Impact Of Geometer's Sketchpad On Students Achievement In Graph Functions

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ABSTRACT

The purpose of this study is to investigate the effect of using the Geometer's Sketchpad software in the teaching and learning of graph functions among Form Six (Grade 12) students in a Malaysian secondary school. This study utilized a quasi-experimental design using intact group of students from two classes in an urban secondary school. Two instruments were used to gather information on the students' mathematics achievement and attitudes towards learning graph functions.A survey questionnaire was used to gauge students' perception on the usage of Geometer's Sketchpad in the learning of graph functions.In the study, the experimental groups used Geometer's Sketchpad-based worksheets and each student has an access to one computer equipped with the Sketchpad software. The control group used only the textbooks. Both groups took the same pre-test.This study indicated that the results ofthe experimental group had a significant mean difference compared to the control group. The use of Geometer's Sketchpad in mathematics classroom has positive effect on the students' mathematics achievement and attitude towards the learning of graph of functions also improved.

Keywords:	*Graph Functions, students achievement, dynamical geometric software, educational technology, students attitude*

INTRODUCTION

Geometers' Sketchpad encourage and facilitate those new broader conceptions of school algebra, and they raise deep questions about the appropriate role of traditional symbol manipulation skills (CBMS, 2000). With Geometers' Sketchpad, students' not only solve problems or compute solutions, they construct models to solve problems and generate solutions and thus have experiences closer to that of doing algebra than simply studying it (Jackiw, 2004). According to Heibert (1999), students knowledge and skills are very fragile and apparently learned without much depth in conceptual understanding.

This is one of the reasons why is necessary to change the way mathematics is taught. We are now able to help our students analyze, visualize and make informal conjectures by using many types of manipulative that includes the geometric and algebraic computer software. In 1989, the Curriculum and Evaluation Standards for School Mathematics (The Standards) was published by the National Council of Teachers of Mathematics which recommended the change in the way we teach mathematics. Furthermore, the Standards promoted algebra as on of the content strands of the mathematics curriculum for kindergarten through Grade 12. In addition, the Standards also wanted an increase in open exploration and conjecturing plus more attention on mathematical reasoning with the use of the available technology.

Mathematic educators have long promoted the use of technology in the teaching and learning of mathematics (National Council of Teachers of Mathematics 1989, 2000). Electronic technologies like computers and educational software are essential tools for the teaching and learning of mathematics. They can support investigation by student in every area of mathematics, including geometry, statistics, algebra , measurement and number (NCTM, 2000). Currently Geometer's Sketchpad is not only used for creating, exploring and analyzing in the field of geometry but also in algebra , calculus, pre-calculus and trigonometry, and other areas (Jackiw, 2002). Moreover, the graphing

utilities of Geometer's Sketchpad facilitates the exploration of the characteristics of functions. The latest version of Sketchpad features enhancements such as built-in web integration, improved sample explorations, and manipulation of functions that make it an effective learning environment in a greater variety of classes (Key Curriculum Press, 2004) .

In Malaysia, the concept of function is first introduced specifically in the   Form 4(Grade 9) Additional Mathematics syllabus. Students are introduced to the concepts of function and its properties (Ministry of Education, 1998, 2003) . This is continued in the Form Five Modern Mathematics syllabus where students are exposed to the shape and properties of graphs of linear, quadratic and cubic functions (Ministry of Education, 1998, 2003). In the latest Modern Mathematics curriculum specifications, the suggested learning activities is to explore the graphs of functions using the Geometer's Sketchpad (Ministry of Education, 2006). This is then expanded in the Mathematics T syllabus for Form Six (Grade 12) students whereby the students need to understand the more complex concept of functions and the type of functions . Moreover, the students need to master the basic properties and sketch the graphs of algebraic functions, trigonometric functions and absolute value functions (Malaysia Examination Council, 2003). The concept of functions has assumed a important role in the algebra curriculum in the past decade. Students are taught to model a wide range of phenomenon and are expected to be comfortable using numerical, graphical, symbols and tabular representations for functions. In addition, it was found that among others, pattern and functions dealing with algebraic equations plays an important role to students' success in mathematics (TIMSS, 1995).

