Graphic Calculators: Effect on the Mathematical Performance of Students

KENNETH C. OCAMPO, M.A. Math
Instructor I
BS-Mathematics Program Head
Jose Rizal Memorial State University – Dipolog Campus
kennethocampo@jrmsu.edu.ph

Abstract — The study aimed to find out the students' skills in mathematical computation using calculators in teaching Mathematics among freshmen students in the College of Education of Jose Rizal Memorial State University, Dipolog Campus, Dipolog City during the First Semester of Academic Year 2012 – 2013. The study utilized the quasi – experimental design 10 method of research, utilizing the Pretest – Posttest Nonequivalent Group Design. There were 48 students utilized as subjects of the study for the experimental group while there were 47 students who were utilized as subjects of the study in the control group. The teacher–made–questionnaire was used to determine the pretest and posttest performance of the students in both groups. The statistical methods used were the arithmetic mean, z – test one – sample group, t – test for independent samples, and t – test for correlated samples.

The study revealed that the skill of the students in Mathematical computation in the experimental group was greatly influenced by the graphic calculators used in the teaching of College Algebra. Finding implied that students in the experimental group performed skillfully better than their counterpart. The study strongly recommends that the Campus Director of Jose Rizal Memorial State University, Dipolog Campus, Dipolog City should allocate a budget for the acquisition of graphic calculators for Mathematics classroom use. Moreover, Mathematics instructors/professors should incorporate the use of graphic calculators during the preparation of the Mathematics syllabi to ensure integration of graphic calculators in Mathematics instruction and to ascertain higher Mathematics performance of the students.

Keywords — Graphic Calculator, Mathematics, Mathematical Performance, Algebra, College Algebra, Mathematics Instruction, Equation Solving, Mathematic Calculator

I. Introduction

Today's Mathematics classrooms are facing rapid changes more than in any other educational discipline. These changes are centered on not only what is being taught, but also on how it is being taught. Educationally, Houppi (2009) averred that the world is in a technological boom – the reason why Mathematics classrooms have been flooded with electronic teaching tools. In effect, there have been transitions in Mathematics classrooms, such as the evolution from blackboard to whiteboard to smartboard, but ultimately those changes have not drastically altered the way in which information is presented. Some classrooms have abandoned the use of textbooks to provide students with the chance to discover more on their own and use each other as learning resources.

The most important of these changes, according to Heid and Edwards (2001), was the utilization of graphic calculators. The user-friendliness and portability of these devices have had a major effect on the access of students to new ways of thinking. Edwards et. al., (2008) pointed out that teachers and students today have a new sense of power in the classroom because of the visual nature of the graphic calculators.

In the Philippines, one of the challenges which Mathematics teachers confront in the integration of technology like graphic calculators in teaching the subject is the unavailability and the lack of the gadget for use in the classroom (De Las Peñas, et. al, 2012). The graphic calculator has a powerful algebraic function. The variety of its built-in programs make it capable to carry out different kinds of calculations and transformations of polynomials, matrices, determinants, factorizations, equation solving, the seeking of limits and trigonometric functions, and many others. Such functions have not only provided strong support for the teaching of Mathematics, especially beginning calculus and other higher Mathematics content at the secondary school level, but also graphic calculators have become good tools for independent exploration and experiments (Shore, et. al, 2003).

With the quest of providing research-based decisions involving graphic calculators and students' performance in Mathematics among Education students of Jose Rizal Memorial State University, Dipolog Campus, Dipolog City, the researcher is encouraged to conduct this study to find out the students' skills in mathematical computation using graphic calculators and determine their relationship to students' performance in Mathematics. The result of this study is expected to construct possible corrective measures to enhance students' skills in mathematical computation using graphic calculators and the performance among the teachers and the students.

Literature Review

Today, mathematical skills and knowledge are steadily gaining importance for everyday life in a lot of countries all around the globe. In fact, Mathematics is viewed as a necessary competency for critical citizenship (Adler, et.al, 2005). And amidst so much growth and development which characterize the world today, changes are taking place in all aspects of human endeavor. This is brought about by technology. According to the National Council of Teachers of Mathematics (NCTM, 2008), technology is an essential component in teaching Mathematics and it influences the way Mathematics is taught and learned. However, some educators are uncertain and anxious about the functions of technology in their student learning (Honey and Graham, 2003).

