

Effects of using Casio FX991 ES PLUS on achievement and anxiety level in Mathematics

Dr. Maria Isabel T. Lucas
dey_lucas@yahoo.com
Pamantasan ng Lungsod ng Maynila
(University of the City of Manila)
Philippines

Dr. Erlinda A. Cayao
erlinda_cayao@yahoo.com
Pamantasan ng Lungsod ng Maynila
(University of the City of Manila)
Philippines

Abstract : *Mathematics anxiety has been a subject of research across levels. This study aimed at checking the effects of using Casio FX991ES Plus on the achievement and anxiety level of selected college students in a chartered local university in Manila, Philippines. Researchers employed the quasi-experimental research design. There were two groups of respondents in this experiment namely: control group who utilized traditional lecture method while the experimental group used the Casio FX991ES Plus Calculator. Both groups were exposed to the same lessons in Fundamentals of Statistics particularly topics in Inferential Statistics. Diagnostic test was administered to both groups to establish equal footing in terms of their abilities. This first researcher handled both the experimental and control groups. Results revealed that the experimental group performs significantly better as regards to the mean score in the achievement test. It can be concluded that their performance is greatly influenced by the use of calculator. In terms of anxiety level, both groups revealed significant difference in the pre and post tests. Although both are significant, it is noteworthy that there is a marked improvement in anxiety level under experimental group as manifested by a greater increase in result. An increase in the score means a reduction in the anxiety level.*

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I. Introduction

Not everybody loves Mathematics. Some students have feelings of fondness for the subject while, some have feelings of anxiety towards it. The love and hate for Mathematics had been the subject of many researches. However, bulk of these researches is more focused on determining the factors for the anxiety of many students on Mathematics.

Many students agreed that math anxiety is experienced across ages; among primary, secondary, and tertiary students. As defined by [7], math anxiety is an emotional reaction to Mathematics based on a past unpleasant experience which harms future learning. [16] said that Math anxiety is an intense emotional feeling of anxiety that people have about their ability to understand and do Mathematics. People who suffer from Math anxiety feel that they are incapable of doing activities and classes that involve Math.

Many studies revealed that math anxiety is more of an emotional problem rather than an intellectual one. On the other hand studies also showed that there are intellectual factors that factors that affect this phenomenon such as learning styles, persistence, self-doubt and dyslexia.

The respondents of this study are taking a course in Mass Communication in a chartered local university in Manila, Philippines. They have attested that they chose this course because they will be required to take few Mathematics subjects, namely Algebra, Trigonometry and Statistics. By the time they reach 3rd year, these students are also required to take Statistics as among their Mathematics subjects in preparation for their research undertaking or thesis accomplishment. Statistics is also a very significant subject that is in line with the course because by the time they graduate, some will be exposed to Communication and Marketing, which requires basic Statistics competencies.

To ease Math anxiety across school levels, including college, various learning interventions had been recommended. The use of technology in learning had been a very significant introduction to learning Mathematics. Among these tools include computers and calculators. These tools had been as aids in understanding concepts in Mathematics and stimulating learning of the subject.

Computers and calculators have been available to teachers and students for more than 30 years now [2]. Since its use in the classrooms as a teaching and learning tool, several researches had been conducted to assess their effects and influence in learning.

The purpose of this study is to determine the Math anxiety level and achievement of selected college students of a chartered local university in Manila, Philippines, specifically under the College of Mass Communication, who are taking up Fundamentals of Statistics and using the Casio FX991 ES plus model calculator. The study seeks to determine if students who have Math anxiety, and who will be eventually exposed to these calculators during the duration of the subject, will show a difference in their performance in Statistics. The Casio FX991 ES plus model is a scientific calculator that has basic features such as fraction calculations, combination and permutation, Statistics (List-based STAT data editor, standard deviation, regression analysis), 7 variable memories and table function. This scientific calculator has the ability to carry out complex computations, numerically solve equations, and perform matrix arithmetic and statistical analysis. The use of this calculator will ease up the tedious computations of some specific values in Statistics. Furthermore, with the help of this calculator, some formulas can easily be followed without undergoing the step by step procedure.

Review of Related Literature

What is Math Anxiety?

