Limiting Factors among Teachers to Use Graphic Calculator in Their Teaching and Learning

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Abstract

Over the century, technology has shown to be one of the important tools for advancement in education. An exemplar in the development of technology in education can be seen in the usage of Graphic Calculator (GC). Most of the developed country is implementing the usage of GC and a positive achievement is recorded. Although Malaysia also started implementing GC, but there are factors that hinders the full implementation. As the teachers are the key personnel of teaching and learning, the purpose of this study is to determine and understand the factors affecting teachers in using GC in their lessons. A qualitative study by face to face interview was carried out among 6 teachers from school. These teachers were chosen using purposive sampling. Content of interview was examined using thematic analysis. Based on the analysis, five factors from teachers were derived which are: 1) lack of knowledge, 2) no exposure, 3) not interested, 4) negative assumption and 5) extra workload. Hence it can be concluded that teachers also contribute to the limiting factor in the usage of GC in education. Implications and suggested further studies are discussed.

Keywords: Graphic Calculator; Science and Mathematics Education; Digital tool.

Introduction

Technology has made a tremendous development over the century in this world. The impact of technology can be seen in various fields including education. One of the technologies incorporated in educational setting is the use of Graphic Calculator (GC). GC has been used in teaching since the early 1990's by the United States of America (Waits & Demana, 1999).

The uses of GC in education have shown a great improvement in the education outcome in all the major countries. Its use was advocated to be implemented at all levels of mathematics education by The National Council of Teachers of Mathematics (NCTM, 2000). Many previous

researches were done regarding the implication of GC have shown overall major positive implication. Students using GC in learning mathematics showed improvement on achievement in mathematics (Noraini & Chew, 2011). As cited by Ellington (2003), flexible methods of problem solving and deeper appreciation were developed among students who use GC compared to those who do not use GC in their studies (Noraini & Chew, 2011).

Kissane (2000) stated that recommendations have been made to implement the usage of GC in upper secondary mathematics due to the favourable positive outcome of GC in students' achievement. Apart from America, Europe and Australia also have started to use GC in education in the early 1990's. It has been made compulsory to use GC in teaching and learning in these countries (Norain, Rohani, Wan & Mohd, 2011). In the year of 2001, the use of GC in teaching and learning as well as in national examination of further mathematics was also permitted in Singapore (Noraini & Chew, 2011).

However, Noraini and Chew cited that in Malaysia, the use of GC is still new and superficial. Implementation of using GC in teaching and learning was done by curriculum development center in early 2004 with the collaboration of Texas Instrument (Noraini & Chew, 2011). Data showed that about 250 GCs were distributed among few secondary schools all over Malaysia. Only two schools were distributed with GCs in Johor (Kamariah & Zulkarnain, 2008). An initiative was made by Ministry of Education Malaysia to implement the use of GC by providing a few examples on how GC could be implemented in Form Four Malaysian secondary mathematics and further mathematics textbooks starting from the year 2006 (Noraini & Chew, 2011).

Background of Problem

Science is considered an important to sustain economic development and improve the quality of life of a nation through the State Science Policy. According to Rancangan Malaysia Ke-Sepuluh (RMK 10) (*or the Tenth Malaysian Plan*), the most important investment is human capital for the development of a country. It is the cornerstone of innovation and productive high-income economy. According to the 2007 Trends in International Mathematics and Science Study (TIMSS) 2007 report (Martin, Mullis, & Foy, 2008), compared with other countries, Malaysia's student performance dropped in science and mathematics. Early Education Blueprint Report 2013-2015 (Ministry of Education, 2012) documented about 20% of Malaysian students failing to achieve a minimum benchmark in science and mathematics.

The main aim to integrate Information and Communication Technology (ICT) in education is to create capable, innovative and innovative human capital as well as to explore new areas for generating national wealth with the involvement and cooperation of expert groups, partnerships with the public-private sector, also community involvement (Ministry of Education, 2017). One of the new approaches to integrate ICT is the use of graphic calculators in science and mathematics education.