Lewin (2012) pointed out that the traditional role of technology in the teaching of Mathematics has been focused on its ability to solve, to evaluate, to produce images and even to guide students through stereotypical working steps that are supposed to be employed in as one works through exercises that appear in the textbooks. But technology has another role that is sometimes neglected. It gives us new and efficient ways to talk with one another. It offers opportunities to convey Mathematics in a much more friendly form than one can find in any ordinary textbook. It allows instructors and students to exchange mathematical ideas even when they are not standing face to face in the same room. It can be a means of communication between people.

Van Voorst (2008) asserted that technology is useful in helping students to view Mathematics less passively, as a set of procedures, and more actively as reasoning, exploring, solving problems, generating new information, and asking new questions. Furthermore, he added that technology helps both teachers and students to visualize certain Mathematics concepts better and that it adds a new dimension to the teaching and learning of Mathematics.

In the same vein, students can develop and demonstrate deeper understanding of mathematical concepts and are able to deal with more advanced mathematical contents than in a "traditional" teaching environment (Berk, D.M. 2004). Observation showed that the traditional mathematical concept is often considered to be memorizing formulas, substituting numbers in equations, repeated practice and long and monotone calculators. This is accurate because many students have become tired of Mathematics, and have strayed from Mathematics because it is boring and has complicated calculations (Ye, 2009). However, the use of graphic calculators to handle complex calculations reduces the burden on students which results in spending more time on understanding, reasoning, and the applications of Mathematics because it stimulates enthusiasm for learning (Streun, Harskamp, & Suhre, 2000).

Graphic calculators are able to provide multiple visual representations, allowing students' hands-on operation to enable them to experience different forms of relationships through real-world examples (Laughbaum, 2002). This type of technology provides a platform of doing simple Mathematics to students. Taking inequality as an example, every inequality can have an important mathematical representation, in particular the geometric representation. If the teachers can bring some geometry contexts of inequalities correctly in teaching, the students are in the visual process of observation and can grasp such inequalities well. This is far more meaningful than demanding students to solve inequalities by calculation. At the same time, teachers can train students' ability for logical thinking by process education and allow them to feel that many mathematical principles can also be proven by both intuitive and visual approaches (Ye, 2009).

There are many more enjoyable benefits with graphic calculators in Mathematics education. It enables students to approach situations graphically, numerically and symbolically, and supports students' visualization, allowing them to explore situations which they may not otherwise be able to tackle and thus perhaps enable them to take their Mathematics to a more advanced level (Jones, 2005). In this way, using graphic calculators is expected to lead to higher achievement among students through increased student use of graphical solution strategies, improved understanding of functions, and increased teacher time spent on presentation and explanation of graphs, tables and problem solving activities (Cedillo, 2001). The impact of the availability of this form of calculator on teaching methods and curricula appears to have been more limited, with teachers reportedly tending to use graphing calculators as an extension of the way they have always taught, rather than provoking any radical change in style of teaching or design of the curriculum.

With calculator technology, students in Mathematics who ordinarily are frustrated or bored by these tedious manipulations have access already to the real Mathematics itself, thus gaining a higher level of mathematical understanding, rather than giving it up (Abalajon, 2000). Appropriate use of technology and associated pedagogy develop students' thinking and reasoning mathematically. Thus, more people will develop useful mathematical understanding and power.

In the Philippines, the integration of graphic calculators in the Mathematics classroom is rarely employed to enhance mathematical understanding and mathematical power. This is one of the challenges confronting Mathematics teachers as in the integration of the technology in Mathematics teaching. The technology is not at all available for use in the classroom (De Las Peñas, et. al, 2007).

Unarguably, the emergence of computer technology with varying numeric capabilities redefines the role of computers in instruction (Ellington, 2003). More importantly, in the Philippines where there is difficulty accessing expensive computer technology, teachers can take advantage of the learning opportunities provided by the graphic calculators. These calculators provide graphical representations and allow computational, tabular, statistical calculations, solutions to equations, numerical differentiation and integration. There are a number of ways this graphic calculator environment can be used to design activities for student learning of mathematics. Graphic calculators highlight some examples when the use of this technology is incorporated in teaching Algebra, Trigonometry and Calculus (Laughbaum, 2002). Further, it helps in improving students' spatial visualization skills, critical thinking ability, understanding of connections among graphical, tabular, numerical, and algebraic representations, and achievement in Mathematics (Acelajado, 2003).

