The Use of Graphic Calculators in Malaysian Secondary Schools: Students' Perception and Teachers' Constraints

Husna B. Hasan
husna@cs.usm.my

Munawir B. Azizan
munawirazizan@yahoo.com.my

Suraiya B. Kassim
ksuraya@cs.usm.my
School of Mathematical Sciences
Universiti Sains Malaysia
Malaysia

Abstract: Graphic calculators were introduced into the Malaysian New Curriculum for Secondary Schools to enhance the quality of teaching and learning of mathematics in the classrooms. This is also in line with its new revised curriculum. A number of schools were selected to receive graphic calculators (TI-83 Plus) to be incorporated into the teaching of mathematics and science subjects. A project on exploration of graphing calculators has been carried out at a rural school. The students involved were in Form 4 (16 years old) at the secondary school. They come from low income families and have limited access to the new technology. Because of that, their interests in mathematics are questionable and they thought mathematics is a very difficult subject in school. Two topics (Statistics and Straight Line) from the syllabus of their mathematics curriculum were chosen. In addition to the traditional way of teaching, the students were also exposed to the graphic calculators to help them understand mathematical concepts. Their perception after learning the topics were noted before and after using the graphic calculators to see whether their interest has changed due to the usage of graphic calculators. Their preferences towards the topics in the syllabus were also noted to see whether graphic calculators could change their preferences on certain topics. At the end of their learning process, a test was given to this group of students and their scores were compared to the control group (not exposed to graphing calculators). Statistical analyses show that their interest in the Statistic topic have been altered by the usage of graphic calculators. There is also a tendency for certain topics to be preferred over others due to graphic calculators. The *t*-test shows that there is a significant difference in scores achieved by the two groups of students. The project students were very satisfied with what they have achieved and they feel that the use of graphic calculator has given them a significant change in the way they think about mathematics as a whole. At the end of the paper, the problems and constraints that the teachers may face during teaching and how to overcome them were discussed.

1. Introduction

The use of graphic calculators was introduced and implemented at the higher learning institutes and secondary schools in Malaysia starting 2003. However, the integration of this technology in the teaching and learning process at the school level is still new, compared to the West which already started back many years ago. In Malaysia, although the Ministry of education started supplying graphic calculators to several selected schools to be incorporated into the teaching and learning of secondary mathematics and sciences, the implementation is still at the minimum level. Not many schools really explore the calculators capabilities or study how the graphing calculators can help them towards increasing the quality of classroom teaching and learning.

The purpose of our project was to explore and investigate the use of TI-83 Plus graphing calculator as a tool in enhancing students understanding of mathematical concepts. According to Noraini (see [7]), the TI-83 Plus graphic calculator was able to motivate the learner, identifying what is to learnt and providing active involvement. Thus, it can lead to positive change in terms of teaching and learning interactions in the class. Students get hands-on experience solving mathematics problems along with the teacher.

Graphic calculators can also motivate the students to learn more and talk about mathematics. It helps them to explore and investigate mathematics problems (see [5]). This encourages them to learn in a group or on their own. Kissane (see [4]) talks about the relationships between calculators and curricula by looking at what graphics calculators can do. One of the highlights is that graphic calculators can offer new opportunities for the students to encounter mathematical ideas not presently in the curriculum. This is in line with the expectations of the agenda in mathematics education outline under the Malaysian education system.

2. Objectives of the study

In his study on Malaysian students, Shaharir (see [9]) identified that one of the factors that contribute to a poor achievement in mathematics is the lack of interest and motivation and the students attitude towards this subject. This project studies the effect of the use of graphic calculators on students' perception towards mathematics, particularly in certain selected topics. In particular, the study looks at students' perception and preferences of the topics before and after the use of graphing calculator in the process of teaching and learning. This project also assesses students' achievement in some particular topics in mathematics.

In addition, this project also try to identify problems that teachers encounter when conducting the classroom with the graphic calculator technology, so that they will be better prepared prior to their teaching. We also hope that the result of the study will strike the teachers' mind the importance of integrating technology into the curriculum system for the betterment of future students.

The subjects of the study are the secondary school students mainly from a rural area. These students come from low income families and have limited access to the new technology. A number of them have to take part-time jobs to help support their family. Because of that, their interest in academic particularly mathematics are questionable and they thought mathematics is a very difficult subject in school. Therefore, the study is carried out with the hope that they will be more motivated, have more interest and develop confidence in mathematics so that they are better prepared for their Malaysian Certificate Examination (a major placement test for pre-university entrance) a year later.