Math anxiety is a phenomenon that is experienced across ages. It can begin as early as fourth grade and can continue throughout their educational experiences including college level. According to [4], Math anxiety exists in college campuses; that students make decisions about course work and career choices in part due to Math anxiety. Because of its wide influence, mathematics has limited students' future career choices, especially in science, technology, engineering and math majors [13].

Use of technology in teaching and learning Mathematics

[13] found out in her study entitled "Using technology as a tool to reduce Mathematics anxiety," that math anxiety is generated by various causes. If the anxiety is caused by the failure of cognition, anxiety can be reduced by improving students' ability of cognition. Using technology as a tool to enhance student's learning can overcome the anxiety caused by the cognitive failure.

Various technological teaching and learning tools in Mathematics such as computers and calculators have been used through the years to ease Math anxiety and to aid in understanding mathematical concepts. [8] mentioned that electronic technologies provide visual images of mathematical ideas. It benefits the students by organizing and analyzing data. Hence, the students are able to compute efficiently and accurately. When technological tools are available, students can focus on making decision, reflecting, reasoning and problem solving. Technology enriches the range and quality of investigations by providing a means of viewing mathematical ideas from multiple perspectives.

The focus of mathematics instruction is not just memorization but learning mathematical concepts and procedures with understanding. Researchers have investigated ways to help all students gain mathematical understanding that include using manipulative, helping students solve problems using technology and writing and reflecting.

Researches have also found out that more advanced tools are necessary in teaching mathematics. These advanced tool help students learn by supporting computation and by giving abstract ideas a more tangible form. Technology can support learning when appropriately integrated with teaching techniques, curriculum and assessments. Technology can reduce the effort devoted to tedious computations and increases students' focus on more important mathematics. Technology can represent mathematics in ways that help students understand concepts [5].

Calculators and students' achievement and performance in Mathematics

In 1986, the National Council of Teachers of Mathematics (NCTM) published a position paper on the use of calculators in mathematics classes. NCTM recommended that these devices be used to extend students' mathematical abilities beyond simply their level of computational ability. They strongly supported the use of calculators, including graphing calculators to all levels of instruction, citing an increase in conceptual development and number sense [4].

Mathematics anxiety can be overcome by improving mathematics performance [13]. The use of calculators had been studied as technological tool in improving mathematics achievement and performance.

Calculators and computer technology have changed the aspects of teaching and learning Mathematics. Calculators can be used to explore, develop and reinforce numerical concepts and computation.

Scientific calculator technology paved a way for students to gain a higher level of mathematical understanding. [5] noted that the use of scientific calculators give more positive feelings and better attitudes about Mathematics for teachers and learners.

In "The meta-analysis of the effects of calculators on students' achievement and attitude levels in pre-college Mathematics classes" by [6], she analyzed 54 research studies to determine the effects of calculators on student achievement and attitude levels. In the studies, Ellington saw that students who used calculators while learning Mathematics reported more positive attitude toward Mathematics than their non-calculator counterparts on surveys taken at the end of the calculator treatment. The results from this meta-analysis support the use of calculators in pre-college Math classrooms.

[2] also conducted a meta-analysis on “What does the research say about achievement of students who use calculator technologies and those who do not?” In her review of related literature, she found out that 52 comparative studies showed that the use of calculator had an impact on students’ achievement. Studies showed that when used appropriately, the calculator can assist in increasing conceptual understanding without adversely affecting procedural knowledge. She compared the meta-analysis of Suydam, Smith, Hembree and King, which gives emphasis on the use of calculators to determine student achievement and performance.

[12], [9] conducted meta-analysis on the study of calculators, which became the springboard for other meta-analyses on the subject of calculators and students’ achievement in Mathematics.

[9]’s meta-analysis covered over 70 studies with quantitative data comparing calculator-based instruction to traditional instruction. The results of the analysis on overall achievement showed that most grade levels were significantly and positively affected by the use of calculators.

Meanwhile, in [12]’s meta-analysis, it was found out that there was significantly higher achievement for students who used calculators for problem-solving, computation and conceptual understanding compared to students who did not use calculators. His study also showed that the calculator had a positive effect in increasing conceptual knowledge at all levels.

