

Analyzing the Influence of Calculator Statistical Features on Grade 11 Students' Statistics Performance

Reynan H. Olquin, MST

Abstract

The research entitled “Analyzing the Influence of Calculator Statistical Features on Grade 11 Students’ Statistics Performance”. The different scientific calculators were used in the control group which are commonly used in every class statistics. The statistical features of the graphing calculator were used in the control group. This study aims to determine the effects of statistical features of calculators on students’ performance in grade 11 statistics. Specifically, the study sought to answer the following questions: Is there a significant difference between the pretest of the Control and Experimental groups? Is there a significant difference between the pretest and posttest of the Control and Experimental groups? Is there a significant difference between the gain score of the control group and the experimental group? And, give a general observation of the study. The result of the study shows that there is a significant difference between the use of the different statistical functions of calculators. The experimental group showed better performance and easily used the statistical features of graphing calculators. In the Control group, students had difficulties in solving the z-test, and p-value. The statistical feature of graphing calculators is useful in higher topics in statistics.

Keywords: Graphing Calculator, Statistics, Experimental, Control, Students, Features

Introduction

Many forms of technology around the world gained the interest of teachers and learners. Educators use technology to enrich their potential and ability in teaching. For many years, the use of calculators in the classroom has been debated by parents, students, and teachers. However, people realized the significant role of calculators in complex and complicated problem-solving. And, this idea is supported by Common Core Standards for Mathematics Practice (SMP).

The functions of statistical features of the graphing calculator help make the computations less tedious and allow the use of real data. A less common and reporting detail is with the test performance and score. Some studies show students’ improvement with the use of some functions of calculators (Carlson,1996).

Graphing calculators offer a suite of statistical features that play a pivotal role in shaping students’ performance in subjects like Statistics, Science, and Mathematics. One of the most impactful capabilities is data visualization, allowing students to graphically represent datasets. This visual representation aids in the interpretation of statistical patterns, making it easier for students to discern trends and outliers. Additionally, features such as regression analysis empower students to model real-world scenarios, enhancing their ability to apply statistical principles in practical contexts. The calculators’ support for hypothesis-testing and probability distributions further deepen students’ understanding of inferential statistics, enabling them to

Reynan H. Olquin, MST, Agustin M. Valdevieso Sr. High School, Marva, Taguranao, Matalam, Cotabato

make informed decisions based on rigorous analysis. The dynamic data entry and analysis functions foster active engagement, allowing students to manipulate datasets in real-time and gain a nuanced understanding of how variables influence statistical outcomes. The calculators' comprehensive statistical functions simplify complex calculations, reducing computational errors and enhancing the efficiency of statistical analysis.

The Department of Education, under its jurisdiction, has provided public schools with Senior High School (SHS) programs and graphing calculators to make a difference in the pedagogy of teaching Statistics to SHS students. The evolution of this tool is a leap in the advancement of solving statistical problems. Concerning this, the Department of Education conducted a 4-day national seminar in October (2019) in Cebu City for Grade 11 Senior High School teachers on the use of graphing calculators. Teachers were given the chance to manipulate the different functions of the graphing calculators. One of the main lessons presented was the use of the Statistical Function in hypothesis-testing which is a skill to be developed for Grade 11 students.

In the 21st Century, teaching and learning must cope with the demands of the encroachment of graphing technologies. It is for this reason that in the SHS Curriculum, technology is used as an aid for the teaching and learning process. The graphing calculator is a graphing teaching aid for statistics (Kemp, Kissane, & Bradley, 1998).

Objectives of the Study

This study was conducted to determine the effects of statistical features of calculators. The control group used scientific calculators, while the experimental group used a statistical feature of graphing calculators.

Specifically, it aimed to:

1. Determine if there was a significant difference between the pretest of the control and experimental group,
2. Determine if there was a significant difference between the pretest and posttest scores of the control group and experimental group,
3. Determine if there was a significant difference between the gain score of the control and experimental group.
4. Give a general observation of the study.

