TI-NSPIRE CX Graphing Calculator: Enhancing Students' Performance in Mathematics Learning

Nor'ain Mohd. Tajudin[1] & Noraini Idris[2]
[1]*norain@fsmt.upsi.edu.my* &[2]*noridris@upsi.edu.my*
[1] Mathematics Department, Faculty of Science and Mathematics
[2] Deputy Vice Chancellor's Office (Research & Innovation)
Sultan Idris Education University
35900 Tanjong Malim, Perak
MALAYSIA

ABSTRACT

Graphing calculators have become one of the most widely adopted technologies in mathematics education that have a powerful potential to help students master important mathematical concepts because they provide specific functionalities that are valuable for mathematics learning. The objective of this study is to compare the effect between the TI-Nspire CX graphing calculator (GC) strategy group and conventional instructional (CI) strategy group on students' performance in learning Straight Lines and Statistics topics. This study employed the quasi-experimental nonequivalent control-group pretest posttest design. The samples of the study are two intact Form Four classes from four selected secondary schools in Perak and Selangor. For each school, one of the classes served as the experimental group (GC strategy group) while the other class served as the control group (CI strategy group). The total number of students in the sample is 96 in the control group and 111 in the experimental group.There are two instruments used in this study namely The Straight Lines and Statistics Achievement Tests to assess students' performance on the Straight Lines and Statistics topics. Statistical inferences tests such as the independent t-test and ANCOVA were used to analyze the data. The results showed that students in the experimental group from all schools had significantly better scores in both tests than those from the control group. Integrating the use of TI-Nspire graphing calculators can be beneficial for students as this instructional strategy has proven to improve students' performance. Furthermore, TI-Nspire has the potential to be a tool in promoting higher level mathematical thinking that encompasses mathematical problems solving, reasoning and mathematical exploration.

Keywords: TI-Nspire graphing calculator strategy, Conventional Instructional strategy, Students' performance, Straight Lines and Statistics topics

I. INTRODUCTION

The increased use of technology and the changing demands of the workplace have changed the nature of mathematics instructions since the last few years. There is a need to develop students that can survive in today's society of technology. This requires highly skilled workers; able to apply their mathematical knowledge which includes and goes beyond the simple skills of solving complex problems. Indeed, the National Council of Teachers of Mathematics (NCTM) (1989) reflects a shift in the changing importance of thinking and problem solving in school. The vision of the recommendation by the NCTM (2000) is learning mathematics with understanding it. In fact, this learning environment is the ultimate goal of many research and implementation efforts in mathematics education (Hiebert & Carpenter 1992). According to Hiebert and Carpenter (1992), students who learn mathematics with understanding will retain what they learn and transfer it to novel situation. Thus, parallel with the growing influence of technological advancement, there is a need for a curriculum that can develop the mathematical power of students. This involves a shift from a curriculum dominated by memorization of isolated facts and procedures to one that emphasizes on conceptual understanding and mathematical problem solving.

ICT development should provide an added value to the teaching strategies, because many studies have showed the effectiveness of ICT in enhancing teaching and learning process (Johnson 2004; Noraini 2006, Noraini & Chew Cheng Meng, 2011; Nor'ain, Rohani, Wan Zah & Mohd Majid 2009, 2011). With the advent of ICT development incentives in education through the Education Development 2001-2010 (Ministry of Education, 2001), the level of development of the Malaysian education should accordingly recorded an increase and be on the right track towards producing a generation of high-skilled by the year 2020. However, reports of student's achievement in the Trends in International Mathematics and Science Study (TIMSS)(Mullis, Martin, Robitaille & Foy 2009; Mullis, Martin, Foy & Arora 2012) showed a decline in the results. TIMSS analysis found that the achievement still lags that of Malaysia Asian Nations partners such as Japan, Hong Kong, Korea, Taipei and Singapore. Malaysia's ranking fell from 10th (2003), down to the 20th (2007) and recently (2011) continues to decrease to number 26. This report describes the existence of shortcomings in managing the development of mathematics education at the school level in Malaysia. Our students were also found to be able to use basic mathematical knowledge in straightforward situations, however they are not capable of solving more complex problems, as well as having a low level of reasoning.