In a meta-analysis by [14], he found out that calculator use significantly increased student scores on Mathematics test particularly the test that contains a large proportion of computation items. He found out too that calculator may be more beneficial for disadvantaged students or those with math anxiety. He also said that judicious use of calculator, use of the right type of calculator and integration of the calculator in Mathematics instruction are keys to maximizing the positive impact of allowing students to use calculators on Mathematics tests.

In the paper of [4] on “The effects of graphing calculators on student performance in high school Algebra,” the study determined if students performed better on systems of equations when graphing calculators were utilized in students’ daily lessons. In the study, results showed that students showed improvements on pre-test and post-test scores.

Meanwhile, in the study of [10] on “Exploring the effects of TI-84 plus on achievement and anxiety in Mathematics,” it was revealed that students showed better achievement when they used graphing calculators. He said that the results of the study indicated that the graphing calculator can possibly contribute towards improved learning in Mathematics. Also, the results showed that the significantly reduced scores in the Test of Mathematics Anxiety achieved by the students in the experimental groups implied that learning Statistics and Straight Line Geometry with the graphing calculator had been beneficial for the students. The study showed that students seem to have indirectly acquired the skills of logical thinking while manipulating and processing data on the graphing calculator. These results implied that the graphing calculator did not only help students to process data and perform calculations, but it also helped them develop and acquire better thinking skills. Similarly, the students in the experimental group showed that a reduced result mathematics anxiety, which indicated that the usage of the graphing calculator seemed to have helped the students to be able to extract information and patterns from given data or diagrams. It was also seen that most students enjoyed their Mathematics lesson when they could make use of graphing calculator.

On the other hand, the study of [1] also made use of graphing calculators in College Algebra. Her study was designed to determine students' cognitive and non-cognitive gains from using graphing calculators. The study involved two groups: the low ability and the high ability group composing of 81 freshmen students from the College of Liberal Arts of the De La Salle University in the Philippines, specifically. The study revealed that 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 include students' improved achievement, better attitude, and reduced anxiety in mathematics increased self-confidence, and improved classroom dynamics. It was also revealed that the use of graphing calculators has made significant changes in the respondents' attitude and anxiety in mathematics, regardless of their abilities. In her study, the researcher showed that the graphing calculator is a powerful partner in teaching and learning mathematics

On the other hand, the study of [3] on the effectiveness of using scientific calculator in solving non-linear equations by Newton-Raphson method showed that the use scientific calculator had a positive effect on students' ability to obtain the correct solutions as well as reduces time to solve problems.

Purpose of the Study

The purpose of this was to determine the effect of CASIO FX991 ES plus calculator in the achievement and anxiety level of selected students in Fundamentals of Statistics.

Specifically, the study seeks to:

1. Describe the achievement and anxiety level of the experimental and control groups in Statistics.
2. Determine if there is any significant difference exists between the achievement and anxiety of students under the experimental and control group.
3. Gather respondents' reactions about the use of the scientific calculator.

II. Methodology

This study employed the quasi experimental research design. The respondents of this study came from the two classes of 3rd year Mass Communication students of a chartered local university in Manila, Philippines who are taking up Fundamentals of Statistics during the 2nd semester of the academic year 2014-2015. There were two groups of respondents in this experiment, namely: control group (using traditional method of teaching) and experimental group (using the Casio FX991 ES Plus calculator). Both groups were exposed to the same lessons in Fundamental of Statistics, particularly topics in Inferential Statistics. A diagnostic test was given to the respondents before the experiment to established equal footing between the two groups. The experiment lasted for 10 weeks from January to March 2014, with the first researcher handling the two classes.

The study measured the respondents' anxiety level in Statistics using Survey of Attitudes Toward Statistics (SATS) by Candace Schau [11] before and after the experiment commenced. Permission to use the instrument was granted to the researchers by the proponent. Likewise, the study measured the respondents' performance in Statistics using the validated teacher-made test. The test was administered to the respondents after the experiment. The achievement test of the students in the experimental and control groups as well as the measure of their anxiety level was

tested for significant difference and compared. Moreover, the researcher conducted an informal interview with a random sample of respondents for validation of respondents' responses in the instrument used in this study.