Review of Related Literature

Calculators on Students' Achievement in Statistics

According to Jones (1996), using a calculator in Mathematics and Statistics can minimize tiring procedures, so that students concentrate on the concept, develop higher-order thinking skills, and learn relevant applications. A powerful calculator helps students as another resource for cognitive sense and estimation skills and guides them by following procedures necessary to understanding mathematics and other subjects. One significant challenge in the performance of students in statistics arises when they lack access to or proficiency in utilizing the advanced statistical features of calculators. Without the support of these technological tools, students may encounter difficulties in handling complex statistical computations and analyses.

With the use of the graphing calculator, students will no longer develop anxiety in problem-solving (Jones, 1996). They will be guided with their computations on multiplication and other operations and will come up with the right answers. The teacher should still teach the students to enhance better mental estimation ability so that they will realize that the calculator makes sense in a problem situation which allows students to focus on the steps involved in problem-solving.

Graphing calculators help students to use true data in the problem. It helps students to answer quickly between the symbolic representation and tabular representation of data and gives a lot of opportunities to solve how each representation contributes to analyzing the data. Calculator makes statistics subjects and statistical reasoning affordable to all learners. Through this, learners will break down the data, compare the results to expected results, describe a model, and make it possible without a calculator.

To improve the students' performance and their level of metacognitive awareness while solving problems, calculators can be used. Integrating calculators can pose an instructional mode and learners can make explicit steps of solutions while doing the activity. It can elicit appropriate cognitive processes to the relevant schema of construction. Students can have better conceptual knowledge with the use of a calculator (Alin, Tajudin, and Konting, 2007).

Methodology

Research Design

The The quasi-experimental method of research was used to determine the use of calculator statistical functions in hypothesis-testing on the performance of Grade 11 students.

Research Instrument

The instrument used was a statistics performance test designed to assess the students achievement in statistics. The tool was constructed and adopted from Grade 11 statistics books and other resources. The tool contained 15 multiple-choice problems on hypothesis-testing.

Sampling Method

The experimental group, consisting of 50 Grade 11 General Academic students, exclusively utilized the Run-Math and STAT functions of the graphing calculator to address z-test, t-test, and regression/correlation problems within the realm of hypothesis-testing. Complementing this technological approach, the students also referenced t-tables and z-tables provided by the teacher. The graphing calculator's statistical functions proved instrumental in efficiently solving complex statistical analyses, covering z-test, t-test, and p-value calculations.

The control group, comprising 47 Grade 11 students specializing in Humanities and Social Sciences, formed a distinct section in the research. Employing scientific calculators, this group tackled z-tests, t-tests, and regression/correlation analysis as part of their hypothesis-testing procedures. Notably, the scientific calculators utilized by the control group demonstrated proficiency in resolving correlation and regression analysis; however, they could not calculate z-values, t-values, and p-values.

Data Gathering Procedure

Before the pretest, the researcher explained the purpose of the research in both groups. Then, the pretest was administered to both groups in the first session of the class. The groups answered the pretest using the calculator, z-table, and t-table within 45 minutes. On the posttest, the experimental group used the Run-Math and Statistical functions of the graphing calculator. They were also allowed to use a z-table and a t-table. The control group used a scientific calculator, t-table, and z-table. Both groups answered within 45 minutes.

Method of Data Analysis

The research study was quantitative. The data gathered were analyzed and interpreted using the t-test for the difference of two means and measured the difference between the experimental and control groups.

Results and Discussion

Table 1 Difference between the pre-test of the Control group and the Experimental group					
Group	Mean	SD	Computed t	p-value	Conclusion
Contro	3	1.27	-1.05	.2973	Not Significant
Experimental	3.4	1.57			

Table 1 shows that the p-value is greater than 0.05 which means that the performance of the two groups during the pretest has no significant difference. Both groups used the scientific calculator during the test and were given 45 minutes to answer the test which simply shows that both groups manifested an equivalent level of understanding on the given hypothesis testing.

