The Effect of GSP on Students' Understanding in The Graphs of Trigonometric Functions

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Abstract: *The present study examined the effectiveness of the use of GSP in classroom teaching and learning process. It investigated whether GSP has any contribution in students' understanding in sketching the Graphs of Trigonometric Functions. Further it investigated whether GSP is able to develop appropriate concept images of the Graphs of Trigonometric Functions.*

Experimental design was used in this study. Information-gathering exercises were carried out for one week with 113 form five students from four schools in Kuala Lumpur, a Science Residential School, a Technical School, a Vocational School and a daily school. The students enrolled in two groups, the experimental group and the controlled group in each school. The students in the experimental group were taught using GSP presentation resources while the students in the control group were taught by using the textbook. Both groups took the same pre-test and post test, which was designed by the researchers.

Statistical Packages for Social Studies (SPSS) was used in data analysis. Analysis of variance is performed on two of the respective dimensions lead to three objectives of this study. The method of analysis and the result generated are offered as a mean to gauge the effectiveness of Geometers' Sketchpad into teaching and learning.

The results indicated that there was more gain in the scores from the pre-test to the post test. The results of the study also indicated that there was a statistical significant difference between the statistics descriptive of the student's scores with favour to the experimental group in two of the four independent variables.

1. INTRODUCTION

The integration of technology into the teaching and learning of mathematics has not escaped the attention of educators. As a discipline, mathematics too is very much influenced by the rapid development of information and communication technology (ICT) and mathematics educators have been looking at ways to integrate ICT into the curriculum over the last decade [1]. The principle of integrating ICT in mathematics teaching and learning is no longer controversial but on the contrary it has come to be embedded in the mathematics curricula of most countries in the world [2][3]. Increasingly the use of technology is now seen as essential in the teaching and learning of mathematics in schools [2][4].

In Malaysia, the use of dynamic mathematical software such as Geometer's Sketchpad in the teaching and learning process has been explicitly suggested in the curriculum specifications for secondary school mathematics. Subsequently, the Malaysian Ministry of Education (MMOE) made the decision of subscribing to the license of Geometer's Sketchpad in 2004 [1]. In light of this, it is perceived that many teachers and secondary school students nationwide will benefit from it. According to Zimmermann, W., & Cunningham, S. [5], the Geometer's Sketchpad should be use as an effective tool to acquire and to enhance the understanding of mathematical concepts and knowledge. Geometer's Sketchpad not only helps students to model problems and enables them to

understand certain topics better but it can also help students to explore mathematical concepts more effectively. In addition, the use of technology is believed to help inject excitement and enthusiasm in the teaching and learning of mathematics.

To date, not many schools really explore the usage of Geometer's Sketchpad effectively. Teoh and Fong [6] cautioned that teacher enthusiasm and willingness to use the tool is still an issue to be addressed. Thus, a study of whether Geometer's Sketchpad has any contribution towards the achievement of quality classroom teaching and learning mathematics is needed.

2. LITERATURE REVIEW

The Geometer's Sketchpad (GSP) is one of the dynamic geometry software system for creating, exploring, analyzing a wide range of mathematics concepts in the field of algebra, geometry, trigonometry, calculus, and other areas [4]. Furner and Marinas [7] further suggested that GSP is an excellent interactive tool which encourages a process of discovery in which students first visualize and analyze a problem and then make conjectures. GSP also allows learners to work through numerous examples and enables them to discover patterns by constructing their own sketches [8].

There have been quite a number of local studies carried out to evaluate the influence and impact of the use of GSP on mathematics learning and teaching. Nurul Hidayah [9] found that a group of secondary school students who had undergone use of GSP instructional program gained higher achievement scores as compared to their counterparts in the control group. On the other hand, Kamariah, Rohani, Ahmad Fauzi and Aida Suraya [10] concluded that there was no significant difference in mean mathematical performance between the GSP group and the traditional teaching strategy group. These two opposite findings have initiated us to carry out a more focused study on the effect of GSP on students' understanding in the graph of Trigonometric Functions.

3. SIGNIFICANCE OF THE STUDY

Technology is not only for those professionals who work in science or industry anymore. Now we have decent level of facilities with technology in elementary and secondary schools, but it is questionable whether we take advantage of the technology that is available to us. It is time to build up more substantial and practical foundations for the use of technology in mathematics classroom so that technology can contribute to students' better understanding. By raising the awareness among Malaysian Educators on the potential of technology usage in mathematics classroom, it can help them to design student-centered instructional activities with the use of GSP.