TIMSS reports (Mullis, Martin, Robitaille & Foy 2009; Mullis, Martin, Foy & Arora 2012) also showed teachers in Malaysia normally prefer teacher-centered approach namely the 'chalk-and-talk" in the explaining and elaboration of the principles, theories, definitions and concepts. It also demonstrated that they adopt a passive lecture teaching style with textbooks as the primary source in their teaching practices. Students too still make the teacher as dominant learning center. In addition, recently research by AKEPT (Ministry of Education, 2013) found that 50% of the teachers observed failed to deliver their lessons effectively, particularly to inculcate higher order thinking skills. This report seems to show science and mathematics teachers in Malaysia are not creative and less able to implement quality teaching in order to maximize student learning. In fact it seems that the ICT planned initiatives over the past decade failed to achieve its goals and increase student success. Despite years of educational development and innovations, it would seem that a lot more needs to be done to improve the mathematics performance among Malaysian secondary school students. New instructional methods or techniques should be attempted if improvements are to be forthcoming.

The use of graphing calculators in teaching and learning enable various kinds of guided explorations to be undertaken. For example, students can investigate the effects of changing parameters of a function on the shape of its graph. They can also explore the relationships between gradients of pairs of lines and the lines themselves. These activities would have been too difficult to attempt without technology. Exploratory activity in mathematics may facilitate an active approach to learning as opposed to a passive approach where students just sit back passively listening to the teacher. This creates an enthusiastic learning environment. This clearly shows the application of constructivist learning environment.

Graphing calculators offer a method of performing computations and algebraic manipulations that is more efficient and precise than paper-and-pencil method alone. Examples include finding the solutions of simultaneous equations or determine the equation of a straight line that is passing through two points. The mathematical concepts underpinning those procedures are rich and important for understanding. However, students often seem to put more effort in calculation and correspondingly less to making sense of the problems. Both attention to concepts and skill would be desirable in mathematics learning. Rather than just development of mechanical and computational skills, graphing calculators also allow for cultivation of analytical adeptness and proficiency in complex thought process. Problems representing real-world situation and data with complicated numbers can also be addressed. This would offer new opportunities for students to encounter mathematical ideas not in the curriculum at present. With appropriate use of graphing calculator, students can avoid time-consuming, tedious procedures and devote a great deal of time concentrating on understanding concepts, developing higher order thinking skills, and learning relevant applications. In addition to paper-and-pencil, mental and estimation skills, the graphing calculator assists student to execute the procedures necessary to understand and apply mathematics.

There is strong support from mathematics educators and professional mathematics organizations for increasing the use of the graphing calculator in mathematics learning. As this technology is commonplace in classroom, the impact of this usage on the students' understanding of mathematical concepts within a particular course must be considered. Kastberg and Leatheam (2005) in reporting a research studies on the use of graphing calculator up to this time, argue that the maximum potential for this technology has not been explored. Those studies provide a starting point for more efforts to better understand the methods to effectively use the technology in the classroom. Thus, further rigorous research is needed. This study directly responds to the need for empirical evidence regarding the effects of integrating the use of graphing calculator, specifically the TI-Nspire CX graphing calculator in mathematics instruction at the Malaysian secondary school level. Specifically, this study seeks to compare the effect between the GC strategy group and conventional instructional (CI) strategy group on students' performance in learning Straight Lines and Statistics topics. This study is designed to test the following hypothesis: There is no significant difference in the mean test performance in the learning of Straight Lines and Statistics topics between the GC strategy group and CI strategy group.

II. Materials and Method

This study employed the quasi-experimental nonequivalent control-group pretest posttest design. Figure 1 shows the diagrammatic representation of the nonequivalent control-group pretest posttest design. An X indicates an experimental treatment, and a "dash" indicates no experimental treatment. The O_1s indicate the measurements made during the pretest while the O_2s indicate the measurements made during the posttest. A pre test and post test was

ISSN 2350 – 7756

administered to both the control and experimental groups. The experimental group underwent an intervention where they learnt mathematics using the TI-Nspire CX graphing calculator for four weeks while the control group on the other hand learnt mathematics using conventional learning method.