Table 2 Difference between the pre-test and post-test of the Control and Experimental group							
	Pre-test		Post-test				
Group	Mean	SD	Mean	SD	Computed t	p-value	Conclusion
Control	3	1.27	7.78	1.73	-11.52	0.00001	Significant
Experimental	3.4	1.57	9.8	1.81	-14.65	0.00001	Significant

Table 2 shows the significant improvement in the performance of the experimental group and Control group during the post-test. The experimental group increased the mean from 3.4 to 9.8 with the aid of the statistical function and Run-Math of the graphing calculator. The statistical function of the graphing calculator in statistics avoids long procedures in which students can easily focus on the problem. During the posttest, all students of the experimental group answered 50% above on the given test items which proves the better impact of the graphing calculator on their performance. During the pretest, the respondents answered the problems for more than 30 minutes; during the posttest, some of the students answered the items for less than 25 minutes. This shows how the respondents quickly solved the given problems with the aid of the graphing calculator which gives ample amount of time for the respondents to review their answers. The features of

more graphing calculators can develop the statistical analysis beyond the level and capacity of learners. Gorman (2008) said that the calculator helps the students to be more interactive and can perform better.

In contrast, the control group showed significant improvement in performance during the posttest in which 86% of the students of the control group answered the given test items. The result of the test showed students' improvement after the discussion and introduction of statistical features of the scientific calculator. The mean score increased from 3 to 7.8. On the pretest, students answered the test in 20 minutes; on the posttest, they answered the test in 45 minutes which needed to be solved showing the long process of solutions. On the contrary, the non-honor students answered the test in 30 minutes since they were not into long process problem-solving. However, the result shows that there is a significant difference between the pretest and posttest of the control group.

Table 3 Difference between the gain score of the Control group and the Experimental group						
	N	Mean	SD	Computed t	p-value	Conclusion
Control	27	7.78	1.73	-4.29	0.000072	Significant
Experimental	30	9.8	1.81			

Table 3 shows the p-value which is less than 0.05. It was concluded that there was a significant difference between the performance of the control group and the experimental group. The experimental group shows better performance than the control group as they show a higher mean. The students in the experiment answered the test in less time with short solutions. Less time because the statistical features graphing calculator can solve the problem directly and have more graphing features which implies that the long process involved in statistical problems is no longer an issue for the students. The statistical features of the graphing calculator can solve higher statistical problems while the control group needs to solve some of the long process solutions to get the answer which demands an ample amount of time and formulas to solve statistical problems.

Researchers' General Observation

The researchers observed during the conduct of the study the difference between the use of the scientific calculator of the control group and the statistical features of the graphing calculator of the experimental group in teaching Grade 11 Statistics. When in the control group, the students had difficulties in the long process of problem-solving. On the topic that needs a long process solution, the researchers needed to teach the control group the step-by-step solution which consumed too much time in the discussion of the problem in finding the needed values. In addition to that, students were also raising more questions on what keys to press in the calculator which made it more tedious because it needed a one-on-one tutorial on how the calculator is to be manipulated. The scientific calculator is not that powerful to solve statistical problems directly. While in the experimental group, when the researcher introduced the long process solution in solving the statistical problems, the respondents got bored and tired since it was the last period of the afternoon. However, when they were introduced to the advantage of using the calculator in solving the statistical problems, the respondents showed interest. The topics in hypothesis-testing became easy to teach as the respondents were focused and

they appreciated the importance of the calculator in problem-solving. The statistical features of the graphing calculator are useful in graphing Statistical topics such as p-value, f-test, Chi-square, and ANOVA.

There are varied strategies employed in teaching the two groups, using graphing and scientific calculators. In the control group, there is difficulty in using the statistical features of the scientific calculator since there are complicated keys to press and the features of the said calculator are not so powerful to solve higher statistical problems. On the contrary, the experimental group showed no difficulties, using the graphing calculators with graphing statistical features such as solving the t-test, z-test, p-value, chi-square, ANOVA, and F-test.

