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Scientific Calculator Proficiency and Competency Among Secondary School Students in Mathematics Education

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Abstract

Scientific calculator has been implemented from early years of secondary school to the undergraduate years in mathematics education in Malaysia. As one of the learning tools, scientific calculator is meant to assist students in understanding concepts and solving mathematical computation. Teachers and students should have the proficiency in using scientific calculator in order to benefit from this technology. Competency in using scientific calculator in solving mathematics lesson among students promotes the ability and confidence in learning mathematics. However, with many topics to cover during mathematics lesson, the use of scientific calculator seems to be left behind and is up to the students to catch up. This study explores secondary school student's proficiency and competency in using scientific calculator during a structured seminar. Data was collected from 56 secondary school students in Pulau Pinang who involved in a mathematical seminar. Findings show positive outcome from the seminar, even though there was no significant difference from paired-samples t-test done (Mean: Pre=6.7, Post=6.9), there was 40 percent decrease of number of students in the low scores group. This study suggests that a similar calculator seminar being trained to students occasionally as part of an initiative to support and maximize the use of scientific calculators in mathematics education.

Keywords: Calculator Scientific, Education, Mathematics, Seminar

Introduction

The scientific calculator is implemented in mathematics education as a learning aid used by teachers and students (Kamarulhaili & Sim, 2005; Leng, 2011). It is a valuable tool for gaining direct and stimulated experiences in learning mathematics. Incorporating such technology into mathematics education requires them to have the knowledge and ability to fully utilise it (Nabie & Yidana, 2001; Ebal et al., 2019). Students, as a generation that are growing up in a technologically environment, should feel comfortable exploring the functions of a scientific calculator.

In Malaysia, most secondary school students, especially those who are in Form Four and Form Five, are required to take at least one of two mathematics subject called Modern Mathematics and Additional Mathematics. Both of these subjects consist of a handful topics those students are expected to master within two years. Excel in these subjects opens up opportunities to science and technology courses in their future university studies (Olson & Riordan, 2012; Sole, 2019). Consequently, it contributes to great pressure and loss of interest in learning mathematics when they faced with difficulties in solving the questions. Proficiency in using a scientific calculator will surely come handy for the students to lift the burden in learning mathematics. This paper, therefore, attempts to assess secondary school students on their knowledge and ability to use related functions in their scientific calculator. This is to prove that having the ability to use most of scientific calculator functions can save time when solving mathematical problems and improve students' understanding.

Literature Review

Calculator as Learning Tool

There are four types of calculators that can be used in the classroom which are the basic calculator, graphing calculator, scientific calculator and lastly the online calculator. Each type of calculator has their own unique purpose and features. The issue of using calculators among students has been debated for decades. In Malaysia, scientific calculators are used at various levels and also allowed in the Sijil Pelajaran Malaysia (SPM) which is the national examination for form five students (Radzuan et al., 2021). However, there are no clear answers as to whether or not calculators should be permitted in the classroom (Line, 2020) because both arguments have their own points. For example, a study conducted by Polly (2008) found that students that use calculators frequently perform better than those who do not. On the other hand, Line (2020) found that students scored higher grades when they can use the calculator only for the last ten minutes of an assessment compared to the usage of calculator during the whole assessment. According to Polly, the students can improve their conceptual understanding as they can calculate and solve the problems quickly by using the calculator. Hence, they have more time to develop knowledge deeper.