The use of graphic calculators in education can help to create an active learning environment and more effective interactions among teachers and students (Norain et al., 2011). The use of graphic calculators in Malaysia is still in its early stages and there are still many schools that are not familiar with this technology (Noraini, 2006). There is still less research conducted in Malaysia regarding the use of graphic calculators, and if had, not in depth that covers all aspects (Muhd. Khairiltitov, 2003).

The use of graphic calculators in Malaysia should be increased. Malaysia has yet to fully apply graphic calculators in science and mathematics education while other countries such as America, Australia, Japan, England and Singapore have made compulsory for schools to use graphic calculators since 1998 (Norain et al.., 2011). This caused Malaysia to be lagging behind in the use of technology in the education system as compared to other countries. This is a good reason to conduct more research on the use of graphic calculators in Malaysia and overcome the problems that are to be solved in order to apply this technology in the science and mathematical education system in Malaysia.

So far, the use of graphic calculators has not yet been expanded in most schools (Kamariah & Zulkarnain, 2008). This is due to some constraint factors such as expensive cost as compared to the usual calculator, students are not introduced and taught exactly how to use graphic calculator, teachers do not promote the benefit of using graphics calculators as well as negative impressions by teachers and students that the use of graphic calculator is more complicated than ordinary calculator (Jung-Chih & Yung-Ling, 2015).

Problem Statement

Most teachers still teach science and mathematics in schools with emphasis on teacher-centered teaching strategy. Teachers are more focused on academic achievement without emphasizing personality and student development (Abdul Majid, 2002). The use of technology such as graphic calculators in science and mathematics education is still not applied by school teachers (Kamariah & Zulkarnain, 2008). This is due to the limited knowledge of teachers in the use of graphic calculators in science and mathematics education. Teachers are not exposed to programs that promote deep learning and in-depth knowledge in this graphic calculator application. That is why teachers do not try to use graphic calculator instead prefer to use traditional methods to teach chemistry at school. Hence it can be concluded that there is a relevant need in discovering the limiting factors among the science and mathematics teachers in using graphic calculators.

Rationale and Purpose of Study

In the VISION 2020, the sixth challenge was about incorporating technology in teaching and learning to create the contributor of technology in upcoming years of technology civilization (Kamariah & Zulkarnain, 2008). Like other major developed countries, Malaysia is also focusing on the use of technologies such as GC in teaching and learning. Thus GC was started for use in Malaysia since 2004 (Noraini & Chew, 2011).

Unfortunately, Malaysia is still unable to make the VISION 2020 a reality as Malaysia is still far behind as compared to other developed countries. According to Noraini (2006), the usage of GC in teaching and learning still has not been utilized fully in Malaysia. There are very little researches done about GC in Malaysia. Even the few previous research done was not in-depth and very superficial (Muhd Khairiltitov, 2003). Previous research done was more focused on implication and students' achievement. No proper data can be derived to see the factors affecting the implementation of GC in Malaysia. This shows that there is a rationale to carry out more studies on GC in Malaysia to overcome the current issues related to the use of GC in teaching and learning.

Although uses of GC have shown positive achievement, there is a need to study the major role played by the teachers in using GC for teaching and learning. They are the key personnel in using GC. Teachers should have the abundance of knowledge, skills and interest in using GC in order to achieve the aspiration set in the VISION 2020 as aforementioned. According to a

statement made by Doerr and Zangor (2000), the relationship between teachers' knowledge and implementation of GC is remained unexplained (Kamariah & Zulkarnain, 2008). The purpose of this study is focused to examine the factors affecting the teachers to use GC in their teaching.

Aim and Research Objectives

The objective of this study was derived based on the following points:

i) Teachers play the key role to implement GC in teaching and learning.
ii) Factors affecting teachers' competency correspond to their inadequacy to implement GC in teaching and learning.
iii) Relevant understanding on affective factors need to be developed in order to derive a proper solution on this issue with the hope to aid in realizing Malaysia's VISION.