Brady (2008) investigated "The Effect of Graphing Calculator Use on Student Achievement in Advanced Placement Calculus". The findings of this study revealed observed differences on calculator and/or non-calculator portions of the instrument based on many different factors including type of calculator used, teacher enthusiasm for the graphing calculator and teachers' integration decisions.

In a particular study of Kastberg, et al (2005) entitled "Research on Graphing Calculators at the Secondary Level: Implications for Mathematics Teacher Education" found out that access to graphing calculators was associated with student achievement gains and a wide array of problem-solving approaches. The study revealed further that students' achievement was positively affected when they used curricula designed with graphing calculators as a primary tool. Findings of teachers' use and privilege of graphing calculators illustrated the impact professionals had on students' mathematical knowledge and calculator expertise.

The study on the "Effects of Graphic Calculator-Based Performance Assessment on Mathematics Achievement" was conducted by Idris, et. al (2011) which found out that the experimental groups in all the eleven schools performed significantly better than the control groups in the mathematics achievement test after the intervention, indicating that graphic calculator-based performance assessment was effective in improving secondary students' mathematics achievement.

While in the study of Idris (2006) on "Exploring the Effects of TI-84 Plus on Achievement and Anxiety in Mathematics", the sample of the study consisted of four classes of form four students from two of the public schools in Selangor, Malaysia. In each school, one class was assigned to be the experimental group (N=54) and the other the control group (N=55). For the experimental group, all students used the graphing calculator. The treatment took about ten weeks. Regular teachers taught and used the graphing calculator. A paper and pencil test on the achievement and anxiety test developed by the researcher was given to both groups before and after the treatment. The result showed that there was a significant difference in the achievement and anxiety of the treatment groups ($p < 0.01$).

Campagnone (2005) also dealt on "The Effects of Graphing Calculators on Student Performance in High School Algebra". The purpose of this study was to determine if students performed better on Systems of Equations when graphing calculators were utilized in the daily lessons. Pre and post tests as well as attitude surveys were given, and the chapter test results compared to those of the previous year's students. Students showed improvement on pre to post test scores, and this year's students scored much higher on their chapter test. However, students generally did not believe that using calculators helped them to do better.

Similarly, Heller, et al (2005) investigated "The Impact of Handheld Graphing Calculator Use on Student Achievement in Algebra 1". Results showed that the more access students had graphing calculators, and the more instructional time in which graphing calculators were used, the higher the test scores. In addition, scores were significantly higher where teachers reported receiving professional development on how to use a graphing calculator in math instruction.

"The Impact of Graphing Calculator Use on Algebra I End of Course Examinations. Multiple Linear Regression Viewpoints" was also investigated by Sherron, et al (2007). Researchers examined data with descriptive statistics and multiple linear regressions, to investigate differences and relationships between mathematics achievement, graphing calculators, and student and teacher variables. Researchers found that students demonstrated higher levels of math performance when a graphing calculator was used. There was also a positive correlation between the residual gain scores and students using a classroom set of graphing calculators.

On the other hand, Ellington (2012) studied "The Effects of Non-CAS Graphing Calculators on Student Achievement and Attitude Levels in Mathematics: A Meta-Analysis". The results on the achievement and attitude levels of students are presented. The studies evaluated cover middle and high school mathematics courses, as well as college courses through first semester calculus. When calculators were part of instruction but not testing, students' benefited from using calculators while developing the skills necessary to understand mathematics concepts. When calculators were included in testing and instruction, the procedural, conceptual, and overall achievement skills of students improved.

Acelajado (2003) in her study on "Use of Graphing Calculators in College Algebra: Cognitive and Noncognitive Gains of Mathematics Students" revealed significant cognitive and non-cognitive gains were brought about by the use of graphing calculators within each ability group. Cognitive and non-cognitive gains from using graphing calculators included students' improved achievement, better attitude, and reduced anxiety in mathematics, increased self-confidence, and improved classroom dynamics. The study revealed further that the use of graphing calculators had made significant changes in the respondents' attitude and anxiety in mathematics, regardless of their abilities.