In the teaching of algebraic function, most of it is taught using the chalk and talk method or commonly known as the traditional method. Drawing of graphs is usually done by sketches that are static, not according to scale and some distorted (Teoh& Fong, 2005).   Students cannot visualize the shape of the graphs and have a poor understanding of the shape of the graphs. The presence of visualization software like the Geometer's Sketchpad will present an alternative to overcome these instructional inadequacies. This study aims to investigate the impact of using Geometer's Sketchpad in the graphing of functions among Form Six students. Graph functions achievement and students attitude are the main areas of study.

NEED OF THE STUDY

As we know Mathematics is long known as a dull subject due to the memorization of formulae and monotonous computation. Most of the time the tools to manipulate numbers are the pencil and paper. However, according to Heid (1997) mathematics usually deals with logic and reasoning, problem solving, number sense and a search of relationships. Therefore, to enhance the teaching and learning process we look at technology as a tool. Graphing software like Geometers' Sketchpad can help inject excitement and enthusiasm in the teaching and learning of mathematics.

In the school curriculum, the study of algebra has long been perceived as difficult because of the abstract nature of the content (Looney, 2004). As we know the function concept is considered by many to be one of the most central concepts in all mathematics, yet it is one for which students rarely develop adequate understanding. Numerous studies (Harvey, Waits, &Demana, 1995) have been conducted to examine the effects of Geometer's Sketchpad on function understanding. These studies were generally focused on student achievement and generally showed that students using educational software like Geometer's Sketchpad performed as well on tests of traditional algebra as did students without such technology and, at the same time, improved performance on visual and graphing tasks .

In Malaysia, studies done by Nurulhidayah Lucy (2001) and Teoh& Fong (2005) also supported the findings that Geometer'sSketchpad   does indeed increase students achievement in the visual and graphing of functions. NorainiIdris (2003, 2006) found that students' using Geometer's Sketchpad in the experimental group achieved significantly greater change in van Hiele levels compared to students who did not use the Geometer's Sketchpad.

Students face many obstacles trying to understand functions. According to Sierpinska (1992) , the most objective ones are epistemological obstacles identified and described. Another difficulty in students' understanding of the concept of function stems form its dual nature. Indeed, function can be understood in two essentially different ways: structurally –as an object and operationally – as a process (Sfand, 1991). Those two ways of understanding functions, although apparently ruling out one another, should, however, complete each other and constitute a coherent unity-like two sides of the same coin   (Sfand, 1991) .

This study is intended to investigate the Form 6 students achievement in graphing functions . In addition, this

study also wants to know how it can help in visualization of the graphs. The usage of the Geometer's Sketchpad in this area will show whether there is a change to a positive attitude of learning among the students. Lastly, it is hoped that this study will further encourage the usage of this software in the teaching and learning of graph functions.

PURPOSE OF THE STUDY

Graphical representation of functions is accessible and can be used in a meaningful way. The main focus of this study is to find out the effectiveness of Geometer's Sketchpad in the graphing of algebraic functions among Form Six students . Specifically, the objectives of the study is

a) to investigate the effectiveness of using Geometer's Sketchpad on the students' achievement in graph functions

b) to examine the Geometer's Sketchpad usage in mathematics classroom specifically on the students attitude towards graph functions

c) to obtain the perception of students on the use of Geometer's Sketchpad in the teaching and learning of graph functions

RESEARCH QUESTIONS

This study attempts to answer the following research questions :

1) Is there any significant difference in the students' achievement in graphing of functions between the experimental and control group ?

2) Is there any significant difference in the students' attitude   between the experimental and control group in learning graph functions ?

3) What are the students perceptions about using the Geometers' Sketchpad in learning graph functions ?

Nowadays, teachers use various tools and devices like charts, models and videos to help students understand and master concepts. The software Geometer's Sketchpad not only allows user to make constructions but is also able to solve problems related to graph functions. As we know, this study is important in the implementation of dynamic software like Geometer's Sketchpad in the pre-university level. If using Geometer's Sketchpad is found to be effective, teachers will be encouraged to use this software as one of the possible ways in the teaching and   learning on graphing of functions.