Also, teachers play a big role in using calculators in the learning of mathematics. Thomas et al (2006) have done research on teachers about using calculators in mathematics classrooms. In their study, they found that teachers are in favour of using calculators in their classroom. However, a minority of teachers fear using calculators will weaken the students' by-hand skills. Richardson (2014) suggested that calculators can be used in secondary schools, provided with a skilled pedagogy. Using a scientific calculator alone is not enough. It should be integrated with the text books, curriculum and support from teachers to encourage students to use the technology (Kissane, 2016; Kissane & Kemp, 2012). Other than the scientific calculator, the online version of calculators also can be considered to be used in class to improve STEM education in general (Kissane, 2020). In some countries, scientific calculators are expensive for the students. As an alternative, Lucas (2019) suggested scientific calculator apps as an alternative tool. The digital natives who are the students are more familiar with the technologies such as smartphones (Prensky, 2001). Scientific calculator apps that are available in the App Store for iPhone and Play Store for Android phones for free. So, students can download and use the apps in their mathematics class and they will not be left behind even though they do not have the real scientific calculator. On the other hand, graphing calculators are also as helpful as scientific calculators for students to learn and solve mathematical problems. In a study conducted by Parrot and Leong (2018) found that the

students using graphing calculators perform better than the students who did not use calculators. The graphing calculator supports multiple representations of mathematical ideas and enhances clarity and understanding.

Importance of Scientific Calculator

It can be used as an aid in learning mathematics and science. Students can do their own practice and they can validate their answers by themself by using the calculator (Nabie & Yidana, 2001). Ochanda and Indoshi (2011) also agreed that these advantages should be taken advantage of in order to improve the number of students who are adept in using a calculator, making teaching and learning more effective and learner-centred. Also, it also can be used by the students to reassure themselves about their thinking (Kissane and Kemp, 2014). An observation has been made by Boaler (2016) that students can learn more from their mistakes rather than learn from the correct answers. According to Hadi et al (2018), the errors that students make in solving the HOTS test are comprehension error, transformation error, process skill error and encoding error. These are the indicators for students' difficulties in solving mathematical HOTS problems. They agreed that utilising technology in teaching and learning to strengthen the mathematical understanding among students. Based on a study conducted by Radzuan et al (2021), they found that the use of a scientific calculator can help low-achieving pupils improve their maths skills thus, this will reduce the gap between the high achieving and the low achieving students. When students are guided on using the scientific calculator, they will find a lot of possibilities of mathematical thinking (Dagan et al., 2020). Not only for finding answers, but the engineering students also are encouraged to explore the calculator and treat it as a computation machine.

Methodology

In this study, data was taken from the participants of Seminar of Scientific Calculator organized by Department of Computer and Mathematical Sciences, University Teknologi MARA Cawangan Pulau Pinang. A total of 56 students from secondary schools (Form Four students) throughout the state of Pulau Pinang participated in the seminar. The students came from four districts in Pulau Pinang, namely Seberang Perai Utara (SPU), Seberang Perai Tengah (SPT), Seberang Perai Selatan (SPS), and Barat Daya, where they attended public secondary schools. However, only 44 students completed the survey and the assessment. The survey consists of respondent’s demographic and questions regarding their proficiency in using scientific calculator.

Table 1
The Description of Question Based on Mathematics Syllabus

Topic	Description	Number of questions
Quadratic function	Solving quadratic function.	1
	Factorise the function.	1
System of equation	Solving 2-by-2 system of linear equations.	1
	Solving 3-by-3 system of linear equations.	1
Logarithms	Solving logarithms with the same based.	1
Index	Find value of index function.	1
Statistics	Find mean and variance.	2
Number based	Change based.	1
Vector	Solve operation of vector.	1

The assessment was a pre-test and post-test given to the students with a total of 10 mathematics questions related to their mathematics syllabus (Table 1). Their scores were recorded and compared for both tests.

Results and Discussion

A total of 44 Form Four students from schools throughout the state of Pulau Pinang were participated in the Seminar of Scientific Calculator. The students came from four districts in Pulau Pinang, namely Seberang Perai Utara (SPU), Seberang Perai Tengah (SPT), Seberang Perai Selatan (SPS), and Barat Daya, where they attended public secondary schools. Table 2 summarizes the demographics of the students. 34% of students attended schools in SPU, 32% attended SPT schools, 25% attended SPS schools and the remaining 9% attended Barat Daya schools. The majority of the students who participated in the seminar (84%) were female, with only 16% being male.