Similar study was also conducted by Acelajado (2007) entitled "The Impact of Using Technology on Students Achievement, Attitude and Anxiety". The study revealed that significant differences were noted in the pretest and posttest mean scores in the achievement, attitude, and anxiety of the different ability groups in favor of the high ability group. However, no significant difference existed between the levels of anxiety of the three groups of students, although the use of graphing calculators was found to reduce their anxiety scores. Graphing calculators were most helpful in the study of functions and their graphs and systems of equations. Moreover, positive effects of using graphing calculators included students' improved achievement, reduced anxiety in mathematics, increased self-confidence, and active involvement of students in the learning process.

II. Methodology

The study employed the quasi – experimental design 10 utilizing the Pretest – Posttest Nonequivalent Group Design. This design utilized two groups which were the experimental and control groups. The experimental group was exposed to the experimental treatment while the control group was exposed to the traditional method of teaching Mathematics. This method is deemed appropriate since the study attempted to discover the effects of graphic calculators in teaching Mathematics on students' performance.

In this investigation, the researcher focused and considered two teaching approaches such as graphic calculator utilization and the traditional model in teaching Mathematics as independent variables. Graphic calculator technology is a hand-held mathematics computer that draws and analyzes graphs, computes the values of mathematical expression, solves equations, performs symbolic manipulation, performs statistical analyses, makes programs and communicates information between devices (Jones, 2005).

Along this premise, this study attempted to find out the students' skills in mathematical computation using a graphic calculator which included skill in solving zeros of function, skill in writing equations of functions, skill in solving problems involving functions, skill in solving inequalities, and skill in graphing functions.

III. Results and Discussion

The data which are presented in tables are results of the pretest administered to the control and experimental groups. The pretest skill performance was obtained before the groups were exposed to the assigned interventions.

Control Group

Table 2 Pretest Skill Performance in Mathematical Computation of the Students in the Control Group

Students' Skills	No. of Items	μ	$\overline{X}$	σ	z	Description
Solving Zeros of a Function	12	9	2.64	1.566	27.85	Less Skillful
Writing Equations of Functions	12	9	2.40	1.469	30.78	Not Skillful
Solving Problems Involving Functions	12	9	2.49	1.545	28.89	Less Skillful
Solving Inequalities	12	9	2.13	1.610	29.26	Not Skillful
Graphing Functions	12	9	1.87	1.454	33.61	Not Skillful
Total	**60**	**45**	**11.53**	**7.171**	**32.00**	**Not Skillful**

μ = hypothetical mean, σ = standard deviation

$\overline{X}$ = actual mean, z = computed z – value

Table 2 presents the pretest skill performance in mathematical computation of the students in the control group. Five skills were measured in the experiment, namely: skill in solving zeros of function, skill in writing equations of functions, skill in solving problems involving functions, skill in solving inequalities, and skill in graphing functions. Sixty (60) items were used to determine the five skills broken into 12 items per skill. The expected performance of the students was set at 75 percent of the items that determined each skill. In this case, a score of 9 was set as the expected performance per skill and score of 45 for the whole instrument.

As reflected in the table, the students of the control group were "less skillful" in solving zeros of a function and solving problems involving functions. Further, the respondents in the control group were not "skillful" in writing equations of functions, solving inequalities and graphing functions. Overall and on average, the control group was "not skillful" to the different skills presented in the table. This was supported by the actual mean of 11.53 with standard deviation of 7.171 which did not exceed the expected hypothetical mean of 45. The obtained actual mean was described as "not skillful". The computed z which is 32.00 is greater than the critical value of 1.96 at .05 level of significance which indicates that the obtained actual mean of 11.53 differed significantly from the expected mean of 45. This means that the scores of the respondents in the control group are significantly below the hypothetical mean during the pretest. This implies that respondents do not have stock knowledge on the topics tested in the pretest. This implies further that the respondents need the necessary interventions to improve Mathematics performance.

This finding is corroborated by De Las Peñas, et. al (2012) who found out that the control group did not perform well during the pretest. Acelajado (2003) also supported the present claim.

