IJAMS
INTERNATIONAL JOURNAL OF ADVANCED MULTIDISCIPLINARY STUDIES
Volume V, Issue 1 January 2025, eISSN: 2799-0664

Efficiency Of Utilizing an Alternative Way in Squaring 3-Digit To 4-Digit With 0 As Its Middle Number

GLAIRE M. PAGLINAWAN
CARL JOSHUA L. DUAN
KATHLYN ALLYSA T. CLORES
THEA ANNE N. DELOS REYES
RUSTOM V. SUPLITO
JEAN MAICA V. FRANCISCO
RAYMOND LORESTO
JESLENE L. PUSING
Osmeña Colleges
Masbate City

Abstract — This study investigated the Joasian Method, an alternative technique for squaring 3-4 digit numbers with 0 as the middle digit, developed by Glaire M. Paglinawan. Conducted among Bachelor of Secondary Education majoring in Mathematics at Osmeña Colleges, the research aimed to assess the method's effectiveness and efficiency. A pretest-posttest quasi-experimental design was used, involving 150 participants to answer the assessment tool and performance level scale that the researcher constructed. The researchers conducted a 20-30 minutes intervention of Joasian Method. The researchers used measures of variability and paired t-test as their statistical treatment. Results indicated significant improvements in both time consumed and scores achieved by respondents' post-intervention. The mean time decreased from 22.71 to 11.79 minutes, shifting the performance level from "Developing" to "Competent," while the mean score improved from 18.97 to 20, maintaining a "Proficient" level. A paired t-test confirmed the statistical significance of these improvements, with a t-value of 15.88 exceeding the critical value of ±1.976, leading to the rejection of the null hypothesis. The study concluded that the intervention led to a positive impact on the respondents' performance, as evidenced by improvements in both time consumed and scores achieved. This indicated that there was a significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention. Therefore, researchers recommended incorporating the method into mathematical education, promoting mastery through practice, and sharing the technique with broader audiences to aid those struggling with squaring numbers manually.

Keywords — Efficiency, Alternative Method, Squaring Numbers, Quasi-Experimental

I. Introduction

Squaring numbers can be a fun and challenging activity for everyone. While some techniques can help you quickly find the square of a number, they are not always applicable in every case. Essentially, squaring a number means multiplying it by itself. (Williams, 2021).

According to Hiebert E. (2013), students have various methods of comprehending square numbers, and it is not as straightforward as it might seem initially.

One of the alternative methods in dealing with squaring 3-Digit to 4-Digit with 0 as its middle number is Joasian Method. The Joasian Method refers to the process of squaring 3–4-digit numbers with 0 as its middle number. This newly created method or innovation was developed by a researcher named Glaire M. Paglinawan. The proponent of the Joasian Method got an opportunity to conduct his mathematical investigation on the subject of Major Course 16: Mathematical Investigation, Problem Solving, and Modeling, a major subject of the proponent. The mathematical investigation is entitled "An Alternative Way of Squaring 3-4-digits with 0 as its Middle Number(s)", an unpublished manuscript from the proponent. The study aimed to investigate an alternative method of squaring 3–4 digits with 0 as its middle number without using a calculator. The researcher created a way for learners to square 3–4 digits faster by just using their cognition or with traditional pen and paper without relying on an electronic calculator (Paglinawan G. et.al, 2024).

The mathematical investigation conducted by Paglinawan G. et al. (2024) contains tables, theorems, cases, and methods that are relevant, effective, and efficient in squaring 3–4 digits with 0 as its middle number without using any calculator. The investigation still applies the rules for squaring 1-2-digit numbers; however, the proponent of the mini-mathematical investigation modified the method since 3–4 digits have a bigger result than 1–2-digit numbers. The benefits of this investigation are that learners can exercise their brains, enhancing their critical thinking skills; they will be number-oriented; and they will have numerical mastery in squaring 3–4 digits with zero as its middle number using the Joasian Method that the proponent invented. The investigation took 4 months to be completed, revised, and finalized by the researcher. The mathematical investigation was approved by the proponent's instructor of Major Course 16: Mathematical Investigation, Problem Solving, and Modeling, named Qayser D. Siblante, in the first semester of the academic year 2023-2024. The researchers observed that students are struggling with square numbers above 3-digit numbers manually, so they rely on electronic calculators (Paglinawan G. et.al, 2024).

According to Bernardino (2023), with the frequent use of scientific calculators in classroom settings, students have become dependent on the gadget, and this caused their basic numerical skills to deteriorate over the years. Squaring numbers is a fundamental topic in mathematics, typically approached by multiplying the number by itself. This method is widely known and used by many. However, some may struggle with this concept and prefer to use a calculator to solve it. (M.A. Loren, J.K.D. Dumas, R.S. Estos and M.C.M. Murillon, 2018).