Group	Pretest	Treatment	Posttest
Experimental	O_1	X	O_2
Control	O_1	-	O_2

Figure 1
Research Design of the Study

The samples of the study are two intact Form Four classes from two secondary schools in Perak and Selangor. These classes were selected by the teachers as the students are at the same level of achievement based on their previous school examination results. For each school, one of the classes served as the experimental group (GC strategy group) while the other class served as the control group (CI strategy group). The total number of students in the sample is 96 in the control group and 111 in the experimental group from the four public secondary schools.

There are two instruments used in this study as follows to assess students' performance on the Straight Lines and Statistics topics:

i. The Straight Lines Achievement Test (SLAT), and
ii. The Statistics Achievement Test (SAT)

The SLAT and SAT tests are designed by the researcher to measure students' performance on the Straight Lines and Statistics topics. Initially, a test specification table for both SLAT and SAT is prepared by the researcher incorporating the different levels of ability or achievement according to Blooms Taxonomy (Bloom, 1989). Furthermore, it was constructed based on the Form Four Malaysian mathematics syllabus and the Form Four Malaysian mathematics textbooks. It was a systematic formal test, using a paper-and-pencil procedure and it produced numerical scores. All the questions are submitted to the validators for content validation. The reliability index of Cronbach's coefficient alpha for both instruments was determined to be 0.70. Thus, the reliability of both tests was considered sufficiently acceptable.

The data collection instruments for this study were in the form of pretest and post-test. The teachers in the four schools were provided with the TI-Nspire CX graphic calculators and teaching modules for the topics Statistics and Straight Lines. They were briefed on how to use the teaching modules as well as administer the various data collection instruments. The students were divided into two groups, control group and experimental group. Before the treatment which involved the use of graphic calculators was administered onto the experimental group, the teachers administered the Straight Lines and Statistics Achievement Test to assess students' performance on the Straight Lines and Statistics topics to both control and experimental groups. Lessons using the graphic calculators were videotaped. Upon completion of the treatment, the teachers once again administered the Straight Lines and Statistics Achievement Test to assess students' performance on the Straight Lines and Statistics topics. This provided the researchers with post-test data.

The data collected from the research instruments was analyzed quantitatively to answer the research questions. Data obtained from the pre test and post test of Straight Lines Achievement (SLAT) and Statistics Achievement Test (SAT). Exploratory were analyzed using the descriptive and inferential statistics. The statistical analysis software SPSS was utilised to calculate the mean and standard deviation of the scores from the control and experimental groups of each participating school. In this study, firstly, the independent mean t-test was conducted on the SLAT and SAT scores to determine if the difference between the experimental group and the control group of each participating schools prior to the intervention is significant or not significant.

If the tests show that the difference between the two groups prior to the treatment is not significant, then the independent mean t-test will be conducted on the scores of the post – SLAT and SAT tests of each participating schools to determine whether the difference between the experimental group and the control group after the treatment is significant or not significant. If the tests show that the difference between the two groups prior to the treatment are significant, then the ANCOVA test will be conducted on the scores of the post – SLAT and SAT tests of each participating schools to determine whether the difference between the experimental group and the control group after the treatment is significant or not significant. The ANCOVA is used in this case as it will make correction to the difference that existed between the experimental and control groups prior to treatment so that the difference observed between the experimental and control groups after treatment is only due to the treatment and not because of the difference that existed between the two groups earlier. The use of the ANCOVA will also enable the study to determine whether the difference between the experimental and control groups after the treatment is significant or not significant.

III. RESULTS

Students' achievement was measured by the overall test performance in the Straight Line Achievement Test (SLAT) and Statistics Achievement Test (SAT). Both tests were systematic formal tests, using a paper-and-pencil procedure and it produced numerical scores. The total test performance for the SLAT was 30, meanwhile the total test performance for the SAT was 34. The test was conducted in the four sample schools twice, firstly as a pretest before the study and again as a posttest at the end of the study. The results are tabulated in Table 1 to 7.

