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Case Study: Using VDO or CAI in Studying Methods of Proof*

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The objective of the research is to study the effectiveness of the students' performance and the attitude of the students towards using VDO (MTH 225 principle of mathematics) or CAI (MTH 225 principle of mathematics) in studying the topic "Methods of Proof", of 74 students. The students would be categorized into: group A, students who choose to study via VDO; group B, students who choose to study via CAI; group C, students who both VDO and CAI; and group D, choose other resources, such as document from instructor. The data used are the result from testing basic knowledge on topic "logic", testing the effectiveness from self-study, mid-term test on topic "Methods of Proof" and questionnaires on attitude towards self-study lesson. From considering the result of two tests on the topic "Methods of Proof", it appeared that 44 students showed an increase in performance, whereas three students illustrated stable performance. However, the basic knowledge of the students is at an "average level", the achievement rate is at a "satisfactory level" and the score of the test is at an "average level". "Majority" of the students has activity studying behavior and has a "high level" of attitude towards studying principle of mathematics. In the usage of VDO, group A demonstrates an "average" attitude, whereas group C has an "above average" attitude towards the use of VDO. On the other hand, groups B and C illustrate an "above average" attitude towards the use of CAI in learning. Students of all the four groups showed an "average" performance in applying various processes. The result of the case study has shown that using VDO or CAI in teaching has been able to create understanding for the students at a certain level. Moreover, for a better result, teacher should also provide additional explanation to the students. However, the behavior of the students towards learning is one of the most important factors that affect the achievement of the students.

Keywords: using VDO (MTH 225 principle of mathematics) or CAI (MTH 225 principle of mathematics), methods of proof, effectiveness, attitude

Introduction

The subject "Principle of Mathematics" is a root to the other subjects for the students majoring in mathematics and statistics, according to the curriculum of Bachelor of Science or Bachelor of Education. Many students do not understand exactly the concept of mathematics that it does not consist only of finding the answers but also of logical reasoning, which requires understanding and basic knowledge. The content of this subject contains logical reasoning, with proofs to illustrate accuracy. "Methods of Proof" is the topic that explains the process of giving reasoning, finding the truth value from a given statement and using the given

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information, such as definition and theories in the conclusion. Usually, students have difficulties in understanding the steps of proving and the process of acquiring the result. A researcher, who has over 30 years of teaching experience, discovered that majority of the students has an achievement rate varying from average to below average, especially in writing proof, which is considered to be the most important topic in principle of mathematics.

In the first semester of the year 2008, the researcher studied the factors that affect the students' achievement rate on the subject "Principle of Mathematics", which reveals that students' basic knowledge in mathematics is one of the main issues affecting the achievement rate (Chundang & Setteechaichana, 2009, p. 9). From the test on the efficiency rate of the high school mathematics teachers during 2010 by a project of the Office of the Basic Education Commission for increasing the level of teacher in Thailand, it was found that out of the 5,375 participants, only three teachers (0.06%) achieved above 80%, whereas 4,497 (83.66%) achieved below 60% (MatichonOnline, 2010). This shows that many teachers do not have sufficient knowledge on the mathematics subject. This result may yield to the system of teaching that aims particularly on memorizing instead of thinking and analyzing and affect the knowledge of Thai students. Moreover, the result from O-NET (Ordination National Educational Test) on mathematics of grade 12 students in the year 2008 revealed that students had a mean score of 36.08 in mathematics (National Institute of Educational Testing Service, 2010). Because of diverse causal, it may yield that students did not pass the criterion 50% and attained mean score in mathematics less than other subjects. It is cleared that basic knowledge of the students is an important causal that affect the achievement in all levels. The basic knowledge which is necessary for study "Principle of Mathematics" comprises of knowledge from grades 10-12 in the topics of sets, real numbers, logic, relations and functions and basic calculus. As the sampling group consists of students majoring in mathematics, statistics and didactic mathematics, they should have good basic knowledge before entering the university level. As students had low basic knowledge on logic and did not acquire good foundation as they should, this has been a major problem since the past until now. The researcher believes that the problem is caused by both the teachers and the students. The guidance for teachers to reduce the setback is to provide the strong basic knowledge for the students, which can be done by several methods.