According to Erica J. A. Hiebert (2013), students have various methods of comprehending square numbers, and it is not as straightforward as it might seem initially. Therefore, there is always a possibility of differences in understanding or incorrect inferences about square numbers by students. As learners progress towards more complex concepts, such as general exponents,

square roots, and exponential growth, they need to link their new knowledge to a solid foundation of square numbers. Students do have trouble when working with square numbers and square roots, and although the topics may seem simple, there is a wide variety of ways in which to think about and work with square numbers (Erica J. A Hiebert, 2014). Every child has the right to learn mathematics, even if they do not become mathematicians in the future (Turgut, 2020).

According to Navida, G. (2022), the Bachelor of Secondary Education majoring in Mathematics are proficient in their major course subject or specialization. Students who complete a Bachelor of Secondary Education majoring in Mathematics demonstrate a high level of proficiency in their specialized subject. Their rigorous training equips them with the necessary knowledge and skills to effectively teach and inspire students in the field of mathematics, ensuring they are well-prepared to contribute to the educational system and foster a strong mathematical foundation in their future students.

This study aims to assess the effectiveness and efficiency of the alternative method among Bachelor of Secondary Education major in Mathematics at Osmeña Colleges. The researchers seek to answer the following:

1. What is the performance level of the respondents before and after the intervention, considering the time consumed:

   1.1 before the intervention; and

   1.2 after the intervention?

2. Is there a significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention?

Hypotheses

H_o: There is no significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention.

H_a: There is a significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention.

II. Methodology

Research Design: This study followed a pretest-posttest design, which is a type of quasi-experimental design. Quasi-experimental research is similar to experimental research in that there is manipulation of an independent variable. It differs from experimental research because either there is no control group, no random selection, no random assignment, and/or no active manipulation (Abraham & MacDonald, 2011). In this research design, all participants were

assigned to an experimental group, indicating the absence of a control group. The purpose of this study was to assess the effectiveness and efficiency of the alternative method among Bachelor of Secondary Education major in Mathematics' in terms of time consumed and scores.

Respondents and Sampling: This study included all one hundred fifty (150) participants who are pursuing a Bachelor of Secondary Education major in Mathematics degree at Osmeña Colleges. The census method was used to cater all the Bachelor of Secondary Education major in Mathematics from freshman to junior college to participants in this study. The table presents the information about a population and the participation rate in this study:

Actual Population	No. of Participants	Percentage
155	150	97%

155 from Bachelor of Secondary Education major in Mathematics are enrolled in Osmena Colleges academic year 2023-2024. 150 participants of Bachelor of Secondary Education major in Mathematics are present and willing to be involve in this study.

Research Instrument: The researchers constructed a 20-item assessment tool used for both the pretest and posttest to assess the effectiveness of the Alternative Method among Bachelor of Secondary Education major in Mathematics students at Osmeña Colleges. The researchers adopted the performance level scale from Gonzales L. (2022) for assessing scores and adapted this scale to interpret time consumed (mean per minute). Below are the scales used to determine performance level of the respondents in terms of time consumed and scores:

Performance Level Scale of Respondents' Score
(Gonzales L. 2022)

Score Interval	Performance Level	Description
17-20	Proficient	The respondents have a strong command of a particular skill or knowledge area.
13-16	Competent	The respondents' level of performance is satisfactory or acceptable in a particular area.
9- 12	Developing	The respondents are still learning and developing their skills in a particular area.
5-8	Beginner	The respondents have limited knowledge, skills, and abilities in a particular area.
1-4	Novice	The respondents have little to no knowledge, skills, and abilities in a particular area.

The score interval is in descending order because the higher the score, the higher the proficiency.

Performance Level Scale of Respondents' Time Consumed (Mean Per Minute)

Time Interval	Performance Level	Description
1-10	Proficient	The respondents have a strong command of a particular skill or knowledge area.
11-20	Competent	The respondents' level of performance is satisfactory or acceptable in a particular area.
21-30	Developing	The respondents are still learning and developing their skills in a particular area.
31-40	Beginner	The respondents have limited knowledge, skills, and abilities in a particular area.
41-above	Novice	The respondents have little to no knowledge, skills, and abilities in a particular area.

The time interval is in ascending order because the lower the time consumed, the higher the proficiency.