Table 2
Summary of students' demographic

	SPU	SPT	SPS	Barat Daya	Total
Male	5	1	0	1	7
Female	9	14	11	3	37
Total	14	15	11	4	44

The Seminar of Scientific Calculator was organized with the intention of teaching students how to use a scientific calculator to solve mathematical problems. During this seminar, students were also shown the most common errors they made when using scientific calculators. The effectiveness of the seminar was evaluated by administering pre- and post-tests to the participating students. Both tests used the same set of ten Mathematics questions covering topics such as quadratic equations, simultaneous equations, indices and logarithmic, statistics and vector. Table 3 provides a summary of statistics for pre-test and post-test scores. The pre-test and post-test mean scores were only slightly different, with the pre-test mean score of 6.659 and the post-test mean score of 6.886. However, the pre-test score distribution was more variable than the post-test, with a standard deviation of 2.271 for the pre-test and 1.466 for the post-test. This corresponds to a decrease in the number of students scoring less

than five marks, from 11% during the pre-test to only 5% during the post-test. This finding indicates that the knowledge of scientific calculators gained during the seminar helped students in improving their post-test scores. The paired-samples t-test result, however, reveals that the p-value (0.479) is greater than the 0.05 significant level, implying that the samples do not provide enough evidence to conclude that there was a statistically significant difference between the mean score of pre-test and post-test.

Table 3
A summary of statistics for pre-test and post-test scores

	Mean	**Std deviation**	**No. of students with a score of less than 5 marks (%)**
Pre-test	6.886	1.466	11
Post-test	6.659	2.271	5

Nonetheless, the results of the questionnaire survey show that all students agreed that attending the seminar helped them improve their knowledge of how to use scientific calculators. They also recognized the significance of having knowledge and proficiency in using scientific calculators for subjects requiring calculation, particularly Mathematics. Scientific calculators are an alternative to manual calculations in that they can perform calculations quickly, easily, and accurately. As shown in Figure 2 for the survey of the benefits of using a scientific calculator, all students with majority of them (82%) strongly agreed that a scientific calculator is an effective learning tool that can assist them solve most mathematical problems in a short amount of time. With the help of calculators, students can relieve the burden of performing tedious and excessive computations. Radzuan et al (2021) discovered that using a scientific calculator in the teaching and learning of mathematics did help low-achieving students in improving their mathematics performance because they were able to spend more time understanding mathematical concepts. Moreover, students will be encouraged to engage in higher-order thinking, while teachers will be encouraged to ask more detailed questions (Young, 2017, as cited in Radzuan et al., 2021).

Aside from that, all of them with 73% strongly agreed they felt more confident in their answers than when they solved the mathematical problems without using a scientific calculator. Improving students' confidence in mathematics has been shown in several studies to be one of the positive impacts of utilizing scientific calculators as an instructional tool (Ochanda & Indoshi, 2011). Furthermore, positive emotions will foster a positive learning environment, encouraging them to enjoy mathematics subjects. According to Wong and Wong (2019, as cited by Radzuan et al., 2021), students' frustration and helplessness in attempting to answer mathematics questions may leave them with a negative perception of mathematics.

The Malaysian Ministry of Education (MOE) has allowed the use of scientific calculators in the teaching and learning of Mathematics and Additional Mathematics subjects in secondary schools, in accordance with the implementation of the *Kurikulum Bersepadu Sekolah Menengah* (KBSM) curriculum, which was revised in 2002. (The Star, 2003, as cited in Radzuan et al., 2021). As demonstrated in Figure 2, more than 66% of students agreed or strongly agreed that their Mathematics teachers taught them how to use most of the basic functions in scientific calculators to solve mathematical problems. Only a small percentage of them, approximately 29%, disagreed. This could be due to teachers only having a limited

amount of time to teach all of the basic functions required to solve mathematical or calculation problems. Arumugam et al (2019) reported that teachers were concerned about time constraints because more attention should be paid in class to help students understand better. Another reason could be that teachers who were not technologically savvy found it difficult to incorporate scientific calculators into mathematics teaching and learning (Ochanda & Indoshi, 2011). They suggested that schools hold seminars to improve teachers' knowledge and skills in the use of scientific calculators. These seminars should be made available to students as well.