The main aim of this study is to examine problems/challenges faced by the teachers so that the researcher can learn better the current issues in education system that prevents the development of technology skills among citizens the usage of GC in teaching and learning in achieving Malaysia's VISION. The following are objectives for this study:

i) To examine factors and issues faced by the teachers of school X (pseudonym for the research school) in using GC in their classroom for teaching and learning.
ii) To determine the teachers' perception in implementing GC.

Research Questions

Although there are many factors affecting the implementation of GC for teaching and learning, this study mainly focuses on factors affecting the teachers in using GC. Thus two research questions were generated in response to Research Objectives as aforementioned.

i) What are the factors affecting teachers on using GC in their teaching and learning process?
ii) What are teacher's perception about the implementation of GC in teaching and learning?

Literature Review

Various journals that published previous studies were reviewed thoroughly to understand what graphic calculator is. This section will also review research related to graphic calculator in education which focused on its positive implications.

Graphic Calculator

Recommendation was made by NTCM (2000) on the integration of GC in all levels of mathematics since early 1986 (Brumberg, 2007). The first GC was introduced in the year 1986 by the brand Casio. This GC enables the drawing of graphs. Around ten years later, another model of GC was introduced by the company Texas Instruments (Waits & Demana, 1999). GC was defined by Kor and Lim (2003) as handheld, battery powered device equipped with functions to plot graphs, give numerical solutions to equations and perform statistical calculations, with operations on matrices and can perform more advanced mathematical functions such as algebra, geometry and advanced statistics (Parrot & Kwan, 2018). As time goes by, few other models were also introduced with various functions. The latest GC would be the TI-Nspire CX by Texas Instruments. The examples of GCs are illustrated in Figure 1.

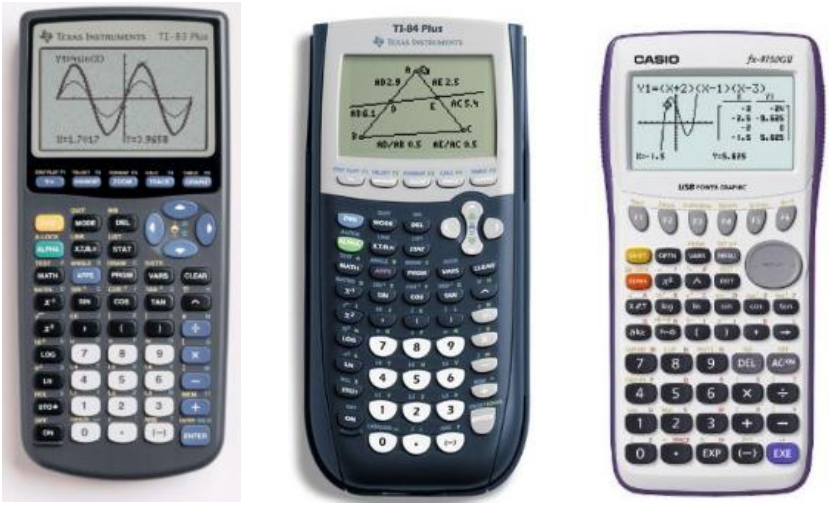

Figure 1. Examples of Graphic Calculator (GC) by Texas Instrument (TI) TI83 plus, TI84 plus and Casio.

Graphic Calculator in Education

Literature revealed too much time was spent on paper and pencil exercises with computations by students and teachers. A study was conducted in which students were provided with calculators to do more problems at the same time. This made it possible for the students to make guesses and test them. The student was an active part of the study process. The graphic calculator enabled the student to view what they studied, opening them to a more conceptual and not only procedural understanding of the subject. The student participated actively in the process of finding solutions for the problem (Brumberg, 2007).