SAMPLING

43 Form Six students from two intact classes participated in this study.. The students were from an urban secondary school in Kuala Lumpur. This school has a total student population of 1600 students The student population in this school reflects the multiracial citizens in the country. It is a controlled secondary school which allows students with good academic record in the primary school to gain admission. The selection of the students' began with the researcher seeking permission from the principal to conduct the study. Purposive sampling was used since the two classes were intact. The researcher randomly selected one class as an experimental group while the other class became the control group. Twenty two students from one intact class were selected as the sample for the experimental group that underwent lessons using Geometer's Sketchpad. Another twenty one students from another class became the control group and they were taught using the traditional chalk and talk approach. Most of the students came from a middle income family.

INSTRUMENTATION

Two research instrument were developed by the researcher. The first instrument was the achievement test while the second was the attitude test.

a) Graph Functions Achievement Test

The Graph Functions Achievement Test was created to measure and gauge the students' knowledge and ability to understand and solve problems related to the graphing of functions. In this study , the graph functions achievement test was also used to provide information on how well the students learned what they have been taught in school. This test used the a paper-and-pencil procedure and it was a formal test. Two experienced mathematics teachers with and average of 10 years of teaching experience and the researcher prepared this test to ensure its content and construct validity.

The content of the test are as shown in Table 1

Table 1 *Content of Graph Functions Achievement Test*

Content of Graph Functions Achievement Test

Content	Focus	Question number	
		Pre-Test	Post-Test
Algebraic Function	a) Determine the properties of algebraic function	1(a)	1(a)
	b) Sketch the shape of the cubic function graph	4(a)	4(a)
	c) Determine the properties in variation of cubic functions	4(c)	4(c)
	d) Sketch the shape of the quartic functions graph	4(b)	4(b)
	e) Determine the properties in variation of quartic functions	4(d)	4(d)
	f) Sketch and know the properties of rational algebraic function	5	5
Trigonometric Function	a) Determine the shape of the trigonometric graph and the variation as the parameter is changed	2(a)	2(a)
	b) State the properties in variation of trigonometric function graph	2(b)	2(b)
Absolute Value Function	a) Sketch the absolute value graph	1(a)	1(b)
	b) State the properties in variation of absolute value function graph	2	2
Total questions		5	5

b) Attitude Test

This test consists of 10 questions on a four (4) point Likert Scale.. It is a formal and systematic test that used a paper and pencil procedure for gathering information on students' attitude.

The Attitude Test evaluates the 3 dimensions which have relevance to the teaching and learning of graph

functions. The dimensions covered include

a) Usage of Geometer's Sketchpad in graph functions

b) Interest towards graph functions with Geometer's Sketchpad

c) Self-Concept towards Graph Functions

c) Students' Perception

A student questionnaire was created to know their perceptions and beliefs on the usage of Geometer's Sketchpad in the learning of graph functions. The student questionnaire was consists of a series of statement on a five (5) point LikertScale . This instrument is divided into 3 categories namely :

i) Usage of the Geometer's Sketchpad

ii) How Geometer's Sketchpad helps the understanding of graph functions concepts

iii) Students' confidence in problem solving when using Geometer's Sketchpad and

the ability to communicate when using Geometer's Sketchpad

INSTRUCTIONAL ACTIVITIES

This research used instructional activities based on Geometers' Sketchpad to help the students in understanding the graphing of functions better. In the instructional activities, the students are exposed on using Geometers' Sketchpad to draw the algebraic functions, trigonometric functions and absolute value functions. The students used the instructional activities for ten weeks.

The activities allowed the students to explore, discover and investigate the concepts of graphing of functions. Besides that , these activities also helped the students to enhance their logical and critical thinking. The students will also be exposed to a modern technology which will help them in mathematical problem solving and communications.

RELIABILITY AND VALIDITY OF INSTRUMENTS

The instrument, the Graph Functions Achievement Test was designed by the researcher with the help of two experienced mathematics teachers. This test was validated by two very experienced mathematics teachers. One of them is the head of the mathematics department with 15 years of experience teaching mathematics in secondary schools while the other teacher is an expert Mathematics teacher with 10 years of experience teaching mathematics.