TABLE 1
School A, Perak
Mean, Standard Deviation and t-Values for Both Groups

Test		Group	N	Mean	s.d	t-value	p-value
Straight Line Achievement (SLAT)	Pretest	Experimental	25	4.16	2.66		
		Control	25	1.80	2.29	2.264	.002
Statistics Achievement (SAT)	Pretest	Experimental	25	10.08	4.56		
		Control	25	15.44	4.29	-4.278	.000

Table 1 shows the means and standard deviations for pre-SLAT and SAT test for both experimental and control groups for School A, Perak. The results show that in pre- SLAT test, the control group had a mean score of 1.80 (standard deviation = 2.29) and the experimental group had a mean of 4.16 (standard deviation = 2.66). The computed t-value between the pretests of the control and experimental group is 2.264 at p =.002. Hypothesis testing shows that this value is significant at $p < 0.05$. This means that the students in the control and experimental were not similar in their achievement in the Straight Lines topic prior to the treatment. Meanwhile, in pre- SAT test, the control group had a mean score of 15.44 (standard deviation = 4.29) and the experimental group had a mean of 10.08 (standard deviation = 4.56). The computed t-value between the pretests of the control and experimental group is -4.278 at p = .000. Hypothesis testing shows that this value is significant at $p < 0.05$. This also mean that the students in the control and experimental were not similar in their achievement in the Statistics topic prior to the treatment. Therefore, the ANCOVA test is conducted on the scores of the post–SLAT and post-SAT tests to determine whether the difference between the experimental group and the control group after the treatment is significant or not significant.

TABLE 2
School A, Perak
Mean, Standard Deviation for Experimental and Control Groups on Pre and Post Test of SLAT and SAT

Test		Group	N	Mean	s.d
Straight Line Achievement (SLAT)	Covariat (pretest) Dependent (Posttest)	Experimental	25	23.04	3.80
		Control	25	9.20	6.49
Statistics Achievement (SAT)	Covariat (pretest) Dependent (Posttest)	Experimental	25	20.24	5.16
		Control	25	14.72	7.04

Means and standard deviations of the students' achievement in SLAT and SAT tests based on the posttest given are shown in Table 2. The post-SLAT test mean for the experimental group was 23.04 (standard deviation = 3.80) and the posttest mean for the control group was 9.20 (standard deviation = 6.49). Using the analysis of covariance, there was a significant difference on the mean performance scores in the SLAT between the experimental and the control groups ($F(1, 48) = 59.86$, $p < 0.05$, partial eta squared = .560). The results of the ANCOVA showed that the experimental groups performed significantly better than the control group in learning the Straight Lines topic.

Meanwhile, the post-SAT test mean for the experimental group was 20.24 (standard deviation = 5.16) and the posttest mean for the control group was 14.72 (standard deviation = 7.04). Using the analysis of covariance, there was a significant difference on the mean performance scores in the SAT between the experimental and the control groups ($F(1, 48) = 10.38$, $p < 0.05$, partial eta squared = .181). The findings of the ANCOVA showed that the experimental group performed significantly better that the control group in learning Statistics topic.

Table 3 presents the means and standard deviations for pre-SLAT and SAT tests for both experimental and control groups for School B, Perak. The results show that in pre-SLAT test, the control group had a mean score of 16.38 (standard deviation = 6.13) and the experimental group had a mean of 15.95 (standard deviation = 8.04). The computed t-value between the pretests of the control and experimental group is -.200 at p = .843. Hypothesis testing shows that this value is not significant at $p > 0.05$. This means that the students in the control and experimental groups were similar in their achievement in the Straight Lines topic prior to the treatment.