The result of this study can be shared together with the Curriculum Development Division and The Teacher Training Division, Ministry of Education. It is important for pre-service teachers to learn the usage of GSP. The early exposure of GSP in the training of pre-service teachers will further enhance their own understandings and therefore they will confident to carry out their teaching lesson by using GSP. This study can contribute to the current and future preparation of a teacher in ways that promote how to use technology for teaching and learning mathematics with better understanding. Furthermore, this study will contribute to Human Resource Division, Ministry of Education to train in-service teachers in order to successfully integrate of GSP in teaching and learning mathematics.

4. OBJECTIVE OF THE STUDY

This study aims to examine the effect of GSP on students' understanding in the graphs of Trigonometric Functions. Specifically, it investigates whether GSP has any contribution in students' understanding in sketching the graphs of Trigonometric Functions. Further, it investigates whether GSP is able to develop appropriate concept images of the graphs of Trigonometric Functions.

5. LIMITATION

One of the limitations of the data analysis was sample size. Although the samples were taken from four different types of urban schools in Kuala Lumpur, the choice of samples did not reflect the population of students in Malaysia. The other limitation was time taken to complete the lesson in 80 minutes. The constraint of time leaves student with no opportunity to further explore GSP. Students with partial computer skills or first-time user of GSP may face problems as they might spent longer time to familiarise themselves with GSP. Thus, their concentration during lesson may be distracted.

6. METHODOLOGY

An experimental design was used in this study with students selected to be assigned to two groups. Information-gathering exercises were carried out for 80 minutes with 113 Form five students from four schools in Kuala Lumpur, namely, a science residential school, a technical school, a vocational school and a daily school.

The students were enrolled in two groups, the experimental group and the controlled group in each school. The students in the experimental group were taught using GSP presentation resources while the students in the control group were taught by using textbook. The GSP presentation resources employed the exploratory-discovery approach in the learning of sketching the graphs of Trigonometric Functions. Both groups took the same pre-test and post test, which was designed by the researchers. The data were analyzed using One-Way ANOVA.

7. RESULTS

The results of the study are discussed based on the objectives stated. Analyses of the pre-test and post test achievement scores were done using the SPSS package.

Table 1: *Mean Variation Between Pre-Test and Post Test*

Variables	Groups	N	Mean	Std. Deviation
SHAPE	Pre-Test	113	2.24	1.947
	Post Test	113	5.27	1.086
	Total	226	3.75	2.185
MAX	Pre-Test	113	3.51	1.818
	Post Test	113	5.25	1.122
	Total	226	4.38	1.740
MIN	Pre-Test	113	3.35	1.684
	Post Test	113	5.09	1.090
	Total	226	4.22	1.663
CYCLE	Pre-Test	113	2.58	1.972
	Post Test	113	5.28	1.169
	Total	226	3.93	2.111

The result between the pre-test and the post test (*Table* 1) shows that the mean from all the variables increases drastically from pre-test (M=2.24, 3.51, 3.35, 2.58) to post test (M=5.27, 5.25, 5.09, 5.28).

Table 2: *ANOVA Test result between Pre-Test and Post Test*

Variables	Groups	Sum of Squares	df	Mean Square	F	Sig
SHAPE	Between Groups	517.540	1	517.540	208.286	.000
	Within Groups	556.584	224	2.485		
	Total	1074.124	225			
MAX	Between Groups	169.982	1	169.982	74.470	.000
	Within Groups	511.292	224	2.283		
	Total	681.274	225			
MIN	Between Groups	171.721	1	171.721	85.355	.000
	Within Groups	450.655	224	2.012		
	Total	622.376	225			
CYCLE	Between Groups	414.319	1	414.319	157.689	.000
	Within Groups	588.549	224	2.627		
	Total	1002.867	225			

The result of the One-Way ANOVA (*Table* 2) shows large F ratio values. This indicates that there is a significant mean performance score between the two tests.

Table 3: *Mean Variation in Pre-test*

Variables	Groups	N	Mean	Std. Deviation
SHAPE	Control	55	2.25	1.946
	GSP	58	2.22	1.965
MAX	Control	55	3.35	1.745
	GSP	58	3.67	1.886
MIN	Control	55	3.38	1.604
	GSP	58	3.31	1.769
CYCLE	Control	55	2.51	1.933
	GSP	58	2.64	2.024

The result in Table 3 explains the mean performance scores of the control group (*M* = 2.25, 3.35, 3.38, 2.51; *SD* =1.946, 1.745, 1.604, 1.933,) compared to the scores of the GSP group (*M*=2.22, 3.67, 3.31, 2.64; *SD*=1.965, 1.886, 1.769, 2.024). The observed mean values do not vary much between the two groups.