Conclusion and Recommendations

Conclusion

In the 6-week conduct of research, tests revealed that there is a significant difference between the use of the scientific calculator of the control group and the statistical features of the graphing calculator of the experimental group. In the Control group discussion, students had difficulties in solving the z-test, and p-value. The statistical features of the scientific calculator are limited to some topics only. Students had solved the long process solutions but the group showed a better performance.

Students were more interactive in the class discussion. In teaching statistics, there is a significant difference in the performance of both groups. This result implies that the statistical features of graphing calculators have the advantage of solving statistical problems without consuming too much time. With these, the students are more motivated to participate in the class discussion. The incorporation of graphing calculators into statistics education has yielded notable advantages, fostering increased student interaction in class discussions and demonstrating a significant disparity in performance between groups. Graphing calculators, with their multifunctional capabilities, prove instrumental in efficiently solving statistical problems while simultaneously promoting a more engaging learning atmosphere. These calculators empower students to visualize statistical concepts through graphical representations, enabling a more intuitive comprehension of data patterns and relationships. This visual approach not only enhances problem-solving skills but also encourages collaborative exploration during class discussions, as students can readily share and analyze graphical outputs. Lastly, the use of graphing calculators contributes not only to improved academic performance but also to the development of a more interactive and visually oriented statistics education.

Recommendation

Based on the results of the research, the researcher recommended that the students' skills in manipulating graphing calculators must be given attention in the fields of Statistics, Science, and Mathematics. Teachers in the fields of Statistics, Science, and Mathematics must incorporate various technologies during classroom discussions such as the DepEd-issued graphing calculators. And, supplementary study on the use of graphing calculators with a greater number of respondents must be conducted to further validate the findings of the study. To further strengthen the validity of the research findings, a call for continuous research and evaluation is paramount. Initiating supplementary studies with larger and more diverse respondent groups will contribute to the robustness of the evidence supporting the positive impact of graphing calculators.

References

- Alin, W.W., Tajudin, N.M., Tarmizi, R.A., & Konting, M.M. (2011). The use of graphic calculators in teaching and learning of Mathematics: Effects on performance and metacognitive awareness. *Malaysian Journal Mathematical Sciences* (1):45-61
- Baccay, E.S., Belecina, R.R., & Mateo, E.B. (2016). *Statistics and Probability*. Rex Book Store. Philippines (pp.215-321)
- Burnil, G. *Graphing calculators and their potential for teaching and learning Statistics*. University of Wisconsin, Madison (pp.15-28)
- Collins, L.B., & Mittag, K.C. (2005). Effect of calculator on students' achievement in an introductory statistics course. *Statistics Education Research Journal*, 4(1), 7-15
- Doller, D. (2018). *The effect of graphing calculator on students' achievement* (pp.17-18).
- Flanagan, J.L. (2008). *Technology: The positive and negative effect on students' achievement*. The College at Brockport: State University of New York (p.16).
- Harvey, J. G., Waits, B. K., & Demana, F. D. (1995). The influence of technology on teaching and learning of algebra. *Journal of Mathematical Behavior*, 14, 75-109.
- Hembree, R., & Dessart, D. J. (1986). Effects of hand-held calculators in precollege mathematics education: A meta-analysis. *Journal for Research in Mathematics Education*, 17, 83-89.
- Iserhagen, J.C. (1999). Technology: A Major Catalyst for Increasing Learning. *The Journal*, 27, 30-34.
- Jones, K. (2005). *Graphing calculators in the teaching and learning of Mathematics: A research bibliography*. University of Southampton, England, MicroMath, 21(2),
- Lancaster, G.A. (2012). Statistical education in the 21st century: A review of challenges, teaching innovation, and strategies. Keele University, England *Statistical Education* 20(2)
- Leathman, K., & Kestberg, S.(2005). *Research of Graphing Calculators in Secondary Level: Implications for Mathematics Teachers Education. Contemporary Issues in Teaching*. 5 (p.31-31)
- Neuman, D.L., Hood, M., & Neuman, M. (2013). Using real life when teaching statistics: students' perception of this strategy in an introductory statistics. Griffith University, Australia *Statistics Education Research Journal* 12(2):59-70.
- Mittag, K.C., & Taylor, S.E., (1996). Using graphing calculator technology in education: Statistics course. *The Online Journal of New Horizons in Education* - October 2018 Volume 8, Issue 4
- Rinaman, W. C. (1998). Revising a basic statistics course, *Journal of Statistics Education*, 6(2).