According to the research of Chundang and Setteechaichana (2009, p. 15), students showed their opinions that they need an additional tutoring from the teacher. The level of the opinion is at the "highest level" where the average mean value is 4.51 from 5. But in practice, teachers are not able to provide the supplementary training. Due to this problem, the researcher decided to involve technology to increase the efficiency of teaching by creating lesson via VDO (MTH225 principle of mathematics) and CAI (MTH225 principle of mathematics) to act as an aid in teaching the subject "Principle of Mathematics". The use of innovative media into the activities is one of the methods in allowing the students to think, analyze and solve the problems. The lesson through VDO includes pictures and sound which was generated an environment of studying like students are learning directly from the teacher. On the other hand, CAI is an interactive media, which presents the questions and answers that related to the concept of each topic "step by step". It can be used for practicing students' skill and testing students' knowledge. In this research, the researcher is interested to study the achievement rate and the attitude of the students towards using two learning materials.

Aims

The objective of the research is to study the effectiveness of the students' performance and the attitude of

the students towards using VDO or CAI in studying the topic “Methods of Proof”.

Materials and Methods

The sample of this research is the students that registered the subject “Principle of Mathematics” in the first semester of the academic year 2010. It comprises of 40 undergraduate students in Mathematics, 29 undergraduate students in statistics and five graduate students in didactic mathematics.

The researcher assigned the students to self-study on topic “Methods of Proof” through VDO and CAI, depending on individual preference of the students. This leads to the classification of the students into four groups: group A with 15 students studying through VDO; group B with 27 students studying through CAI; group C with 27 students studying through both VDO and CAI; and group D with five students studying from other resources, such as documents from instructor, supplementary books, Internet, etc..

The students were tested the basic knowledge by pre-test before studying “Principle of Mathematics”. The questions used in this test are multiple choices or writing short answer. After the completion of the topic on logic and reasoning, the students were assigned to self-study for 10 days on the “Methods of Proof” via VDO and CAI, and were asked to give their attitude toward using the lesson. Students were also tested a post-test to check their achievement rate on the topic “Methods of Proof”, which consisted of five questions. Students were asked to write the solution of each question in detail. Subsequently, the researcher provided an additional explanation and followed by a mid-term examination in the academic year of King Mongkut’s University of Technology Thonburi.

The criterion used for dividing the level of students’ knowledge in each test is given in Table 1.

Table 1

Level of Students’ Knowledge Classify by the Scores in Each Test

Pre-test		Post-test		Mid-term-test	
Range of scores	Level of knowledge	Range of marks	Level of knowledge	Range of marks	Level of knowledge
21-25	Excellent	25-30	Excellent	22.5-28	Excellent
16-20	Good	19-24	Good	16.9-22.4	Good
11-15	Average	13-18	Average	11.3-16.8	Average
6-10	Satisfactory	7-12	Satisfactory	5.7-11.2	Satisfactory
0-5	Unsatisfactory	0-6	Unsatisfactory	0-5.6	Unsatisfactory

Notes. Total scores for pre-test = 25; total scores for post-test = 30; and total scores for mid-term-test = 28.

The criterion used for dividing the level of students’ studying behavior is given as follows:

(1) 3.26-4.00: students very often practice;

(2) 2.51-3.25: students often practice;

(3) 1.76-2.50: students occasionally practice;

(4) 1.00-1.75: students rarely practice.

The criterion used for dividing the level of students’ attitude toward studying or the level of students’ satisfaction toward using VDO/CAI on the topic “Methods of Proof” is given as follows:

(1) 4.21-5.00: highest level satisfaction;

(2) 3.41-4.20: high level satisfaction;

(3) 2.61-3.40: average level satisfaction;

(4) 1.81-2.60: low level satisfaction;

(5) 1.00-1.80: lowest level satisfaction.

Consequent from receiving the scores of all three tests, the attitude scale test and the satisfaction of the students towards using two learning materials were statistical analyzed to attain the maximum, the minimum, the mean score, the percentage of the mean score and the level of the satisfaction.

Results

As students were divided into four groups depending on their individual preference of studying through VDO and CAI, it was found that majority of the students had average grade point 2.01-2.50, which means that their ability is at a moderate level. Approximately, 14% of students had low ability. However, every group had high ability students. The average of the ability of students in group D is at the highest and followed by group B, group C and group A, respectively. The number of students in each group with their cumulative average grade point in each interval is shown in Table 2.

Table 2

Number of the Students in Each Group Related to the Cumulative Average Grade Point

Interval of cumulative average grade point	Number of students			
	Group A	Group B	Group C	Group D
3.51-4.00	0	0	0	0
3.01-3.50	1	3	3	2
2.51-3.00	3	13	7	1
2.00-2.50	6	11	13	1
1.51-2.00	5	0	4	1
Less than 1.50	0	0	0	0

By classifying the level of students' knowledge according to the scores of each test with the criterion given in Table 1, there are number of students in each level as shown in Table 3.