TABLE 3
School B, Perak
Mean, Standard Deviation and t-Values for Both Groups

Test		Group	N	Mean	s.d	t-value	p-value
Straight Line Achievement	Pretest	Experimental	21	15.95	8.04	.200	.843
		Control	24	16.38	6.13		
	Posttest	Experimental	21	18.71	7.91	-.297	.768
		Control	24	19.33	5.69		
Statistics Achievement	Pretest	Experimental	21	21.76	6.14	2.556	.015
		Control	24	17.63	4.45		

The independent mean t-test between the posttests of the control and the experimental groups showed a value of t=-.297 at p = .768. Hypothesis testing shows that this value is not significant, p>0.05. The findings show that both groups have similar achievement in the SLAT test.

For the pre- SAT test, the control group had a mean score of 17.63 (standard deviation = 4.45) and the experimental group had a mean of 21.76 (standard deviation = 6.14). The computed t-value between the pretest of the control and experimental groups is t=2.556 at p = .015. Hypothesis testing shows that this value is significant at p < 0.05. This indicates that both groups were differs in their SAT tests prior to the treatment. Therefore, the ANCOVA test is conducted on the scores of the post–SLAT and post-SAT tests to determine whether the difference between the experimental group and the control group after the treatment is significant or not significant.

TABLE 4
School B, Perak
Mean, Standard Deviation for Experimental and Control Groups on Pre and Post Test of SAT

Test		Group	N	Mean	s.d
Statistics Achievement (SAT)	Covariat (pretest) Dependent (Posttest)	Experimental	21	23.95	6.58
		Control	24	17.79	5.58

Means and standard deviations of the students' achievement in SAT test based on the posttest given are shown in Table 4. The post-SAT test mean for the experimental group was 23.95 (standard deviation =6.58) and the posttest mean for the control group was 17.79 (standard deviation = 5.58). Using the analysis of covariance, there was a significant difference on the mean performance scores in the SAT between the experimental and the control groups (F(1, 43) = 5.272, p < 0.05). These findings indicate that the experimental group significantly performed better than the control group in learning the Statistics topic.

TABLE 5
School C, Federal Territory of Kuala Lumpur
Mean, Standard Deviation and t-Values for Both Groups

Test		Group	N	Mean	s.d	t-value	p-value
Straight Line Achievement (SLAT)	Pretest	Experimental	14	13.14	6.49	4.984	
		Control	17	4.06	2.30		0.000
Statistics Achievement (SAT)	Pretest	Experimental	19	7.89	3.60		
		Control	21	9.62	4.24	-1.379	.176
	Posttest	Experimental	19	14.32	8.27	-.399	.692
		Control	21	15.33	7.86		

Table 5 displays the means and standard deviations for pre-SLAT and SAT test for both experimental and control groups for School C, Federal Territory of Kuala Lumpur. The results show that in pre- SLAT test, the control group had a mean score of 4.06 (standard deviation = 2.30) and the experimental group had a mean of 13.14 (standard deviation = 6.49). The computed t-value between the pretest of the control and experimental group is t=4.984 at p = 0.000. Hypothesis testing shows that this value is significant at $p < 0.05$. This indicates that both groups were differs in their SLAT test prior to the treatment. Therefore, the ANCOVA test is conducted on the scores of the post–SLAT test to determine whether the difference between the experimental group and the control group after the treatment is significant or not significant.

Meanwhile, in pre-SAT test, the control group had a mean score of 9.62 (standard deviation = 4.24) and the experimental group had a mean of 7.89 (standard deviation = 3.60). The computed t-value between the pretests of the control and experimental group is t= -1.379 at p = .176. Hypothesis testing shows that this value is not significant at $p > 0.05$. Therefore, both groups have similar ability in the SAT test prior to the treatment. Meanwhile the t-test between the posttest of the control and the experimental groups showed a value of t=-.399 at p = .692. Hypothesis testing shows that this value is not significant at $p>0.05$. This finding suggested that both groups did not differ significantly in their Statistics achievement.