Many researches have been done earlier to study the uses and outcome of GC in education. Most of the research showed a positive outcome of the use of GC on students' understanding and achievement in their studies. For example, Ghosh (2006) had studied on the effectiveness of technologies to be used in the classroom. Few technologies used in that research include GC and Computer Algebra System (CAS). A positive outcome was noted in this study where students were able to visualize and explore mathematical concepts for themselves. The graphic calculator facilitates deeper understanding by not only showing the specific answer after substitution, but also a connection to a family of equations (Graham & Thomas, 2000).

Noraini (2006) stated that promising implications were shown in teaching and learning of mathematics in Malaysia secondary school using GC. Although teachers play the key role to implement GC in classroom (Kamariah & Zulkarnain, 2008), there were few teachers do not prefer to use GC in classroom (Thomas, Bosley, Delos Santos, & Hong, 2007).

This is probably due to the fact that there are few factors that influence the teachers to implement this GC in their classroom learning. Among the few identified factors are the teacher's affordance and constraints in their learning environment, teacher's perception towards technology and education, as well as teacher's confidence and knowledge in using GC (Hong & Thomas, 2006). All this factors contribute to limitation faced in implementing GC in schools.

Methodology

This is a qualitative descriptive research study. This study was conducted by performing a face to face interview with the chosen sample teachers at school X (name not disclosed as requested by school management for ethical purposes).

This study was carried out in 3 phases. The first phase included preparation of structured questions and fixing appointment. The second phase involved meeting the teachers and conducting interviews. The third phase is the use of thematic analysis to analyze the content of the interview. The flow chart of the phases is illustrated in the following Figure 2.

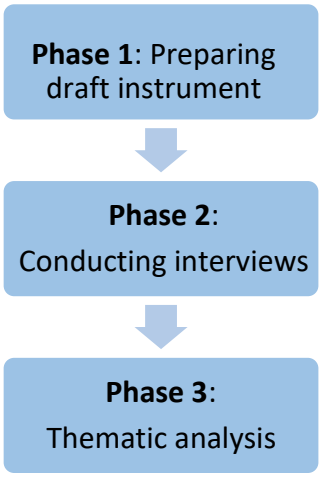

Figure 2. Phases of study.

Population and Sample

Population and sample of this study were determined as shown in Figure 3. There are a total of 86 secondary teachers in School X. Only six research samples were chosen using purposive sampling technique based on the following criteria; i.e. the teacher used GC in teaching and learning session. All the six mathematics teachers involved in using GC were chosen from school X but no science teachers involved in using GC.

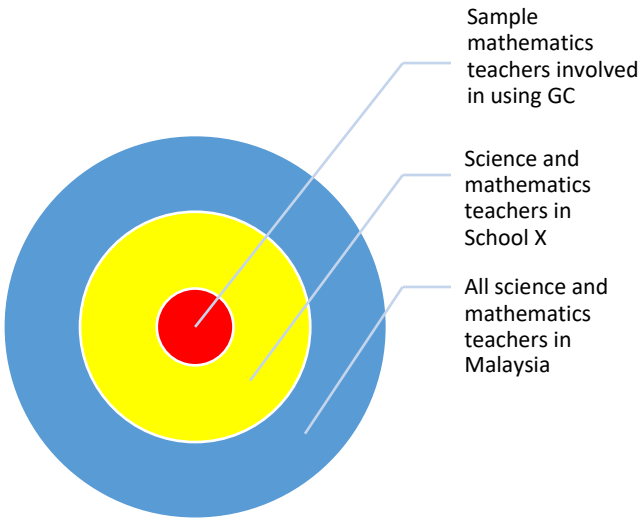

Figure 3. Population and sample.

Conducting Interviews

Eight interview questions were prepared prior to meeting the teachers. The following are summary of the questions:

1. What are the uses of GC?
2. Have you used GC before?
3. What are the reasons for you to use GC?
4. Will you be using GC in the future?
5. Have you been to any GC courses? Why?
6. In future are you interested in attending any GC courses?
7. Have you used any technology in your teaching?
8. What is your opinion on using GC?