LEVEL OF ACHIEVEMENT QUESTIONNAIRE

Name: _____

Score: _____

DIRECTION: CHOOSE THE CORRECT ANSWER

1. The owner of the factory that sells a particular bottled fruit juice that the average capacity of their product is 250ml. to test the claim, a consumer group gets a sample of 100 such bottles, calculates the capacity of each bottle, and then finds the mean capacity to be 248 ml. The standard deviation s is 5 ml. Is the claim true?
 - a. Yes, because the z -value of -4 is less than the t -value of -1.545
 - b. Yes, because the z -value of -7 is less than the t -value of -1.545
 - c. No, because the z -value of 4 is greater than the t -value of 1.545
 - d. No, because the z -value of 7 is greater than the t -value of 1.545

For 2-3 table

A teacher wanted to test whether the total score in the student's optional assignment in Probability Answer Statistics affects the Final Grade of the students in the same subject. The teacher randomly selects 10 students and records them in the table below:

Total Scores in Optional Assignments(X)	125	85	130	90	50	65	80	150	16	120
Final Grade in Probability and Statistics (y)	90	89	90	91	82	85	89	93	70	89

2. What is the computed correlation?
 - a. 0.8640
 - b. 0.8639
 - c. 0.8642
 - d. 0.8641
3. If 55 optional assignment items were done by the student, what would be the student's final grade in statistics and probability?
 - a. 83.71
 - b. 82.71
 - c. 81.71
 - d. None of the above
4. A sample of five measurements, randomly selected from an approximately normally distributed population, resulting in the summary statistics: sample mean = 4.6, $s = 1.5$, and . Solve the test statistics.
 - a. -2.23
 - b. 2.092
 - c. -1.092
 - d. 1.092
5. A random sample of 200 school managers was administered a developed Leadership Skills Test. The sample mean and the standard deviation were 78 and 4.2, respectively. In the standardization of the test, the mean was 73 and the standard deviation was 8. Compute the z -statistics.
 - a. 8.77
 - b. 7.87
 - c. 7.98
 - d. 8.88

6. The following data shows several absences and the number of quizzes missed by five students. Compare the computed t-value to the critical t-value with 0.05.

Number of Absences	1	1	2	3	4
Number of Missed Quizzes	1	2	4	2	4

- Computed $t = 1.30$ less than the critical $t = 3.182$
 - Computed $t = 1.003$ less than the critical $t = 2.182$
 - Computed $t = 3.182$ greater than the critical $t = 1.30$
 - Computed $t = 2.182$ greater than the critical $t = 1.003$
7. The table below shows the scores of 7 students in their 50-item midterm examination in English(x) and Statistics(y): what is the equation of the regression line?