Table 3

Number of the Students Related to the Level of Knowledge on Each Test

Level of knowledge	Number of students		
	Pre-test	Post-test	Mid-term-test
Excellent	2	1	10
Good	11	5	11
Average	39	10	17
Satisfactory	20	48	32
Unsatisfactory	2	10	4

The results of this research were analyzed into five issues as follows: results from testing, behavior of students in study, attitude toward the subject principle of mathematics, satisfaction from using VDO and CAI and self-evaluation of students on topic "Methods of Proof".

Result From Testing

From analyzing the results of each test, it was found that students in groups A, B and C had an "average level" of basic knowledge before studying "Principle of Mathematics" and had a "satisfactory level" in the achievement rate after self-study the lesson, whereas students in group D had a "good level" and had an "average level", respectively. In the mid-term-test, students in groups A, B and D had an "average level" knowledge, whereas students in group C had a "satisfactory level" knowledge.

Table 4

Maximum Minimum and Mean Scores of the Sample Groups A, B, C and D on Each Test

	Group A			Group B			Group C			Group D		
	Pre	Post	Mid	Pre	Post	Mid	Pre	Post	Mid	Pre	Post	Mid
Min	6	3	1	5	4	2	6	1	0	13	4	7
Max	20	24	27	17	21	27	17	22	24	24	27	28
Mean	10.3	10.0	15.6	13	10.4	13.9	11.4	10	10.7	18	14.4	16.6

It is interesting to observe from Table 4 that the result of pre-test is higher than the result of post-test. This may be due to the different styles of questions used in each test and the reason that the previous knowledge of the students from high school on the topic logic is diverse from the topic "Methods of Proof" taught in university. There are 44 students who had their scores in mid-term-test higher than their scores in post-test. Three students illustrated stable performance. Seventeen students had the score increasing more than 30% and three students had the score decreasing more than 30%. This may be due to the additional explanation given by the teacher before the mid-term-test. Group A and group D had the mean score in mid-term above 50%. Some students were able to increase their scores up to the excellent level. The highest percent of the increasing scores in group A is 72.9%, in group B is 63.1%, in group C is 55.7% and in group D is 30.0%. From considering students' ability by their own grade average point in the second semester of the academic year 2009 which was shown in Table 2, it was found that result of these three tests correspond to students' ability. Therefore, students' ability affects the result of the tests. Figure 1 shows that no less than half of the students in each group had their performance in mid-term-test better than post-test.

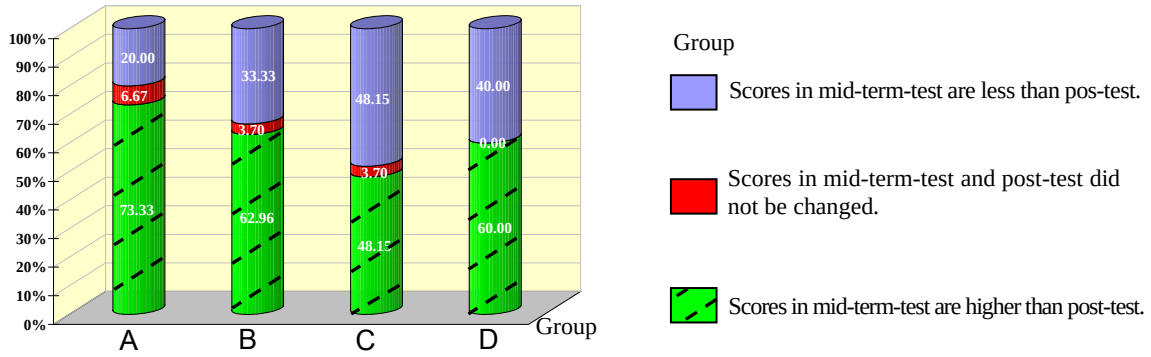

Figure 1. Percent of number of students in each group related to the changing scores between post-test and mid-term-test.

Behavior of the Study

Data used in analyzing the behavior of studying were collected from self-evaluation of the students in answering some part of the questions in questionnaire. Students from every group thought that they had often practiced activity. Out of the total number of students, 41 students set up a regular timetable, involving one to five hours/week on additional learning for all subjects. In contrary, two students consumed approximately 21 to 25 hours/week. This means that most of the students did not utilize adequate time in revising on each subject and have their practice behavior in studying like high school students. Students rely solely on the teacher to provide the maximum knowledge, as well as their behavior within the classroom and outside the classroom.

This behavior might be one obstacle for unsuccessful self-study in the topic “Methods of Proof”.