The researcher had ensured that the content of the interview did not exclude any valuable points that should be asked in order to fulfill the research objectives of this study. Teachers were interviewed according to the flow or schedule that was set by the researcher to obtain the required answers.

Data Collection and Analysis Activities

While interviewing, a voice recorder application from the smartphone was used. The interview verbatim was transcribed onto paper later and reported in this study. From the obtained data, answers were coded. A thematic analysis was conducted to analyze the answers obtained from the teachers with conclusion made based on the findings.

Result and Discussion

It was observed that most of the teachers responded with almost the same answer. Based on the given responses, teachers are still considered one of the main factors affecting the implementation of GC in education. A total of five factors were derived from the thematic analysis result obtained as summarized in the following Figure 4 and elaborated subsequently.

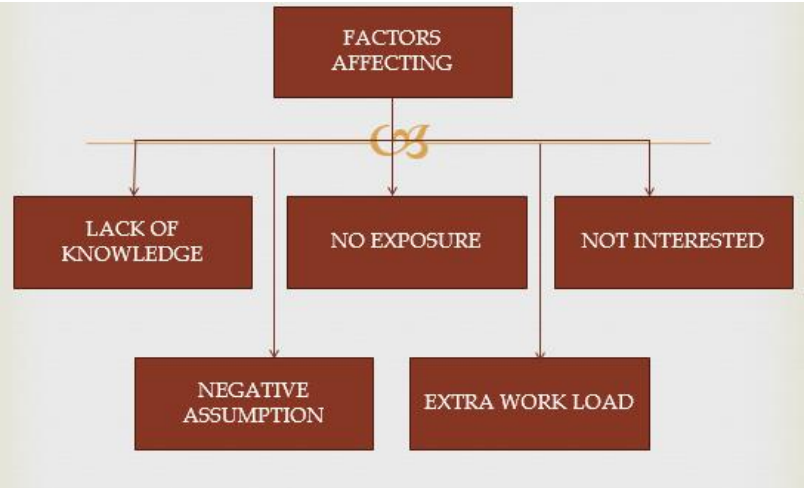

Figure 4. Five factors contributing to GC implementation derived from interview findings.

As shown in Figure 4, there are 5 factors contributing to GC implementation of Graphic Calculator from the thematic analysis completed.

The majority of the teachers have answered that 'lack of knowledge' is the main factor affecting the implementation of GC in their teaching. Teachers claim that they never learned how to use the calculator before during their teacher training period. One teacher stated that "*I never used or learned how to use GC during my teachers training*". A few other teachers even mentioned that "*I get to know the existence of GC once the GC was introduced in this school*". Two teachers responded by asking question "*How am I supposed to teach using GC when I myself don't know how to use this GC*". The point of lack of knowledge has become the contributing factor affecting the implementation of GC. This same point was stated by few other researchers. According to Chen and Lai (2015), teacher's knowledge, belief and professional development are the factors affecting teachers in implementing GC in their teaching. The same point was described by Bynum (2002) where. Teachers' limited knowledge on GC hinders effective classroom usage of GC. Another study conducted by Kamariah and Zulkarnain (2008) proved that the level of skills and knowledge of teachers in using GC is low. According to Kong (2006), teacher's knowledge is an influencing factor in administration of GC in teaching and learning.