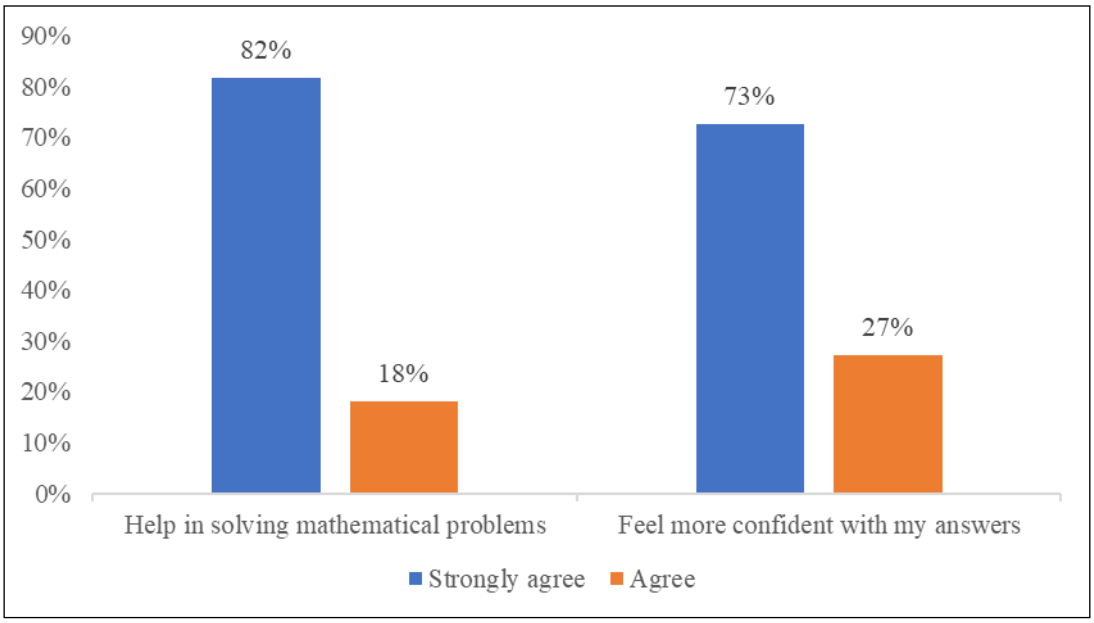

Figure 1: Benefits of using a scientific calculator

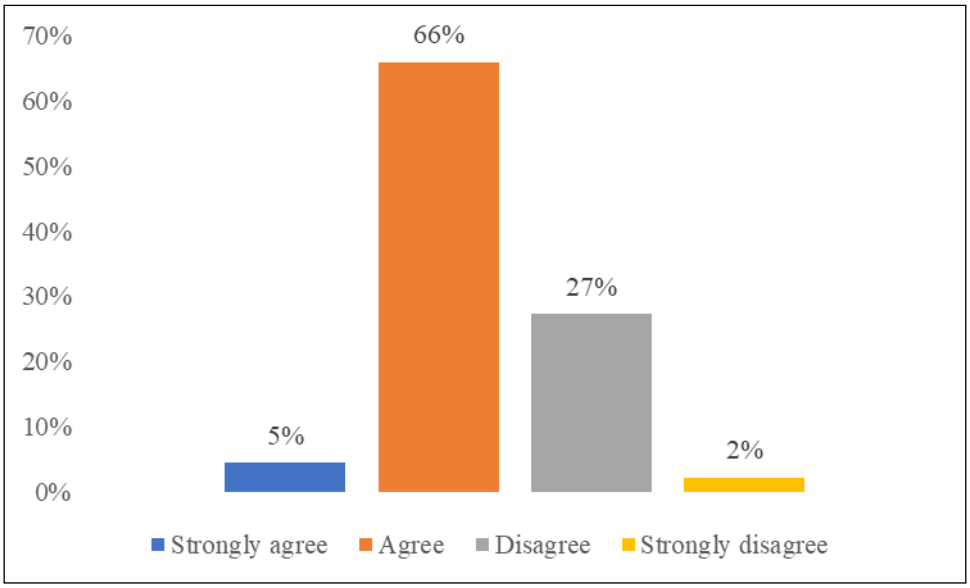

Figure 2: Perception of students on receiving a lesson on most scientific calculator functions at school