Table 4: *ANOVA Test Result in Pre-test*

Variables	Groups	Sum of Squares	df	Mean Square	F	Sig.
SHAPE	Between Groups	.026	1	.026	.007	.934
	Within Groups	424.523	111	3.825		
	Total	424.549	112			
MAX	Between Groups	3.018	1	3.018	.912	.342
	Within Groups	367.212	111	3.308		
	Total	370.230	112			
MIN	Between Groups	.144	1	.144	.050	.823
	Within Groups	317.396	111	2.859		
	Total	317.540	112			
CYCLE	Between Groups	.469	1	.469	.120	.730
	Within Groups	435.142	111	3.920		
	Total	435.611	112			

The result of the One-Way ANOVA in the pre-test (*Table* 4), by comparing the shape, cycle, maximum and minimum values shows small values in the F ratio of 0.07, 0.120, 0.912 and 0.050. This indicates that there is no significant difference between the control and the GSP group. Hence, shows that there seemed to have homogeneity amongst the two groups of students.

Table 5: *Mean Variation in Post Test*

Variables	Groups	N	Mean	Std. Deviation
SHAPE	Control	55	4.95	1.380
	GSP	58	5.57	.565
MAX	Control	55	5.25	.927
	GSP	58	5.24	1.288
MIN	Control	55	5.07	.879
	GSP	58	5.10	1.266
CYCLE	Control	55	5.11	1.257
	GSP	58	5.45	1.062

The result in the post test (*Table* 5), shows that there is an increase between the mean performance scores of the GSP group (*M*=5.57, 5.45; *SD*=0.565, 1.062) compared to the control group (*M*=4.95, 5.11*; SD*=1.380, 1.257) in the shape and cycle categories. However, in the maximum and minimum categories, the mean performance scores do not vary much either for the GSP group (*M*=5.24, 5.10; *SD*=1.288, 1.266) or the control group (*M*=5.25, 5.07; *SD*=0.927, 0.879)

Table 6: *ANOVA Test Result in Post Test*

Variables	Groups	Sum of Squares	df	Mean Square	F	Sig.
SHAPE	Between Groups	10.975	1	10.975	10.063	.002
	Within Groups	121.061	111	1.091		
	Total	132.035	112			
MAX	Between Groups	.005	1	.005	.004	.951
	Within Groups	141.057	111	1.271		
	Total	141.062	112			
MIN	Between Groups	.027	1	.027	.022	.882
	Within Groups	133.088	111	1.199		
	Total	133.115	112			
CYCLE	Between Groups	3.248	1	3.248	2.408	.124
	Within Groups	149.690	111	1.349		
	Total	152.938	112			

The result in Table 5 is further explained by the large F ratio values (*Table* 6) of 10.063 and 2.408 for shape and cycle but small F ratio values of 0.004 and 0.22 for maximum and minimum categories. Hence, significant difference occurred only in the shape and cycle categories.

8. CONCLUSION

This study aims to explore the contribution of GSP to enable the Malaysian Secondary School students to use GSP in learning. Findings seemed to support the work of many researchers that GSP is a totally new and exciting experience for the students. If students were given enough time to be familiar and explore further with GSP, they would be able to benefit fully from its utilization during teaching and learning process.

The findings indicated that there was more gain in the scores from the pre-test to the post test as shown in Table 1 and Table 2. The findings of the study also indicated that there was a statistical significant difference between the statistics descriptive of the student's scores with favour to the GSP group in two of the four independent variables as shown in Table 3 - Table 6. We concluded that GSP does contribute to the conceptual learning in Trigonometric Functions specifically the ability to construct the shape of a sine graph. However, the result of the study has no recognition in GSP contribution towards the understanding in sketching of a sine-graph. Thus, mathematics teachers are encouraged to continue using GSP because visualizations concept to promote and enhance learning is a choice to use GSP.

9. IMPLICATION AND RECOMMENDATION

In this study, GSP was used as a tool in teaching and learning of sketching graphs of Trigonometric Functions. GSP is useful and essential in the teaching and learning mathematics. Students' excitement while learned mathematics by exploring with GSP showed that it is necessary for the students to be familiar and comfortable with the usage of computer or GSP software. When students have the skills using GSP before lesson, then learning would be easier as students can concentrate more to the understanding of concept and mastering of contents of the lesson.

However, more researches also need to be carried out in order to explore further, the utilization of GSP in mathematics learning. Besides that, more classroom tests that require GSP knowledge of other topics are called for to validate further the findings. The implementation of appropriate technology tools in classroom learning of mathematics is essential in order to make the learning session enjoyable, meaningful and beneficial. In future, teachers in Malaysian schools will manage to include the examination oriented culture in their new teaching task that engages the use of technological tools as well.

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