polynomial Function by Graph	90.38	1.35
11. Continuity of Polynomial Functions on Interval	78.82	1.88
Overall Mean	85.12	

Table 2
Achievement test scores

Test items	Total score	Mean	%	S.D.
25 multiple-choice items	25	23.03	92.12	2.28
5 essay questions items	5	2.75	55	1.54
Total	30	25.78	85.93	3.21

Table 3
Student satisfaction

Aspect	Mean	Level
Content	4.13	High
Leaning Management	4.28	High

Learning Material	4.28	High
Evaluation and Assessment	4.28	High
Overall Mean	4.24	High

5. Conclusion, Discussion and Recommendation

5.1 Conclusion and Discussion

The designed learning management using the Geometer's Sketchpad has efficiencies (E_1 / E_2) at 85.12/85.93 which is higher than the expected criterion at 70/70. On the other hand, the achievement test results reflect the understanding of students after they had learned all contents in the selected topic (Limit and Continuity of Functions). The satisfaction of students towards leaning with GSP was at high level which means the use of GSP gave the positive feedback in teaching and learning mathematics.

5.2 Recommendations for Future Studies

1) According to the GSP license agreement, students were limited to use this software only in the designated computer lab at the school. Students should have an opportunity to use the software (or any equivalent software) at home. An online application is recommended if available.
2) The instructors are required to have understandings in both mathematics and computer technology to facilitate this learning process.

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