3. Methodology

The sample of this study consisted of Form 4 (16 years old) students of the secondary level from a rural school in Kedah. The topics involved are Straight Line and Statistics (topics 5 and 6 listed under their curriculum). These topics were chosen based on the suitability of the TI-83 Plus in solving the related problems.

The study was divided into two parts. The first part is a group of 27 students who can be categorized as 'C - D' group, that is low achievers in terms of mathematics achievement. These students have never been exposed to the graphic calculator before. They were first taught Statistics with the traditional approach in the classroom and later with the incorporation of the TI-83 Plus.

The test instrument is a questionnaire administered before and after the use of graphic calculators in the teaching and learning activities. The items in the survey seek to tap students:

(i) interest in Statistics
(ii) perception towards mathematics
(iii) preferences of the topics that they had learnt throughout the year.

The second part of the study involves two groups of students each of size 36 and 29 respectively. These are students who often obtained unsatisfactory scores in some topics in mathematics and they are from the same mathematics achievement background. They were tested based on Straight Line topic. To see the effectiveness of the use of the graphic calculators, one group was taught with the aid of graphic calculators while the other group was taught the same topic without the graphic calculator. At the end of the lessons, both groups were tested and their scores compared.

To analyze the data obtained from the survey, several statistical tests were used. The McNemar nonparametric test was used to test whether there are significant changes in how these students feel about mathematics particularly Statistics after they used graphic calculators. The Friedman test was used to see whether there is a significant difference in their preferences on the topics they had learnt before and after they use graphic calculators. The *t*-test were used to compare the score of the tests obtained by the group of students who were exposed to the graphic calculators and the control group who were not exposed to the graphic calculators.

4. Result and discussion

One of the questions posed in the survey was whether the students like Statistics after they were taught the topic by means of the traditional approach. During the lesson, the students learnt how to build a frequency table, draw a histogram, polygon and ogive. Thirteen out of twenty seven said that they liked Statistics. Nearly half of the group did not like Statistics. Then these students were taught with the use of graphic calculators and the same question was asked again. Surprisingly, all of them said they liked the topic and they wanted to explore more on the topic. At the 5% significant level the McNemar test rejects the hypothesis that there is no significant change in students' interest in Statistics due to the graphic calculators. This indicates that the use of graphic calculators is capable of changing students' interest in the topic. The students tend to like the topic after they used graphic calculators. It is hoped that with this attitude change, they will work harder. It is human nature that people will work harder when they like something and will try their best to get the best result. One of the significant results from the exploration on Statistics is that the students now understand the real meaning of the widths of the intervals in a frequency table. With the aid of graphic calculators, they were able to see clearly the effect on the histogram when they changed the interval widths.

Another question that the students were asked was on how they feel about mathematics as a whole before and after the use of graphic calculators. Before the incorporation of the graphic calculator, twenty-two of them said that mathematics is a difficult and serious subject. However, after the students used the graphic calculators, all of them said that it was fun and not stressful to learn mathematics. The hypothesis that the student's perception towards mathematics has not been altered by the use of graphic calculator is rejected at $\alpha = 0.05$. This means that graphic calculators are capable of making the learning of mathematics more fun and less stressful.

The third aspect that was noted from the survey is the students' preferences on the topics that they learnt under the curriculum. There are seven topics that are listed under their mathematics syllabus. Ten students were randomly selected to participate in this section. Before the use of the graphic calculators, each student was asked to rank the topics in order of preference. Rank 7 was assigned to the least preferred topic and rank 1 to the most preferred. The null hypothesis was that there is no difference in preference of the topics and the alternative was that some topics tend to be preferred over others. After the students used the graphic calculators, they were asked to rank the topics again. The data collected are as follows:

Table 4.1 Total Rank for Each Topic

		Total Rank	
	Topics	**Before**	**After**
A	Standard Form	25	26
B	Quadratic Expression and Equation	51	51
C	Set	32	50
D	Mathematical Reasoning	49	50
E	Straight Line	20	34
F	Statistics	49	13
G	Probability	56	47

The Friedman test was performed on the data collected on these ten students before and after the use of graphic calculators and the test statistics obtained is $T_1 = 7.749$ and $T_2 = 3.718$, respectively. Therefore, the null hypothesis is rejected at 5% significant level for both cases. We may conclude that there is a tendency for some topics to be preferred over others.