Both the teachers have been asked to evaluate each item of the achievement test based on the suitability of the content and assess the concepts and skills. In addition, the panel also studied the items to make sure it is within the ability of students to answer, the difficulty level and suitability of the terms used. Basically, they are satisfied with the content of all the items which is in accordance with the Form Six mathematics syllabus. They also found that the questions are suitable for the academic level of the students.

The students perception questionnaires was validated by two experienced teachers. One of them is the head of the English department with 15 years of experience in secondary schools while the other teacher is a mathematics teacher with 10 years of experience in secondary schools. Both the teachers were informed on the purpose of the questionnaires. They were then requested to evaluate the concepts and skills, suitability of terms and difficulty level of the statements in the questionnaires. Generally, they understood and are satisfied with all the statements in the questionnaire.

In addition, the Attitude Test was validated by 2 experienced mathematics teachers. They were informed on the purpose of the test and were requested to assess it. Generally, they were satisfied with the questions and found it also suitable for the students.

The internal consistency of the instrument is checked by the researcher using the alpha coefficient, also known as Cronbach-Alpha. In addition, the alpha coefficient also checks the reliability of the items and the stability of the students' response towards it. A pilot study was conducted in a secondary school in Kuala Lumpur to a class of 30

Form Six students before the actual data collection using the test-retest method. The pilot test was important to improve any possible defects in text and test item. Comments and suggestions from students were taken down to assist in the actual data collection. Scores obtained from the test-retest are used to calculate the alpha coefficient. Based on the result of the calculation, the reliability coefficient for the overall item of the graph functions achievement test is 0.79.

DESIGN OF STUDY

This study follows a quasi experimental research design . For this study, the subject used is students in their intact classes so that it won't disrupt the daily routine of the school. In this research, the subject is divided into two groups which is the control group and the experimental group. The experimental group which consists of 22 students will be taught using the Geometer's Sketchpad for the duration of ten weeks. Meanwhile in the control group which consists of 21 students, they will be exposed to the traditional method of chalk and talk for ten weeks and using the normal exercises from the textbook. The research design is shown below.

| Experimental group | O 1   X 1   O 2 |
| Control group | O 1   X 2   O 2 |

O 1   represents the pre-test

O 2   represents the post-test

X 1   represents the students learning graph functions using Geometer's Sketchpad

X 2   represents the students learning graph functions using traditional method

Data collection procedure

Before starting the test, some simple instructions were told to the students. They were informed on the purpose of this study and to regard it as a formal test. Furthermore, their co-operation in this study is important and greatly appreciated. The test consists of all subjective questions that includes algebraic function, trigonometric function and absolute value function.

43 Form Six science students took the Graph Functions Achievement test in the beginning of the research (pre-test) which consists of 5 main questions. Pre-test is essential to measure the prior knowledge they have on the topic graph functions. Students were reminded to show all steps involved in obtaining the answer so not to lose any marks. After taking the achievement pre-test, the students were required to take the attitude test.

Students in the experimental group was exposed to the instructional activities that was prepared by the researcher. The instructional activities followed closely the syllabus and curriculum specifications of the Form Six mathematics topic of graph functions. One of the main difference of these lessons compared to the traditional method was that they applied the use of Geometer's Sketchpad in the learning of graph functions. Students were able to visualize and explore the mathematical concept that were being taught. This enhances learning because they are also able to test their own conjectures and learning becomes fun. The lessons also encourages students to interact with each other to solve problems and this will surely improve the communication among them.

In the experimental group, the students were given time to explore Geometer's Sketchpad on their own after the basic use of it was taught. As the lessons progressed, the teacher would share the features of Geometer's Sketchpad . In the control groups , students who are taught using the traditional method which is known as the chalk and talk method that also uses the mathematics textbook. Meanwhile, the experimental group are the students in a class taught using the Geometer's Sketchpad. Both the groups were taught for a duration of ten weeks.