TABLE 6
School C, Federal Territory of Kuala Lumpur
Mean, Standard Deviation for Experimental and Control Groups on Pre and Post Test of SAT

Test		Group	N	Mean	s.d
Statistics Achievement (SAT)	Covariat (pretest) Dependent (Posttest)	Experimental	14	17.00	7.16
		Control	17	2.71	2.17

Table 6 presents the means and standard deviations of the students' achievement in SAT test based on the posttest. The post-SAT test mean for the experimental group was 11.00 (standard deviation = 7.15) and the posttest mean for the control group was 2.71

(standard deviation = 2.17). Using the analysis of covariance, there was no significant difference on the mean performance scores in the SLAT between the experimental and the control groups ($F(1, 28) = 47.40$, $p < 0.05$, partial eta squared=.629). This finding indicated that statistically there was a significant difference in Straight Lines achievement between the experimental and the control groups where the experimental group significantly performed better than the control group in learning the Straight Lines topic.

TABLE 7
School D, Selangor
Mean, Standard Deviation and t-Values for Both Groups

Test		Group	N	Mean	s.d	t-value	p-value
Statistics Achievement	Pretest	Experimental	15	4.53	3.00		
		Control	15	3.13	5.66	.847	.404
	Posttest	Experimental	15	10.53	4.07	4.114	.000
		Control	15	3.13	5.66		

Table 7 displays the means and standard deviations for pre-SAT test for both experimental and control groups for School D, Selangor. Students at School D did not take the SLAT test because they have finished learn this topic earlier before this study was carried out. The results show that in pre- SAT test, the control group had a mean score of 3.13 (standard deviation = 5.66) and the experimental group had a mean of 4.53 (standard deviation =3.00). The computed t-value between the pretests of the control and experimental group is t= .847 at p = .404. Hypothesis testing shows that this value is not significant at $p > 0.05$. This means both group were similar in their achievement in this topic before the treatment was conducted to the experimental group. In post-SAT test, the control group had a mean score of 10.53 (standard deviation = 4.07) and the experimental group had a mean of 3.13 (standard deviation = 5.66). Meanwhile the t-test between the posttests of the control and the experimental groups showed a value of t=4.114 at p = .000. Hypothesis testing shows that this value is significant at $p<0.05$. This finding indicated that the experimental group performs significantly higher than the control group in the SAT test.

IV. DISCUSSION

Table 8 presents the summary of the results of the independent means t-test at p< .05 for four secondary schools involving students' mathematics achievement in the topic mentioned earlier. For the topic Straight Lines, students from all four schools with the exception of School D took the pre test and post test. School D had completed the topic before the commencement of this study. The pre test results from Schools A and C indicated that the achievement of students in the control and experimental groups were not similar. For School B, the pre test results showed that the students from both control and experimental group were similar in achievement. For all three schools, the post test results indicated that students from the experimental group performed better than the students from the control group.

For the topic of Statistics, pre test results of Schools A and B showed that students' achievement from both control and experimental groups were not similar whereas for Schools C and D, their achievement were similar. However, for all four schools the post test results indicated that students from the experimental group performed better than the control group. The findings indicate that for both topics, Straight Lines and Statistics, students who were exposed to the use of graphic calculators performed better in the test. Therefore, the findings have shown that the use of graphing calculators by students in the learning of Straight Lines and Statistics is effective in improving their achievement.

Probably the use of graphic calculators assisted students in their learning of these two topics because statistics concepts can be visualised through these graphic calculators to enhance their understanding. Also, graphic calculators allow visualisation and drawing of graphs which can help students grasp straight lines. The use of graphic calculators provides opportunities for students to explore mathematical concepts and encourage more learning activities in the mathematics classroom. Hence, supports better grasp and understanding of mathematical concepts, leading to better achievement results.

TABLE 8
Summary of the Results of the t-Tests for the Students' Mathematics Achievement

School	Straight Lines Achievement Test (SLAT)			Statistics Achievement Test (SAT)		
	Pre-test	Post-test	ANCOVA (Covariate= SLAT Pretest)	Pre-test	Post-test	ANCOVA (Covariate= SAT Pretest)
A	S	-	S	S	-	S
B	NS	NS	-	S	-	S
C	S	-	S	NS	NS	-
D	-	-	-	NS	S	

Note: NS = not significant at $p<.05$; S=significant at $p<.05$

V. Implications to Teaching and Learning

The use of graphing calculators provides an alternative to teaching mathematics. It allows more flexibility in terms of student activities. Students are exposed to activities that encourage exploration of mathematical concepts and this will help students see mathematics as a 'fun' subject. Graphing calculators also assist teachers in maximising the teaching time in the classroom. For example, teachers can very quickly show students different types of graphs with the use of graphing calculators and they do not have to waste time drawing the graphs manually. This will also allow teachers to encourage more student-centred activities. Through these activities students will be encouraged to do more discussion and group work.