Experimental Group

Table 3 Pretest Skill Performance in Mathematical Computation of the Students in the Experimental Group

Students' Skills	**No. of Items**	μ	$\overline{X}$	σ	z	**Description**
Solving Zeros of a Function	12	9	2.27	1.125	41.44	Not Skillful
Writing Equations of Functions	12	9	2.31	1.151	40.25	Not Skillful
Solving Problems Involving Functions	12	9	2.19	1.197	39.43	Not Skillful
Solving Inequalities	12	9	2.06	1.192	40.32	Not Skillful
Graphing Functions	12	9	1.96	1.202	40.59	Not Skillful
Total	**60**	**45**	**10.79**	**5.604**	**42.29**	**Not Skillful**

μ = hypothetical mean, σ = standard deviation

$\overline{X}$ = actual mean, z = computed z – value

The pretest skill performance in mathematical computation of the respondents in the experimental group is shown in Table 3. The students in the experimental group, like those in the control group, were also given the pretest similar to the pretest administered to the control group. The hypothetical mean was also set at 75 percent of the total possible highest score.

As shown in the table, the students in the experimental group were "not skillful" in all of the five skills from solving zeros of functions to graphing functions. Overall and on average, the table reveals that the experimental group obtained the pretest actual mean score of 10.79 with a standard deviation of 5.604. The obtained mean score of the group which was described as "not skillful" was supported by the computed z – value of 42.29 which is greater than the critical value of 1.96 at.05 level of significance. This indicates that the difference between the actual mean obtained and the expected mean was significant.

Finding means that the scores of the respondents in the experimental group are below the hypothetical mean score during the pretest. This means further that respondents do not have stock knowledge on the topics tested in the pretest. This implies that the respondents have similar performance in the pretest like those in the control group. This implies further that the respondents also need the necessary interventions to improve Mathematics performance.

This finding is also corroborated by De Las Peñas, et. al (2012) who found out that the control group did not perform well during the pretest. Acelajado (2003) also supported the present claim whose study revealed that the students in the experimental group did not perform better during the pretest.

Table 4 Test of Difference on the Pretest Skill Performance in Mathematical Computation Between the Control and Experimental Groups

Group	N	Mean	Mean Difference	Standard Deviation	Computed t	Tabulated t	Decision
Control	47	11.53	0.74	7.171	0.561^{ns}	1.661	Ho not rejected
Experim	48	10.79		5.604			

ns = not significant ***** = significant at .05

Table 4 presents the t – test result comparing the pretest skill performance in mathematical computation of the respondents between the control and experimental groups. The table shows that the control group obtained a slightly higher mean score of 11.53 than the experimental group which obtained a 10.79 mean score. It is safe to say that students in the control group performed a little bit better than those in the experimental group prior to the intervention. However, scores in the experimental group were less dispersed which obtained a standard deviation of 5.604 than the scores in the control group which obtained a standard deviation of 7.171. The table presents further a mean difference of 0.74 in favor of the control group, which when subjected to t – test, the computed t – value of 0.561 is less than the tabulated value of 1.661 at 0.05 level of significance with 93 degrees of freedom. This means that there is no significant difference on the pretest skill performance between the control and experimental groups. This means further that there is no significant difference in the skill performance between the two groups before the intervention. This implies that the students' skills in both the control and experimental groups on the topics for this experiment are comparable.

Posttest Skill Performance of the Control Group

Table 5 Posttest Skill Performance in Mathematical Computation of the Students in the Control Group

Students' Skills	No. of Items	μ	$\overline{X}$	σ	z	Description
Solving Zeros of a Function	12	9	5.511	1.679	14.25	Skillful
Writing Equations of Functions	12	9	5.426	1.612	15.20	Skillful
Solving Problems Involving Functions	12	9	5.447	1.572	15.50	Skillful
Solving Inequalities	12	9	5.383	1.609	15.41	Skillful
Graphing Functions	12	9	5.319	1.682	14.74	Skillful
Total	**60**	**45**	**27.09**	**7.865**	**15.62**	**Skillful**

μ = hypothetical mean, σ = standard deviation

$\overline{X}$ = actual mean, z = computed z – value

Table 5 reveals the posttest performance of the respondents in the control group. Similar to the pretest, there were also five skills treated in the posttest, to wit: skill in solving zeros of function, skill in writing equations of functions, skill in solving problems involving functions, skill in solving inequalities, and skill in graphing functions with 12 items in each skill. The level of expected performance was also set at 75 percent of the total possible highest score in which case 9 items in each skill and 45 items for the whole test.