After going through the instructional activities using Geometers' Sketchpad on graphing of functions for ten weeks, the students in the experimental once again took the graph functions achievement test (post-test) and the

attitude test. The students in the control group were also administered the graph functions achievement test and attitude test after ten weeks. Post–test is important to measure the students achievement after being exposed to two different types of teaching method. Furthermore, this is to evaluate the impact of Geometer's Sketchpad on the learning of the topic graph functions. In addition, questionnaires were also given to both group of students to find out what they thought about using Geometer's Sketchpad in learning graph functions.

The duration of the test is one hour. For the posttest, it was carried out on the same day for both the control and experimental group. Both the pretest and posttest was conducted by the researcher. The graph functions achievement test is a paper and pen test. It contains five main questions which tests the students on algebraic function, trigonometric function and absolute value function. Students need to answer the tests in the space provided in the question paper. After one hour, the researcher will collect the question paper that contains the answers of the students. The students taking the pretest and posttest are the same students from the control and experimental group.

ANALYSIS OF DATA

Descriptive statistics was used to compute the t-values of both the control group and the experimental group using a statistical software called SPSS. In addition, the mean and standard deviation for the scores in the beginning and the end of the research for both the control and experimental were compared to compute their t-values. The t-values were used to compute whether the scores at the beginning and the end of research is significantly different.

In order to find out about the students' attitude in using the Geometer's Sketchpad, an Attitude Test was used. It was also analyzed using descriptive statistics .In addition, the mean and standard deviation for the scores in the beginning and the end of the research for both the control and experimental were compared to compute their t-values.

A questionnaire was created to gauge the students perception on using the Geometer's Sketchpad in the graph functions lessons . A five point Likert scale was used. Data for the students' perceptions on the usage of Geometer's Sketchpad were analyzed with descriptive statistics using frequency and percentages.

Graph Functions Achievement Test

Table 2 Mean, standard deviation and t-values for both groups

	Groups	M	SD	df	t	p
Pre-test	Control (n=21)	12.95	13.48	20	−3.42	0.15
	Experimental (n=22)	29.23	18.62			
Post-test	Control (n=21)	29.14	18.41	20	−5.07	0.00
	Experimental (n=22)	65.9	23.54			

$p < 0.01$

The results shows that the experimental group has a pre-test mean score of 29.23 (standard deviation of 18.62) compared to the control group that had a pretest mean of 12.95 (standard deviation of 13.48). In the post-test the experimental group has a mean score of 65.90 (standard deviation of 23.54) while the control group has a mean of 29.14 (standard deviation of 18.41). The post-test mean shows an increase compared to the pretest means for both the groups. The computed t-value between the pre-tests of the control and experiment groups is −3.42. Hypothesis testing shows that this value is not significant as p =0.15 (p > 0.01) and $t(20) = −3.42$. Meanwhile the t-test between the scores of the post-tests of the control and experimental group showed a value of $t(20) = −5.067$. Hypothesis testing shows that the value is significant at p < 0.01.

The hypothesis testing of the t-values obtained showed a non-significant pre-test differences between the pre-Achievement Tests of both the experimental and control groups. However, hypothesis testing obtained showed a significant post-test differences between the post-Achievement Tests of both the experimental and control groups. In conclusion, the study indicated that there is non-significant pre-test differences and significant post-test differences between both experimental and control groups.

Attitude Test

This attitude test is used to answer the research question: "Is there any significant difference in the students' attitude between the experimental and control group in learning graph functions ?" The questions were categorized into two dimensions , on the usage of Geometer's Sketchpad in graph functions and interest towards graph functions with Geometer's Sketchpad. Students were advised to select the best answer that describes their attitude for each of the questions. The numerical scores is analyzed and the result is tabulated in Table 3.

Table 3 Mean, standard deviation and t-values for both groups

	Groups	M	SD	df	t	p
Pre-test	Control (n=21)	2.36	0.35	20	0.88	0.26
	Experimental (n=22)	2.49	0.28			
Post-test	Control (n=21)	2.55	0.43	20	0.33	0.00
	Experimental (n=22)	2.61	0.24			

$p < 0.01$

Results of the test showed that in the experimental group has a pre-test mean of 2.49 (standard deviation of 0.28) compared to the control group that had a pre-test mean of 2.36 (standard deviation of 0.35). Consequently, the post-test of the experimental group has mean of 2.61 (standard deviation of 0.24) while the control group had a mean of 2.55 (standard deviation of 0.43). The t-test results showed that the differences between the two groups for the pre-test results are not significant as p = 0.26(p>0.01) with $t(20)=0.88$ while the differences between the post-test of the experimental group and the control group as significant with $t(20)=0.33$ as p < 0.01.