Further analysis to compare individual topics was done using the multiple comparison test. Before the use of graphic calculators, the results obtained are as follows:

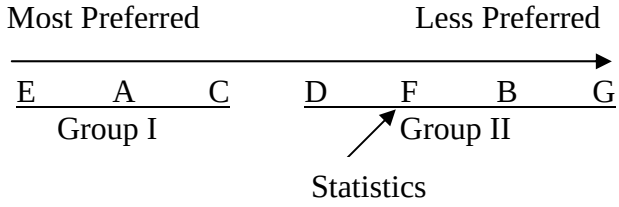

Figure 4.1 Results of the Multiple Comparison Test (BEFORE)

It appears that the topics can be divided into two groups of preferences that is topic E, A and C as the most preferred and D, F, B and G as the least preferred. We can see that Statistics is at the fifth place and falls into group II, the less preferred group. After the use of graphic calculators, we obtained the following results.

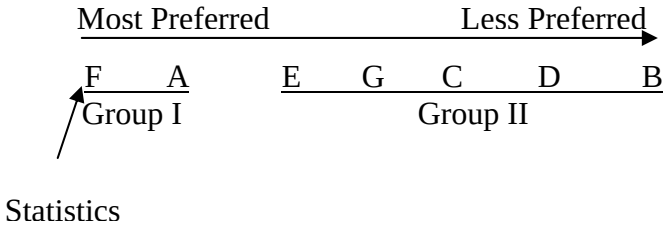

Figure 4.2 Results of the Multiple Comparison test (AFTER)

We are more interested in Statistics since the topic was the one that was taught with the use of graphic calculator. We can see that this topic is now in Group I and it is the most preferred topic now. We conclude that the use of graphic calculator has altered the student's preference of the topics.

As mentioned earlier, the second part of the study is to look at the effectiveness of the use of graphic calculators by means of the student's achievement in a particular topic. The topic of Straight Line was chosen since these students usually have difficulties in getting good marks in the topic during their exam. After the students were taught the topic, a test (without the use of graphic calculator) was given to the group of students who went through the learning process with the use of graphic calculators and the control group who learnt without the use of graphic calculators. It was observed that the students were also very excited when they could visualize the connections between equations and graphs. From the assessment, the scores obtained are summarized as follows:

Table 4.2 A Summary of the Assessment

	Mean	Standard Deviation
Group with the use of GC	9.83	2.678
Control group (without GC)	3.86	2.248

Diagnostic checking on the scores shows that the normality assumption is satisfied. The equality of variances test leads us to conclude that they possess common variances. The *t*-test for the differences in means gives us the test statistics $T_3 = 9.5853$ with p-value ≈ 0.000. It shows that the scores for the group that used graphic calculators is significantly different from the control group even though they were from the same background. It is clear that they are significantly better than the control group.

5. Problems and Teachers' Constraints

Throughout the study, we were faced with some problems while trying to implement the graphic calculators in the process of teaching and learning. A major problem was that none of the students own a personal graphic calculator. In fact, all students from the rural school do not own a graphic calculator. With their family background, it is rather costly for these students to purchase a personal graphic calculator. Because of that, teaching and learning activities are limited. To overcome this problem, the school has to carefully plan the logistics of how to get calculators for the students and use them effectively during the fixed school hours. It would be good if all schools

are provided with enough number of calculators. To implement this for sure requires some commitment from the government particularly the Ministry of Education.

With the incorporation of the graphic calculators in the classroom, the teaching and learning process with graphic calculator are quite slow too since time has to be allocated for learning how to use technology. The teacher needed extra time to explain to the students how to enter the data and familiarize themselves with all the other function keys. With their low academic achievement, it takes them longer to understand everything. However, as proven in our study, it can help them in their perception. The teacher feels that if the student has a chance to own a graphic calculator, he will make himself used to its techniques and explore more.

Perhaps it would be a good idea to have a special class that exposes the students to the use of the graphic calculator outside the school curriculum, so that the process of learning and teaching can be much faster. Bear in mind that the teacher should be an active user too. A teaching module with the incorporation of the same type of graphic calculators can help teachers and students in the teaching and learning process. They can refer to the module whenever they have problems with the use of the technology. Currently, the text books used do not incorporate any hand-held technology.