Regardless of the fact that the use of scientific calculators is included in the syllabus of Mathematics and Additional Mathematics subjects, the survey result shown in Figure 3 shows that 34% of the students had little knowledge of how to perform or use most of the

basic functions in the scientific calculator when solving mathematical or calculation problems. Not knowing how to use a scientific calculator proficiently could be one of the reasons they struggle to solve most mathematical problems, causing them to fall behind in their studies. Dagan et al (2020) discovered that proficient use of calculators in the teaching and learning of Calculus among engineering students improves not only students' exam performance, but also their understanding of Calculus concepts, as well as students' motivation and interest in learning them.

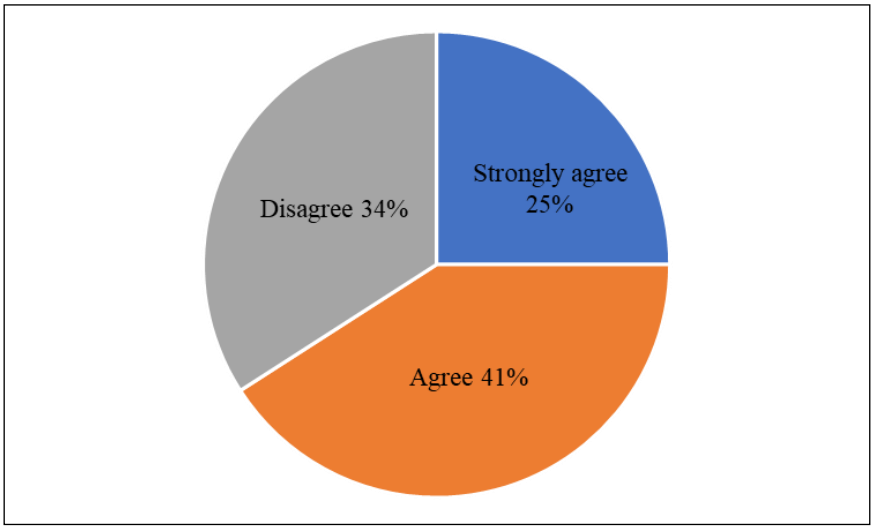

Figure 3: Knowledge on how to perform most of basic functions in scientific calculators

To summarize the empirical findings and discussion, scientific calculators can be regarded as a useful tool in the teaching and learning of Mathematics. Integrating calculators into an integrative teaching and learning approach may improve student learning, particularly for low-achieving students who have lower performance and engagement in these subjects. Teachers should do their part to use scientific calculators in teaching and learning mathematics, as well as support and encourage students to continue using calculators as a learning aid when solving mathematical problems. The Ministry of Education, particularly school administrators, should take the lead in organizing seminars or courses on scientific calculators for students and teachers in order to fully utilize calculators in teaching and learning Mathematics.

Conclusion

Based on the results, all students agreed that a scientific calculator seminar helped them in improving their knowledge on how to use a scientific calculator, and that a scientific calculator is an effective learning tool that can assist them solve most mathematical problems in a short amount of time. They also recognized the significance of having knowledge and proficiency in using scientific calculators for mathematics education. With the aid of scientific calculator, they felt more confident in their answers than when they solved the mathematical problems without using a scientific calculator. Based on these findings, the effectiveness of the seminar is acknowledged by the students, hence a seminar on scientific calculators should be proposed to be held occasionally throughout their school years.

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