Students Perception

The results in this section will describe how the students in the study sample perceive the usage of Geometer's Sketchpad in graphing of functions. It will also answer the third research question , which is " What are the students perceptions about using the Geometers' Sketchpad to learn graph functions ?" The questionnaire consists of 13 responses and is rated on a five point Likert scale. Frequencies and percentages of students' responses are tabulated in Tables 4 to6 below.

This Student Perception Questionnaire were divided into three categories namely :

a) Usage of Geometer's Sketchpad (Question 1-4)

b) How the Geometer's Sketchpad helps the understanding of the graph functions

concepts (Question 5-9)

c) Students' confidence in problem solving and ability to communicate when using

Geometer's Sketchpad (Question 10-13)

In the first category, there are four questions (Questions 1, 2, 3 and 4) that required the students evaluation on the usage of the Geometer's Sketchpad. In the area of Geometer's Sketchpad usage, (refer Table 4) it is very clear that 73.00 % of the sample agreed that Geometer's Sketchpad is easy to use. 19.23% strongly agreed and none were non-committal. However, 3.85 % respectively strongly did not agree and 3.85% did not agree that Geometer's Sketchpad was easy to use. It is clear that 42.30 % strongly agreed and 38.46% agreed that Geometer's Sketchpad gives accurate answers. However, 11.54 were not sure, 3.85% did not agree and another 3.85 % strongly did not agree. One of the important feature of Geometer's Sketchpad is its ability do draws graphs and help students visualize it. From the students responses, 19.23 % of them strongly agreed, 57.70% agreed that Geometer's Sketchpad

illustrate the shape of the graphs clearly, 7.69% were non-committal but 3.85% strongly did not agree and 11.54% did not agree. In addition, 7.69 % strongly agreed and 42.30 % agreed that they were able to interpret the graphs better and clearer with Geometer's Sketchpad . 15.38% were not sure, but 23.07% did not agree while 11.54% strongly did not agree that they could interpret the graphs easily with Geometer's Sketchpad.

Table 4Students' perception on the usage of the Geometer's Sketchpad(frequency, percentage)

	Statement	Strongly do not agree	Do not agree	Not sure	Agree	Strongly agree
1	The GSP is easy to use	1 (3.85%)	1 (3.85%)	0 (0%)	19 (73.00%)	5 (19.23%)
2	The GSP can give accurate answers	1 (3.85%)	1 (3.85%)	3 (11.54%)	10 (38.46%)	11 (42.30%)
3	The GSP can illustrate shape of graphs clearly	1 (3.85%)	3 (11.54%)	2 (7.69%)	15 (57.70%)	5 (19.23%)
4	I can read and interpret graphs easily with GSP	3 (11.54%)	6 (23/07%)	4 (15.38%)	11 (42.30%)	2 (7.69%)

The next category was based on whether using Geometer's Sketchpad could help in the understanding on graphing of functions. Based on Table 5 below, responses to Question 5 showed that 38.46% were not sure that Geometer's Sketchpad helped them understand graph functions better, 30.76% agreed while 15.38% strongly did not agree and another 15.38% also did not agree. From Question 6, 38.46% did not agree that they get to learn the topics on graph functions in greater depth, 23.08% strongly did not agree and another 19.23% were not convinced of the statement. However, 15.38% agrees and 3.85% strongly agreed that they get to learn graph functions in grater depth with Geometer's Sketchpad. When comparing Geometer's Sketchpad with the textbook usage in Question 7 , 30.76% agreed and 3.85% strongly agreed that they understand lesson better when using Geometer's Sketchpad compared to just using the textbooks. Meanwhile, 11.54% were not sure, 26.92% did not agree and another 26.92% strongly did not agree.