As seen in the table, students in the control group were "skillful" in all of the five skills from solving zeros of a function to graphing of functions. The table reflects further that the posttest skill performance in mathematical computation actual mean score of the control group was only 27.09 which was described as "skillful" with a standard deviation of 7.865. This obtained actual mean is supported by the computed z – value of 15.62 which is greater than the tabulated value of 1.96 at .05 level of significance. This indicates that the obtained actual mean was below the hypothetical mean as set forth in the study.

Moreover, the result implies that the students still learn the subject with a traditional method of teaching Mathematics. Noticeably, the control group found Mathematics difficult. Though the table reflects that there was learning during the treatment, the control group only failed to reach the indicated hypothetical mean of the study.

Posttest Skill Performance of the Experimental Group

Table 6 Posttest Skill Performance in Mathematical Computation of the Students in the Experimental Group

Students' Skills	**No. of Items**	μ	$\overline{X}$	σ	z	**Description**
Solving Zeros of a Function	12	9	10.29	0.683	13.10	Very Much Skillful
Writing Equations of Functions	12	9	10.10	0.778	9.83	Very Much Skillful
Solving Problems Involving Functions	12	9	9.88	0.841	7.21	Very Much Skillful
Solving Inequalities	12	9	9.94	0.909	7.15	Very Much Skillful
Graphing Functions	12	9	9.81	0.842	6.69	Very Much Skillful
Total	**60**	**45**	**50.02**	**2.178**	**15.97**	**Very Much Skillful**

μ = hypothetical mean, σ = standard deviation

$\overline{X}$ = actual mean, z = computed z – value

The posttest skill performance in mathematical computation of the students in the experimental group is presented in Table 6. The same standard was set in interpreting the posttest result of the subjects.

A closer look at the table reveals that students reached beyond the hypothetical mean standard on the skills "Solving Zeros of a Function", "Writing Equations of Functions", "Solving Problems Involving Functions", "Solving Inequalities", and "Graphing Functions" which obtained actual mean scores of 10.29, 10.10, 9.88, 9.94, and 9.81, respectively higher than the hypothetical mean score of 9 for each skill. Each actual mean score was described as "very much skillful". Each actual mean score was also supported by the computed z – values of 13.10, 9.83, 7.21, 7.15, and 6.69, respectively which indicate that the actual mean scores were above the hypothetical mean score which is 75 percent of the total possible scores in each skill. These show that the students were "very much skillful" in those topics covered in the experiment.

In totality, the posttest skill performance in mathematical computation of the students in the experimental group obtained an actual mean score of 50.02 which indicated "very much skillful". This obtained actual mean was supported by the computed z – value of 15.97 which validated that the actual mean was above the hypothetical mean of 45. This implies that graphing calculators helps improve their performance.

Table 7 Test of Difference on the Posttest Skill Performance in Mathematical Computation Between the Control and Experimental Groups

Group	N	Mean	Mean Difference	Standard Deviation	Computed t	Tabulated t	Decision
Control	47	27.09	22.93	7.865	19.458*	1.661	Reject Ho
Experim	48	50.02		2.178			

ns = not significant ***** = significant at .05

Table 7 presents the test of difference on the posttest skill performance in mathematical computation between the control and experimental groups. It can be gleaned on the table that the experimental group obtained a higher actual mean score of 50.02 with standard deviation of 2.178 than the control group which obtained only 27.09 actual mean score with standard deviation of 7.865. This means that the experimental group performs better than the control group after the intervention.

The table further reveals a mean difference of 22.93 in favor of the experimental group, which when subjected to t – test, the computed t of 19.458 exceeded the tabulated value of 1.661 at .05 level of significance with 93 degrees of freedom. The null hypothesis that there is no significant difference on the posttest skill performance in mathematical computation between the control and experimental groups is rejected. This indicates that there existed a significant difference in the posttest skill performance in mathematical computation of the two groups after the intervention. This implies a significant variation in the performance of the students taught using the traditional method of teaching and those who were taught using the graphing calculator in teaching Mathematics.