Procedure: The study was conducted simultaneously within a classroom setting. The following procedures were followed: the researcher obtained permissions from relevant authorities; assistance was sought from previous instructors; schedule for the time and place of data gathering was created; a pretest was conducted; an alternative method was introduced to participants; a posttest was conducted; papers were checked for completeness and accuracy; the data were analyzed; and findings and results were concluded. The researchers compared the pretest and posttest assessment data based on the time taken and the scores of the respondents. This analysis aimed to determine the significant differences between the respondents' performance before and after the intervention. The respondents took the pretest and posttest assessments simultaneously and were given open time to complete them. The intervention, which included introducing the learning objectives and the lesson proper, took 20-30 minutes. Educational interventions, where participants receive a 20-30-minute intervention, may also be suitable for this type of design to assess their immediate impact (Harris AD., 2006).

Statistical Treatment: ***Mean, Measures of Variability, Paired t-test.*** The researchers used the mean to summarize the overall score and time consumed of the respondents. They employed measures of variability to provide descriptive statistics of the data. A paired t-test was used to compare related groups and draw conclusions about the differences.

Ethical Considerations: The assessment was conducted anonymously, and responses were treated with utmost confidentiality. Participation was voluntary, and respondents could withdraw at any time. The researcher did not disclose any information provided by the respondents, ensuring their privacy and autonomy were respected. This approach ensured high-quality data for valid conclusions about the research questions.h

III. Results and Discussion

1. Performance Level of the Respondents Before and After the Intervention, Considering the Time Consumed:

Table 1.1 Before the Intervention

Range	Mean (Time Consumed)	Standard Deviation	Interpretation	Mean (Score)	Standard Deviation	Interpretation
29	22.71	5.15	Developing	18.97	2.01	Proficient

Table 1.1 shows the range, mean, standard deviation, the interpretation in terms of time consumed and score of the respondents before the intervention.

The standard deviation of time consumed is 5.15 unit per minute. The highest minutes that the respondents consumed in time before the intervention is 40 minutes and lowest of 11 minutes with a range of 29 minutes. The mean time consumed of the 150 respondents is 22.71 per minute, which indicated the performance level of the respondents is interpreted as "Developing" indicating that respondents' efficiency in terms of time was still learning and developing their skills in a particular area. In terms of scores, the standard deviation is 2.01. The mean score was 18.97 with the lowest score of 14 and a highest score of 20. The performance level of the respondents interpreted as "Proficient". This indicates that respondents have a strong command of a particular skill or knowledge area. Suggesting that respondents were already performing well in terms of scoring before the intervention.

Table 1.2 After the Intervention

Range	Mean (Time Consumed)	Standard Deviation	Interpretation	Mean (Score)	Standard Deviation	Interpretation
23	11.79	4.53	Competent	20	0	Proficient

Table 1.2 shows the range, mean, standard deviation, the interpretation in terms of time consumed and score of the respondents after the intervention.

The standard deviation of time consumed is 4.53 unit per minute. The highest minutes that the respondents consumed in time after the intervention is 27 minutes and lowest of 4 minutes with a range of 23 minutes. The mean time consumed of the 150 respondents is 11.79 per minute, which indicated the performance level of the respondents is interpreted as "Competent" indicating that respondents' level of performance is satisfactory or acceptable in a particular area. In terms of scores, the standard deviation is 0. The mean score was 20 indicating that all respondents got the perfect score on the post-test conducted after the intervention. The performance level of the respondents interpreted as "Proficient". This indicates that respondents have a strong command of a particular skill or knowledge area.

There is a noticeable shift to the left from before the intervention to after the intervention, indicating a significant decrease in the average time taken by students. This suggests improvement in their performance or familiarity with the test content. The post-test is steeper and narrower compared to the pretest, indicating that the time consumed is less variable and more consistent in the post-test. This suggests that students' performances were more uniform after instruction or practice.

Additionally, the intervention led to a significant improvement in both the time consumed and the scores achieved by the respondents. The performance level shifted from "Developing" to "Competent" in terms of time consumed, while the score remained at a "Proficient" level, indicating a strong command of the knowledge area. The data suggests that the intervention had a positive impact on the respondents' performance.

Similar study conducted by Gonzales L. (2022) on his Multi-Modal Strategy where he used Performance Level Scale to interpret the calculated mean score of his respondents. However, solely relying on calculating the mean for time consumed might not be enough to analyze research data. According to Frost, J. (2018), measures of variability are crucial for understanding data spread and dispersion, complementing the central tendency. Greater variability indicates a higher likelihood of extreme values, which often affects reactions more than the mean. Variability also reveals sample heterogeneity, offering insights into the population. While the mean or median summarizes the center, variability measures are essential for a complete understanding of the data and informed decision-making.