Table 5 Students' perception on how GSP helps the understanding of graph functions(frequency, percentage)

	Statement	Strongly do not agree	Do not agree	Not sure	Agree	Strongly agree
5	The GSP helps me to understand graph functions easily	4 (15.38%)	4 (15.38%)	10 (38.46%)	8 (30.76%)	0 (0%)
6	I get to learn the topic on graph functions in greater depth	6 (3.85%)	10 (3.85%)	5 (11.54%)	4 (38.46%)	1 (42.30%)
7	I understand my lessons better when using GSP compared to just using the textbook	7 (26.92%)	7 (26.92%)	3 (11.54%)	8 (30.76%)	1 (3.85%)
8	GSP allows the dynamic investigation of the properties of graph functions	1 (3.84%)	3 (11.53%)	3 (11.53%)	10 (38.46%)	9 (34.62%)
9	When I change the equation of the graph, I can see the shape of the graph changing	0 (0%)	2 (7.69%)	3 (11.53%)	12 (46.15%)	9 (34.62%)

For Question 8, 34.62% strongly agreed and 38.46% agreed that Geometer's Sketchpad allows dynamic investigation of the properties of graph functions. Conversely, only 3.84% strongly disagreed and 11.53% disagreed. Responses to Question 9 indicated that 34.62% strongly agreed and 46.15% agreed that changes in the equation of the graph will change the shape of the graph. However 7.69% disagreed.

The results of the next category is tabulated in Table 6. Questions 10 and 11 inquired about students self-confidence in problem solving when using Geometer's Sketchpad. For Question 10, 15.38% agreed on this while 38.46% were not sure whether they felt more confident at solving problems in the topic of function. However, 30.77% did not agree and 23.08% strongly did not agree on this. By using Geometer's Sketchpad in Question 11 , 34.61% agreed that Geometer's Sketchpad helped them to attempt difficult problems while 3.85% strongly agreed that they more willing to try more difficult questions. However, 15.38% were not too sure about this, 30.77% did not agree and 15.38% strongly did not agree that by using Geometer's Sketchpad had encouraged them to be brave enough to attempt more difficult questions.

In the area of communication in Mathematics, it is clear that 30.76% agreed and 3.85% strongly agreed that Geometer's Sketchpad had helped them in their classroom discussion from Question 12. However, 23.07% were not sure. Meanwhile, 26.92% did not agree and 15.38% strongly did not agree that Geometer's Sketchpad had helped them in their class discussion. Another important area of communication is in the classroom interaction whether in the form of student-student or student-teacher interactions. Responses obtained from the questionnaire indicated that 46.15% agreed and 7.69% strongly agreed that the Geometer's Sketchpad encourages them to interact with both their teachers and friends in the mathematics classroom. However, 19.23% were non-committal on this view. Conversely, 19.23% did not agree and 7.69% strongly did not agree that they are able to interactive meaningfully during the mathematics lesson aided with the Geometer's Sketchpad.

Table 6 Student perception on their self-confidence in problem solving and abilities to communicate when using the Geometer's Sketchpad (frequency, percentage)

	Statement	Strongly do not agree	Do not agree	Not sure	Agree	Strongly agree
10	I am more confident at solving problems in the topic of function	6 (23.08%)	8 (30.77%)	10 (38.46%)	4 (15.38%)	0 (0%)
11	I dare to investigate more difficult problems and solve them	4 (15.38%)	8 (30.77%)	4 (15.38%)	9 (34.61%)	1 (3.85%)
12	The GSP helps me in the classroom discussion	4 (15.38%)	7 (26.92%)	6 (23.07%)	8 (30.76%)	1 (3.85%)
13	I get to interact with both my teachers and friends when I use GSP	2 (7.69%)	5 (19.23%)	5 (19.23%)	12 (46.15%)	2 (7.69%)

In summary, the study concludes that most students who used the Geometer's Sketchpad found that graph functions had become more interesting. Moreover, their understanding of the graph functions topic also improved. In addition, the students adopted a positive attitude in the learning of graph functions. Many students also agreed that using the Geometer's Sketchpad had enabled them to better communicate with their friends and teachers. Also, majority of the students had improved in self-confidence when they use Geometer's Sketchpad during the mathematics lesson

CONCLUSION AND DISCUSSION

In this study, Geometers' Sketchpad was used as a tool in teaching and learning of graph functions. The results of the study shows the impact of how the usage of Geometer's Sketchpad is useful in the teaching and learning of the graph functions at the pre-university level.