Table 8 Test of Difference Between the Pretest and Posttest Skill Performance in Mathematical Computation of the Control Group

Control Group	N	Mean	Mean Difference	Standard Deviation	Computed t	Tabulated t	Decision
Pretest	47	11.53	15.56	7.171	12.694*	1.679	Reject Ho
Posttest	47	27.09		7.865			

ns = not significant * = significant at .05

Presented in Table 8 is the test of difference between the pretest and posttest skill performance in mathematical computation of the control group. The table discloses actual mean scores of 11.53 in the pretest and 27.09 in the posttest which obtained a mean difference of 15.56. This indicates that there was improvement in Mathematics performance after the intervention. When the mean difference was subject to t – test, the computed t which is 12.694 exceeded the tabulated t – value of 1.679 at .05 level of significance with 46 degrees of freedom.

Table 9 Test of Difference Between the Pretest and Posttest Skill Performance in Mathematical Computation of the Experimental Group

Experimental Group	N	Mean	Mean Difference	Standard Deviation	Computed t	Tabulated t	Decision
Pretest	48	10.79	39.23	5.604	51.510*	1.678	Reject Ho
Posttest	48	50.02		2.178			

ns = not significant * = significant at .05

It is shown in Table 9 the test of difference between the pretest and posttest skill performance in mathematical computation of the students in the experimental group. A closer look at the table reveals that the students in the experimental group obtained an actual mean score of 10.79 in the pretest and 50.02 actual mean score in the posttest which provided a mean difference of 39.23. This means that there is an improvement in students' skill performance in mathematical computation of the students in the experimental group after exposing them to graphing calculators in teaching Mathematics. When the mean difference was subjected to t – test, the computed t which is 51.510 is greater than the tabulated t – value of 1.678 at .05 level of significance with 47 degrees of freedom. This means that there exists a significant difference between the pretest and posttest skill performance in mathematical computation of the students in the experimental group. It implies that the graphing calculators applied in teaching Mathematics improve the students' skill performance in mathematical computation in those skills included in the experiment.

The present finding is supported by Tajudin, et. al (2011) whose study revealed that the graphing calculator instruction is superior in comparison to the conventional instruction, hence implying that integrating the use of graphing calculator in teaching and learning of mathematics was more efficient than the conventional instruction strategy.

Table 10 Test of Difference on the Pretest and Posttest Mean Gain on Skill Performance in Mathematical Computation Between the Control and Experimental Groups

Group	N	Mean Gain	Mean Difference	Standard Deviation	Computed t	Tabulated t	Decision
Control	47	15.56	23.67	8.400	16.488*	1.661	Reject Ho
Experimental	48	39.23		5.276			

ns = not significant ***** = significant at .05

Table 10 presents the test of difference on the pretest and posttest mean gain on students' skill performance in mathematical computation between the control and experimental groups. As seen in the table, the mean gain score obtained by the control group was 15.56 while the mean gain score obtained by the experimental group was 39.23. These mean gain scores registered a mean gain score difference of 23.67. Additionally, gain scores of the experimental group were less dispersed, registering a standard deviation of 5.276 compared to the gain scores obtained by the control group obtaining a standard deviation of 8.400. When the mean gain score difference was subjected to t – test, the computed t which is 16.488 is greater than the tabulated t – value of 1.661 at .05 level of significance with 93 degrees of freedom. This means that there exists a significant difference in the mean gain scores obtained between the two groups after exposing them to the interventions. It means further that students in the experimental group perform better than the students in the control group. This implies that using a graphing calculator in teaching Mathematics provides better skill performance in mathematical computation of the students than those who were exposed to the traditional method of teaching.

Idris, et. al (2011) corroborated the present finding. The result of the study showed that the experimental groups in all the eleven schools considered in the study performed significantly better than the control groups in the mathematics achievement test after the intervention which indicated that graphic calculator-based performance assessment was effective in improving secondary students' mathematics achievement.

IV. Conclusion

Based on the findings, the skills of the students are comparable in both the control and the experimental groups before the intervention. However, the students in the experimental group are significantly more skillful than the control group after the intervention. It can be deduced further that a significant variation in the students' skills in mathematical computation between the control group with the traditional method of teaching and the experimental group exists with the use of calculators in teaching and learning Mathematics. In addition, both interventions employed like traditional methods of teaching and using calculators in teaching and learning Mathematics improve the students' skills in mathematical computation. This means that students perform skillfully better during the posttest than during the pretest. However, students' skills in mathematical computation in the experimental group are greatly influenced by the calculator used by teachers and students in the class. This concludes that students in the experimental group perform skillfully better than their counterparts.

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