The second theme concluded from the interview is 'no exposure'. Apart from the reason that teachers don't have adequate knowledge in operating the GC, they claimed that there was not enough exposure for them. One of the teachers mentioned that "*I am not exposed to the GC as I not learned the usage of the GC*". Teachers believe that there are seminars conducted by government on GC but they were unable to attend due to various reasons. This can be seen when teacher stated that "*there are courses available on GC but very limited. Not conducted frequently and usually far. This hinders most of the teachers to attend due to time and distance*". Among all the six teachers, only one teacher attended a course related to GC. However, according to that teacher, she still unable to fully understand despite attended the course. This theme is supported by the findings of few researchers. For example, Kamariah and Zulkarnain (2008) found out that teachers in another school in Batu Pahat never attended any GC courses. They also pointed out in her findings that no in-house training was given to teachers due to the reason that GC will not be used in national exams. Goos (2005) stated that teachers' previous use of GC, time and exposure are the factors contributing to adaptation of GC in their teaching. According to Goos (2005), teachers are not trained to use GC in their pre-service periods.

Surprisingly, the third theme which is 'no interest' was given as answer by all the teachers. All the six teachers claimed that they did not have the interest to implement the usage of GC in their teaching. One teacher mentioned that "*currently my way of teaching enables students to understand and perform well in exams where I don't find it necessary to implement this GC*". According to another teacher, the school's overall grade is excellent and she is not interested in using GC, also worried this might bring down the overall school achievement.

Teachers' no interest in teaching and the fear that implementing GC might bring down the overall school achievement are the main affecting factors. This is in line with the research done by Karadeniz (2015). According to the research, teachers also seem to have the perspective that using technology in their classrooms might affect their teaching strategy. Further questioning over this point showed that most of the teachers very less implemented the usage of technology in education and preferred traditional teaching method. One teacher said that "*I am convenient teaching using the whiteboard rather using technologies*". The most frequently used technologies by one teacher is powerpoint slides and computers. Another teacher added that "*the current scientific calculator is enough in training the students and is easier as the students will be using it in exams compared to GC which is not allowed to use in exams*".

Teachers' perspectives on technology plays an important role in their use of technology in teaching. Not only usage of technology in the classroom, but the teacher's perception plays an important role to motivate students in using GC (McCulloch, 2011, as cited in Karadeniz, 2015). 'Negative assumption' among teachers is the fourth theme derived from the interview. According to teachers, there were many average as well as below average students in each classroom. They concluded that this group of students would find it hard to understand and cope with GC if implemented in the classroom. One teacher stressed that they might give personal attention and more time for this group of students to make them understand. According to him "*I need to focus more on this group of students and pay more time. With the time constraint, I don't think it would ease the process of learning and will make the motivation of the students drop*".

Teachers are concerned on time limits due to more focus should be given in class in order to make the students understand better. This is supported by a study conducted by Leng (2011). According to that research, it was found out that mathematics class duration was inadequate in most of the schools. He also mentioned that students spent about 10 minutes to just engage with the GC prior to class. The same point noted in a study done by McCulloch, (2011, as cited by Karadeniz, 2015). In his study, a teacher mentioned that the short class period was a major drawback in implementing GC in teaching.

All the teachers agreed on this point where they claimed that using GC is an 'extra work load' for them. With current workload, teachers required to learn the skills of implementing GC in order to teach the students. As mentioned by one teacher "*with current workloads, we are required to work after schooling hours and have families to take care of. For I find it hard to allocate extra time to study the skills required to learn GC*". Other teachers also said that they need extra time to coach the students to learn to use the GC. Hence they found it burdening if GC was to be implemented in teaching.

Teachers needed more time to do the extra work to be more competent, to plan lessons with more detail, and to prepare testing worksheets. With the current extra workload, teachers found it difficult to implement GC in their teaching. Lumb, Monaghan and Mulligan (2001) concluded that extra work and time is needed for teachers to incorporate a GC into their lessons.

Conclusion

This study reveals that the following are five factors contributed by the teachers to implement GC in teaching and learning: 1) lack of knowledge, 2) no exposure, 3) not interested, 4) negative assumption and 5) extra workload. It is valuable to address these factors as teachers play the key role in implementing the usage of GC.

More research should be conducted to list out the proper steps that can be taken to overcome these factors so that more GCs can be used in teaching and learning which build our nation's vision to produce generations who are competent and ICT savvy citizens among the world's top countries leading in education.

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