From the results obtained, a number of implications can be put forward in improving mathematics teaching and learning. Firstly, the significant difference of the pretest and posttest mathematics achievement test indicates that Geometers' Sketchpad is possibly contributing in the learning of graph functions. This will further encourage teachers on the potential of using Geometer's Sketchpad as an effective tool in learning mathematics. These result is consistent with the Teoh& Fong (2005) study among high school algebra students, which reported that the mean post-test scores of the experimental group was significantly different with the control group They also found out that the effects of using Geometer's Sketchpad in teaching and learning of quadratic function does enhance the students learning. According to the same study, the researcher encouraged teachers to continue using the software or to start if they have not. The only issue is about teachers' enthusiasm and willingness in the usage of Geometer's Sketchpad. Almeqdadi(2000) , Embse (1996) and McClintock (2002) have also found Geometer's Sketchpad to be effective in learning by the way of visualization in the various areas in mathematics. Almeqdadi further suggested the increase usage of Geometer's Sketchpad in investigating mathematical problems. His study also had proven that Geometer's Sketchpad had positive effects on students' understanding of geometrical concepts. The result of this study also supports the findings of Lester (1996) which mentioned that Geometer's Sketchpad provides intelligent capabilities for improving teaching and learning. NorainiIdris(2001) also conducted a quasi-experimental research on the effects of a van-Hiele based instructional activities with Geometer's Sketchpad on van Hiele levels. The result she obtained indicated a significant difference between the treatment and control groups in rank on van Hiele levels from pre-test to post-test. The researcher concluded that the significant improvement of geometry achievement using the specially prepared van Hiele based instructional with Geometer's Sketchpad indicated the need to provide more interactive and hands on learning activities for geometry learning in lower secondary schools.

In addition, the increase in scores from the pretest and posttest also indicates that the students usage of Geometer's Sketchpad does help in graphing of functions. Geometers' Sketchpad will be a tool in improving students understanding in mathematics concepts in relevant topics. According to NCTM(1999), " Calculators don't think, students do". This also applies to the Sketchpad. Students need to understand the mathematics problem they are solving. With that information, then only they can decide what operations to use and take the next action. Therefore, software like Geometer's Sketchpad does make students to think and explore to find the solutions. Purdy (2000) also discovered that in a maximum-volume problems, Geometer's Sketchpad helps in the practical exploration of the problem. Furthermore, he discovered that his students have been lead to a deeper understanding of the problem and its solution as a result of their exploration.

Secondly, the significantly better results in the Attitude Test achieved by the experimental group of students implied that the learning of graphs functions with the Geometer's Sketchpad had been beneficial and useful for the students. The students seems to have a more positive attitude in the graphing of algebraic functions, trigonometric functions and absolute value functions while using Geometer's Sketchpad. Students are enjoying the lessons of graphing functions and also able to interpret the properties of the graphs of the functions better with Sketchpad. These findings support the results of Groman (1996) that students reaction is overwhelmingly positive on using Geometer's Sketchpad in mathematics class. Furthermore, the usage of Geometer's Sketchpad indicated a more positive reaction from both the students and instructors in developing conjectures and constructions. Garofalo&Bell (2004) showed how Geometer's Sketchpad sketches could be extended and expanded to different levels to enrich the teaching and learning of mathematics.

According to Rahim (2002) in his study on classroom use of Geometer's Sketchpad by pre-service teachers showed that the attitude of the teachers range from uncertainty to overconfidence about the potential of the software. Most of the teachers agreed that the software is useful in investigating and discovery and it would be useful to use in other areas of mathematics such as trigonometric , geometry and algebra.

In conclusion, this study suggests that the use of Geometers' Sketchpad in the mathematics classroom is useful in helping   students perform better in graphing of functions . Furthermore, they have a positive attitude towards learning the graphing of functions and mathematics with the usage of Geometer's Sketchpad. Consequently, the Geometers' Sketchpad also encourages students to learn the graphing of functions in a more enjoyable and interesting way.

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