X	25	30	15	45	12	44	22
Y	36	35	6	5	40	10	24

- $y = 0.58x + 38.22$
- $y = -0.58x - 38.22$
- $y = 0.58x - 38.22$
- $y = 0.58x + 38.22$

For number 8

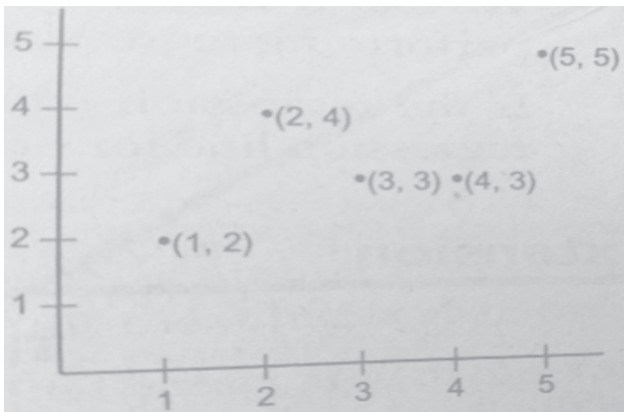
The figures given below pertain to the annual disposable income and consumption expenditure of five families:

Disposable(X)	8.5	14.9	10.5	20.5	22.8
Consumption(Y)	7.6	13.2	12.8	16.9	18.6

8. Which of the following is correct?
- There is a very low relationship between disposable income and consumption expenditure.
 - There is a moderate relationship between disposable income and consumption expenditure.
 - There is a very high relationship between disposable income and consumption expenditure.
 - There is a perfect relationship between disposable income and consumption expenditure.
9. A researcher investigates the relationship between family income and savings. Using the data from 15 families, the computed r income between income and savings was found to be 0.76. What is the conclusion if a 0.05 level of significance is used?
- Since the computed value of $t = 4.22$ is greater than the critical value of t which is 2.16, we reject the null hypothesis.
 - Since the computed value of $t = 2.01$ is less than the critical value of t which is 2.306, we accept the null hypothesis.
 - Since the computed $t = 1.30$ is less than the critical value which is 3.182, we accept the null hypothesis.
 - Since the computed value of $t = 6.22$ is greater than the critical value of t which is 4.16, we reject the null hypothesis.

10. A student analyzed the Math grades of his classmates and the number of times they were absent in the subject. He found out that the regression line that will predict grade (y) if the number of absences (x) is known as $y = 97.732 - 2.61X$. What is the predicted grade of the student having no absences?
- a. 90 b. 95 c. 97 d. 99
11. A sample of five measurements, randomly selected from an approximately normally distributed population, resulted in the summary statistics: Sample mean = 4.6, $s = 1.5$. Test the null hypothesis that the mean of the population is 6 against the alternative Use Solve the value of P.
- a. 0.0336 b. 0.0366 c. 0.0666 d. 0.333
12. The height of a random sample of 100 entering HRM freshmen of a certain college is 157 cm with a standard deviation of 8 cm. Test the data against the claim that the overall height of all entering HRM students is 160 cm. Previous studies showed that use . Solve the z
- a. 3.75 b. -3.75 c. 7.35 d. -7.35

For 13-14(refers to the picture)



13. The computed r, slope b, and y-intercept a, are?
- a. $r = 0.48$, $b = 1.9$, and $a = 0.5$
 b. $r = 0.58$, $b = 1.9$, and $a = -.42$
 c. $r = 0.7$, $b = 3.67$, and $a = -.42$
 d. $r = 0.67$, $b = 3.67$, and $a = .42$
14. The predicted value of y when x is 2.5?
- a. 3.15 b. 3.45 c. 3.75 d. 3.95

For Number 15.

In a contest for Mr. Campus Personality, two judges gave their rank to 8 candidates.

Candidate	1	2	3	4	5	6	7	8
Judge 1	1	2	3	4	5	6	7.5	7.5
Judge 2	4	2	1	3	5	6	7	8

15. Which is the best interpretation of the above problem?

- The two judges have a “very high” degree of agreement. It is implied that as to the selection of Mr. Campus Personality, the two judges are more or less the same.
- The two judges have a “very low” of agreement. It implies that as to the selection of Mr. Campus Personality, the two judges are less the same.
- The two judges have a “perfect” agreement. It implies that as to the selection of Mr. Campus Personality, the two judges are the same.
- The two judges have a “moderate” of agreement. It implies that as to the selection of Mr. Campus Personality, the two judges are a little bit more the same.