2. Paired t-test for the Pretest and Post-test Before and After Exposed to the Alternative Method as to:

Table 2 Paired t-test on Time Duration (in minutes)

Paired t-test	Degree of Freedom	Confidence Level	Critical Value	Decision Rule
15.88	149	0.05	±1.976	Reject the H_o

Table 2 shows the paired t-test, degree of freedom, critical value and decision as the Bachelor of Secondary Education major in Mathematics in the alternative method in terms of time consumed.

The paired t-test yielded a test statistic of 15.88 with 149 degrees of freedom. The critical value with an alpha of 0.05 is ±1.976. Based on these results, the decision is to reject the null hypothesis (H_0). This indicates that there is a significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention.

Hayes, A. (2023) suggests that using a paired t-test allows researchers to assess the impact of interventions, treatments, or other factors on outcome variables. It's crucial to comprehend the critical value in hypothesis testing for accurate statistical analysis. The critical value serves as the threshold for rejecting the null hypothesis and is instrumental in determining the statistical

significance of study results. By comparing the computed t-statistic to the critical value, researchers can effectively evaluate the hypotheses under examination.

IV. Conclusion

The intervention led to a positive impact on the respondents' performance, as evidenced by improvements in both time consumed and scores achieved. These findings align with similar studies and underscore the importance of considering variability measures alongside central tendency measures for a complete understanding of research data. The dispersion after the intervention is steeper and narrower than before the intervention, suggesting that time consumed are less variable and more consistent after instruction or practice. The statistics indicate that students completed the post-test faster and with less variability in their times compared to the pretest. The paired t-test is greater than the critical value. Consequently, we failed to reject the null hypothesis (H0) and accept the alternative hypothesis (Ha). This indicates that there is a significant difference in the performance level of the respondents, considering the time consumed, before and after the intervention.

V. Recommendations

The following are the recommendations that the researchers suggest:

1. **Utilize the Method.** Use Joasian Method because it helps you to calculate in squaring 3–4-digit numbers with 0 as its middle number/s quickly and effectively without using any calculator.

2. **Mastery.** Master the Josian method, because the more you practice the method, it helps you to not just calculate it traditionally, but also mentally.

3. **Share it with others.** This technique is not only for majoring in Mathematics, but also to those who are struggling to calculate squaring 3–4-digit numbers with 0 as its middle number/s whether they are a students, teachers or non-teachers.

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AUTHOR'S PROFILE

GLAIRE M. PAGLINAWAN

Glaire M. Paglinawan is a dedicated researcher, educator and the main author of the research, currently pursuing a degree in Bachelor of Secondary Education major in Mathematics at Osmeña Colleges. With a keen interest in innovative teaching methodologies, Glaire has developed the Joasian Method, an alternative approach for squaring 3-4 digit numbers.

This method reflects his commitment to enhancing mathematical skills and reducing dependency on electronic calculators. Glaire's research was conducted to aligns with his broader goals of improving mathematical education and fostering critical thinking among students. He aims to continue his work in educational research and contribute valuable insights to the field of mathematics education.

CARL JOSHUA L. DUAN

Carl Joshua L. Duan is a dedicated working student, educator and the one of the co-authors of the research, currently pursuing a degree in Bachelor of Secondary Education major in Mathematics at Osmeña Colleges. His contribution to this research helps significantly of the research.

KATHYLN ALLYSA T. CLORES

Kathyln Allysa T. Clores is a dedicated working student, educator and the one of the co-authors of the research. She is currently pursuing a degree in Bachelor of Secondary Education major in Mathematics at Osmeña Colleges. Balancing academic responsibilities and working load, her endless support and contribution make this research possible to accomplish.

THEA ANNE N. DELOS REYES

Thea Anne N. Delos Reyes is a hard-working student. She is currently pursuing a Bachelor of Secondary Education majoring in English at Osmeña Colleges. Her dedication in this study helps significantly to improve, revise and finalize this study to her outmost excellence in bringing her brilliancy toward education and teaching career path.

RUSTOM V. SUPLITO

Rustom V. Suplito is a dedicated working student, educator, and one of the co-authors of this research. He is currently pursuing a Bachelor of Secondary Education majoring in Mathematics at Osmeña Colleges. By balancing academic responsibilities with his current work, his unwavering support and contributions have been great of help in the successful completion of this research.

JEAN MAICA V. FRANCISCO

Jean Maica V. Francisco is a dedicated working student, educator, and one of the co-authors of this research. She is currently pursuing a Bachelor of Secondary Education majoring in Mathematics at Osmeña Colleges. By balancing academic responsibilities with her professional work and motherhood, her support and contributions have been invaluable to the successful completion of this research.