III. Results And Discussions

Table 1 Test of Difference on the Diagnostic Test Between the Control and Experimental Groups

Groups	N	Mean	Standard Deviation	Computed t	p-value	Conclusion
Control	31	28.65	5.42	1.862	0.066	Not Significant
Experimental	39	26.46	4.39			

The data presented in Table 1 is the result of the diagnostic test administered to both control and experimental groups. The test established the equality of the two groups before the start of the experiment. Based on the result, the mean score in the diagnostic test of the control group is 28.65 (85.81%) while in the experimental group the mean score is 26.46 (83.08%). A mean difference of 2.19 was noted and testing for the equality of variances shows that the two groups are equivalent or comparable before the experiment. Furthermore, testing the difference of means using t-test for independent samples reveals that there is no significant difference in the mean diagnostic result of the control and experimental groups.

Table 2 Test of Difference on the Achievement Test Between the Control And Experimental Groups

Groups	N	Mean	Standard Deviation	Computed t	p-value	Conclusion
Control	31	26.77	4.49	-2.060	0.044	Significant
Experimental	39	28.74	3.20			

Table 2 shows the test of difference on the achievement test of the control and experimental groups. The mean score of the experimental group is 26.77 (83.46%) while that of the experimental group is 28.74 (85.93%). Both groups were far behind the 75% passing mark. The test of difference in the means yielded to a significant difference on the achievement test of the two groups. The experimental group performs significantly better as regards to the mean score in the achievement test than the control group after using the FX 991ES Plus calculator. The respondents' performance in the achievement test under the experimental group is greatly influenced by the use of calculator. It was observed during the study that respondents using calculator gives more attention to more important aspect in Statistics such as interpreting the conclusion and providing implications to the result.

The result of this study is congruent with the findings in the meta-analysis of calculator based instruction to traditional instruction by [9]. The results of the analysis on the over-all achievement shows that most grade levels are significantly and positively affected by the use of calculators. Likewise, in the study of [12], it was found out that there is a significantly higher achievement for students who used calculator compared to students who do not use calculator.

Table 3 Test of Difference Between the Pretest and Posttest in Anxiety Level of The Control and Experimental Groups

Group		Mean	Verbal Interpretation	Mean Difference	Standard Deviation	Computed t	Critical t	Conclusion
Control	Pretest	4.85	Slightly Anxious	-0.68	0.51	-7.655	2.042	Significant
	Posttest	5.53	Slightly Anxious		0.68			
Experimental	Pretest	4.52	Moderately Anxious	-0.77	0.72	-5.302	2.024	Significant
	Posttest	5.29	Slightly Anxious		0.77			

Table 3 reveals the t-test analysis of the pretest and posttest mean on the anxiety level of the control and experimental group. Under the control group, it can be seen that the mean anxiety level in the pretest is 4.85 with a verbal interpretation of slightly anxious and the posttest mean is 5.53 which is also interpreted as slightly anxious. Based on the computed t-value and critical value at 0.05 level of significance, there is a significant difference between the pretest and posttest anxiety level in statistics of the control group. Meanwhile, under the experimental group the pretest mean in the anxiety level is 4.52 and interpreted as moderately anxious while the posttest result is 5.29 with an interpretation of slightly anxious. Using t-test for paired samples, the results conveyed a significant difference on the level of anxiety under the experimental group and experimental group.

Comparing the results on the mean difference of both groups, control group yielded to 0.68 and 0.77 to experimental group. Although both means reveals significantly different, it is noteworthy that there is a marked improvement of anxiety level under the experimental group as manifested by a greater increased in the result. An increase in the score means a reduction in the anxiety level.

The use of calculator somehow had a positive effect on their ability to solve problems in Statistics and most likely reduces their fear and anxiety towards the subject. It was also observed that most respondents, regardless of their abilities, enjoyed and appreciate the lesson when they make use of the calculator. This implies that the use of calculator in teaching and learning Statistics enhances the respondents' enthusiasm in carrying out mathematical routines and lessen their burdens on the tedious step-by-step computations.

The result of this study proved to be similar with the findings of the following researches. In the study of [10], the results showed significantly reduced scores in anxiety achieved by the students who used TI-84 plus calculator. Likewise in the study of [1], it was revealed that the use of calculator has made significant changes in the respondents' attitude and anxiety in mathematics. In her study, it was revealed that the graphing is a powerful partner in teaching and learning mathematics.

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