In addition, teachers can make the best use of this technology by employing the "balanced approach". This approach can be achieved by routinely employing three strategies that were recommended by Waits and Demana (2000): solves analytically using traditional paper and pencil algebraic methods, and then supports the results using a graphing calculator, solves using a graphing calculator, and then confirms analytically the result using traditional paper and pencil algebraic methods, and solves using graphing calculator when appropriate (because traditional analytic paper and pencil methods are tedious and/or time consuming or there is simply no other way!). It is hoped that this approach will exploit the fullest advantages of the use of graphing calculator in helping students to achieve in-depth understanding of mathematical concepts and facilitating students in solving mathematical problems.

In this study, integrating the use of TI-Nspire CX graphing calculator in teaching and learning of topics, namely the Straight Lines and Statistics shows promising implications for the potential of the tool in teaching mathematics at the Malaysian secondary school level. The findings from this study have provided valid evidence that to a certain extent, the graphing calculator strategy is superior to conventional instruction strategy. Integrating the use of graphic calculator can be beneficial for students as this instructional strategy has proven to improve students' performance. Therefore, the findings from this study imply that graphing calculator strategy is an effective and efficient instructional strategy in facilitating the mathematics learning. Furthermore, TI-Nspire CX has the potential to be a tool in promoting higher level mathematical thinking that encompasses mathematical problems solving, reasoning and mathematical exploration.

References

Hiebert, J., & Carpenter, T. (1992). Learning and teaching with understanding. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 65 - 100). Reston, VA: National Council of Teachers of Mathematics.

Kastberg, S., & Leatham, K. (2005). Research on graphing calculators at the secondary level: Implications for mathematics teacher education. *Contemporary Issues in Technology and Teacher Education* [Online serial], *5*(1). Available: http://www.citejournal.org/vol5/iss1/mathematics/article1.cfm

Mullis, I.V.S., Martin, M.O., Foy, P., & Arora, A. (2012). *TIMSS 2011 International Reports in Mathematics.* Available: http://timssandpirls.bc.edu/timss2011/international-results-mathematics.html

Mullis, I.V.S., Martin, M.O., Robitaille, D.F., & Foy, P. (2009). *TIMSS Advanced 2008 International Report*. Available: http://timssandpirls.bc.edu/timss_advanced/ir.html

National Council of Teachers of Mathematics (1998). *Principals and Standards for School mathematics: Discussion Draft October 1998*. Reston, VA: NCTM.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics*, Reston, VA.

Nor'ain Mohd Tajudin, Rohani Ahmad Tarmizi. Mohd Majid Kontang & Wan Zah Wan Ali (2009). Instructional Efficiency of The Integration of Graphing Calculators in Teaching and Learning Mathematics. *International Journal of Instruction*, 2(2), 11-30.

Nor'ain Mohd. Tajudin, Rohani Ahmad Tarmizi, Wan Zah Wan Ali & Mohd. Majid Konting (2011). The Use of Graphing Calculators in Teaching and Learning of Mathematics on Performance and Metacognitive Awareness. *American International Journal of Contemporary Research.* 1(1), 59-72.

Noraini Idris & Chew Cheng Meng, (2011). Effect of Graphic Calculator-Based Performance Assessment on Mathematics Achievement. *Academic Research International*, 1(1), 5 -14.

Noraini Idris (2006). Exploring the effects of TI-84 plus on achievement and anxiety in Mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 2(3), 66-78.

Waits, B. & Demana, F. (2000). The role of graphing calcultors in mathematics reform. In Edward. D. Laughbaum. *Hand-Held Technology in Mathematics and Science Education: A Collection of Papers*. Columbus, OH: The Ohio State University.