In students’ opinion about their studying behavior in the classroom, it was shown that a large number of students prefer to take note all the information written by the instructor rather than listen to the instructor’ explanation. Moreover, they dislike interacting with the instructor in the class. Students behaved, as they believe it to be the way of showing their interest and concentration towards the subject and their note can be used for further revision. This belief is not correct, because behavior of writing all the information without understanding cannot bring students to increase their knowledge even with constant revision. Therefore, during studying in classroom, students should give full attention to the explanation by the instructor before writing the information in their own understanding and revise their knowledge after that class.

In students’ opinion about their studying behavior outside the classroom, it was shown that they took pleasure in entering the library for acquiring additional understanding

Attitude Toward the Subject “Principle of Mathematics”

From analyzing the result of questionnaire answering in their attitude towards the subject principle of mathematics on the topic “Methods of Proof”, it was found that students from groups A, B and C show “high” enthusiasm on studying the subject, unlike group D with “average” interest. As group D believes the topic requires “average” effort, other groups require “highest” attempt for understanding the topic. It is interesting to note that students from group D had different attitude towards the topic, because some of them had good basic knowledge with a level “good” to “excellent” and illustrated an efficient studying behavior as well.

Satisfaction From Using VDO and CAI

From analyzing the result of questionnaire answering in using lesson through VDO, it was shown in Figure 2 that students in group A had an “average” level of satisfaction, whereas group C had a “high” level of satisfaction. Most of the students suggested that font size showed in VDO was small and color of the alphabet did not clear enough, causing the reduction of interest toward its usage. This problem should be improved for the new constructing media. The result from using lesson through CAI of groups B and C illustrated “high” level of satisfaction, except on the aspect of “introducing to the lesson” and on the aspect of “reading easiness of font and color”. Students in group B satisfied those two aspects with “average”, whereas students in group C satisfied with “high” level of satisfaction. This may be due to that students in group C are higher interested in the content than the outlook. On the other hand, students in group B may concentrate on the outlook more than the content.

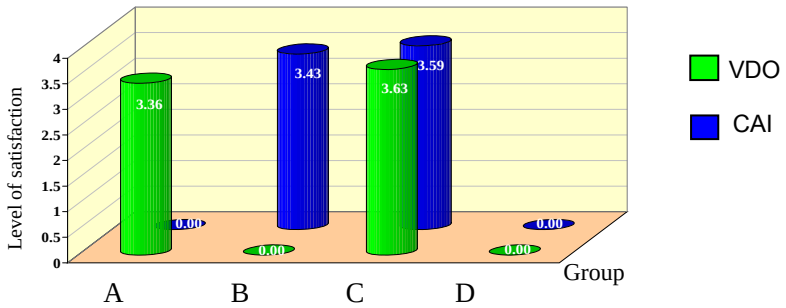

Figure 2. Level of satisfaction through using VDO/CAI.

However, students were believable in the instructor and preferred to study from the instructor more than

studying the lesson through VDO or CAI. This feeling might be one of the reasons for students' lacking of attention in self-study and causing the students' inefficiency in studying the topic on methods of proofs.

Self-evaluation on Topic "Methods of Proof"

From evaluation self-efficiency of the students after self-study the lesson, it was clarified in a big picture that they understand that the concept of "Methods of Proof", know how to proof, were able to choose the suitable method in proving and write the proof at an "average level". Students in group C thought that they understand the concept with "high level" which is above other groups. It is interesting to consider that students in group D supposed themselves to have "low level" of understanding, as they believed that to have high level of understanding that they should be able to gain outstanding score. Students in groups B, C and D deemed themselves as having "average level" in proving several form of sentences, but students in group A assumed themselves having "low level" of proving. When considering self-efficiency of the students in proving different form of sentences, students in group C supposed themselves to have "average level" of proving sentences in the form $P \vee Q$ and proving by induction method. Their estimate is higher than others group. This contradicts to the estimation of students in group A, who supposed themselves to have "low level" of proving by contradiction and cases. Overmuch, students estimated their skills in completing the assigned work of the 10 scores to be 5.26-6.36, which is an "average level". The assessment on the knowledge of the students on the subject matter by the students had a mean close to the score that they obtained.

Sample of Case Study

In our case study, the researcher randomly chose eight students' results by using the ratio 10:1 as an example of various issues as follows. The level of students' knowledge classify by using the criterion in Table 1 is shown in Table 5.

Table 5

Level of Students' Knowledge Related to Each Test in Case Study

	Level of students' knowledge							
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Pre-test	E	G	G	G	A	A	A	S
Post-test	G	G	U	S	S	U	U	U
Mid-term-test	E	E	S	E	E	E	S	U

Notes. E means excellent; G means good; A means average; S means satisfactory; and U means unsatisfactory.