Different level of thinking among the students can also affect the process of learning. Some people like to use the graphic calculator because they can visualize the concepts. However, there are still some students who favor the traditional way that is using the pen and paper to solve some problems. We did try one concept on Differentiation that is the maximum and the minimum point through the second order differentiation. They learnt that a point

$$\text{i) } (x_1, x_2) \text{ is a maximum point if } \frac{d^2y}{dx^2} < 0,$$

$$\text{ii) } (x_1, x_2) \text{ is a minimum point if } \frac{d^2y}{dx^2} > 0.$$

With the use of graphic calculators, the students can see clearly this concept because they can visualize them. However, there was a group of students who feel that the use of graphic calculator slowed down the process of getting the answer. They felt that calculating based on the theory learnt in classroom is faster. This is the opinion of the better group of students.

In a classroom, there is always a mixture of students who learn things at different rates. Some are very fast at learning graphic calculator but some are very slow. It is not easy for a teacher who handles this type of class when they use the graphic calculators. The fast group will feel bored if the teacher slows down the teaching. The slow group will be lost if the teacher speeds up the teaching. Because of this, the process of learning and teaching is affected and the objective of the course cannot be achieved. It is hoped that if the students have personal graphic calculators, they can practice at their own time. Then the teacher does not have to spend a lot of time on its usage in the classroom.

Also, if the students can be grouped according to their capability of learning, that will be better. For good students, the graphic calculator can enhance more on their understanding of mathematical concepts. This group of student can explore the technology by themselves. However, for slower ones, they would need the teachers' assistance in guiding them to use the graphic calculator effectively.

The topics chosen to be incorporated with the graphic calculator should also be properly chosen. Not all topics are suitable to be taught and learnt with this integration of graphic calculator.

6. Conclusion

This study found that graphic calculators can be a motivation tool for some students to love mathematics especially topics that deal with data. The students' perception on mathematics has been altered by the use of graphic calculators. Though the study only covered two out of seven topics, they feel it is fun now to learn mathematics. This is what the teachers are looking for especially for the 'not so good' students from the rural area. For the teachers from this area, the positive thinking of the students is an important factor in the process of learning. It is noted that the students who succeeded in solving problems with the help of graphic calculators will attempt to solve other problems. They felt motivated to learn and explore more. The students' perception on certain topics too has been altered due to the use of graphic calculators.
It was also found that students who learn with the aid of graphic calculators manage to get better result in the test. Thus, the use of graphic calculators plays a significant role in the process of teaching and learning mathematics subject. Its affordability makes the graphic calculator accessible to everyone.

Acknowledgements The authors would like to thank Statworks (M) Sdn Bhd for the loan of the graphic calculators.

References

[1] Demana, F. (1990). The Role of Technology in Teaching Mathematics, *The Mathematic Teacher, National Council of Teachers of Mathematics*, Vol. 82. No. 1.
[2] Handal, B., Herrington, T. and Chinnappan, M. (2004). Measuring The Adoption of Graphic Calculators by Secondary Mathematics Teachers. *Proceedings of the 2nd National Conference on Graphing Calculators*, October 4-6, 2004 29-43.
[3] Kissane, B., Bradley, J. and Kemp M. (1994). Graphics calculators, equity and assessment. *Australian Senior Mathematics Journal*, 8(2), 31-43. http://cleo.murdoch.edu.au/learning/pubs/mkemp/asmj94.html
[4] Kissane B., (2000). Technology and the curriculum: The case of the graphics calculator. In M.O.J. Thomas (Ed.) *Proceedings of TIME 2000: An International Conference on Technology in Mathematics Education* (pp60 – 71) Auckland, New Zealand. http://www.cleo.murdoch.edu.au/~kissane
[5] Kutzler, B. (2000). The Algebraic Calculator as a pedagogical Tool for Teaching Mathematics. http://www.kutzler.com
[6] Noraini Idris, Tay Bee Lian, Nilawati Mahfud, Goh Lee Siew dan Aziah Aris, (2003). *Pengajaran dan Pembelajaran Matematik dengan Kalkulator Grafik TI-83 Plus*. Penerbitan Bangi Sdn. Bhd.
[7] Noraini Idris. (2004). Exploration and Entertaining Mathematics : Why Graphic Calculators. *Proceedings of the 2nd National Conference on Graphing Calculators*, October 4-6, 2004 . 45-54.

[8] Ooi Yong Seang, Yeo Moy Kim, Yip Chee Kong dan Bechek Bachok, (2002). *KBSM Matematik Tingkatan 4*, Kuala Lumpur. Penerbitan Bangi Sdn. Bhd.
[9] Shaharir Mohamad Zain, (2001). Prinsip dan Pengenalan Panduan Pelaksanaan MATEMADESA, PERSAMA.