Student Number 1 had average grade point between 3.01-3.50 in the second semester of the year 2009. He had a good performance in studying and thought that mathematic is an interesting subject more than others. He liked to read and self-study from other sources. He evaluated his ability himself at an average level;

Student Number 2 also had average grade point between 3.01-3.50. He had a good performance in studying and liked to take a lecture note from the teacher during the study in the class. He thought that the topic "Methods of Proof" is not difficult to study. He studied from VDO and evaluated his ability at a good level;

Student Number 3 had average grade point between 1.51-2.00. He had a practice activity sometimes in studying and thought that the topic "Methods of Proof" is a difficult topic for studying. He studied from VDO and CAI and evaluated his ability at an average level;

Student Number 4 had average grade point between 2.51-3.00. She had a good performance in studying and sometimes took a lecture note from the teacher during the study in the class. She thought that the topic

“Methods of Proof” is an exciting subject and she gave full attention to study. She was “highly” satisfied with the instructional medias. She studied from VDO and CAI and evaluated her ability at an average level;

Student Number 5 had average grade point between 1.51-2.00. He had a very good performance in studying and sometimes took a lecture note from the teacher during the study in the class. He thought that the topic “Methods of Proof” is a very interesting topic to study and he had to pay very much attention to studying. He himself studied from CAI and evaluated his ability at an average level;

Student Number 6 had average grade point between 2.01-2.50. He had a very good performance in studying and usually listened to the instructor and eagerness to study from other resources for self betterment. He thought that the topic “Methods of Proof” is a very difficult topic to study and he needed more attempt in studying. He studied from VDO and evaluated his ability at a good level;

Student Number 7 had average grade point between 1.51-2.00. She did not have a right performance in studying and liked to take a lecture note from the teacher during the study in the class. She thought that the topic “Methods of Proof” is a very difficult topic and she did not pay attention to studying. However, she evaluates her ability at an average level;

Student Number 8 had average grade point between 1.51-2.00. She also did not have a right performance in studying and liked to take a lecture note from the teacher during the study in the class. She thought that the subject “Principle of Mathematics” is a difficult subject and she did not like to study this subject. She studied from VDO and evaluated her ability at a low level.

From the sample of case study, it can be concluded that some students were able to make a progressive performance due to their studying behavior. Some of good students evaluated themselves lower than reality, but some of probation students evaluated themselves higher than reality. Some of probation students were not able to make any progress even with the usage of both VDO as well as additional explanation of the instructor, which is due to their lack of concentration while learning the lesson. The result corresponds to the assessment on the students’ behavior which shows that the students had low attention span, preferred noting the information with less than listening to the instructor and had “satisfactory level” of studying behavior. Nevertheless, students believed the subject to be important with high effort needed. Therefore, they were “highly” satisfied with the instructional media. Moreover, if the students are provided with good basic skills on mathematics, good preparation both in the methods of studying and the environment of learning and eagerness in gaining knowledge with confidence, then the students would acquire the skills in accumulating additional information with great efficiency.

Conclusions and Discussion

In conclusion, the lesson through VDO and CAI has been assisted the students for better understanding at a certain level. However, basic knowledge, behavior in studying and an additional explanation by the instructor are also necessary for the most effective result in achievement rate of the students. Likewise, for higher effective result and the best achievement of the students, the teacher must create a clear objective of using the media and the improvement to the students. Instructional media as ICT (information and communications technology) does have a role in education and can be applied by the teacher to all academic groups of all the subjects. The instructor must begin by deciding on the content, objectives, activities and the method of evaluation. The instructor can organize the activity for the intangible subject like “Principle of Mathematics”, as follows: pre-test, self-study on the lesson through VDO or CAI, and additional explanation by instructor and post-test.

In case of using ICT for explanation instead of instructor, one can ask students to self-practice from CAI. The recommendation from this research is that the media should be applied to the students who have average to good academic performance. However, students who have good basic knowledge will not collaborate with this studying, because they like to study the content from instructor and prefer to use media which purpose content outside the normal curriculum and evaluate their knowledge.

The instructor, who prefers to use ICT instructional media for teaching or expanding information in the regular class, can apply the media to the students who have average performance and are able to manage their studying behavior. Students with average basic knowledge will have good attitude towards using ICT and tend to provide full support, as the students believe that they are able to educate themselves using instructional media available for their betterment. However, students with below average basic knowledge are not able to manage their studying behavior, and all the types of media used will not be able to support them to increase their knowledge.

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