# Innovation Strategies in Teaching Mathematics: A Quasi-Experimental Approach

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**DOI: https://dx.doi.org/10.47772/IJRISS.2025.906000415**

**Received: 11 June 2025; Accepted: 16 June 2025; Published: 21 July 2025**

## ABSTRACT

This study aimed to determine the effectiveness of innovative teaching strategies in improving mathematics academic performance among the Grade 10 students of Luayon National High School. This quantitative study employing the quasi-experimental approach used the Wilcoxon Signed Rank Test to determine if there was a significant difference between the pretest and posttest scores of the control and experimental groups. The Mann-Whitney test was utilized to determine if there was a significant difference between the mean gain scores of the control and the experimental groups. After the intervention, the experimental group had a greater mean gain score than the control group. There was a significant difference between the pretest and posttest of the control and the experimental group. In the same vein, there was a significant difference between the mean gain score of the control and the experimental group. The results of the study showed that innovative strategies in teaching mathematics were a useful tool for closing students' gaps in solving problems involving polynomial functions and circles. Students in the experimental group outperformed the control group in terms of math proficiency and self-assurance because of different innovative teaching strategies. This is because the experimental group's students were able to receive different innovative teaching strategies that were especially tailored to meet their unique learning needs and learning styles, which enabled them to interact more deeply with the subject matter and thus gained a deeper comprehension of the ideas covered.

**Keywords:** Innovation Strategies, Main Gain Scores, Control Group, Experimental Group, Wilcoxon Signed Rank Test, Mann-Whitney Test.

## INTRODUCTION

### Background of the Study

Mathematics, specifically in the fields of Algebra and Geometry become complicated for students to understand and this is reflected in their low academic grades. Developing the fundamental abilities in mathematics and reading needed for modern education require innovative approaches. To achieve these, teachers need to incorporate cross-curricular teaching as well as encourage peer and student interaction.

From a global perspective, the significance of assisting students in recognizing and connecting various concepts has been stressed by educational standards including those of South Africa, the United States of America, and multiple curricula in Germany (Nordheimer, 2017). The mathematical connection capability of students enabled them to apply concepts in the real world especially in between Algebra and Geometry (Haji et al., 2017). However, a recent study revealed that Arab students had 40% lower achievements in math and science. Adding to this is the significant role of psychosocial factors that may influence their performance (Hosein et al., 2019).

In the Philippines, the Department of Education mandated the 60-minute class in mathematics. This aimed to assess students' achievement in national-level competencies. Efforts were made to enhance math education by involving teachers in the Mathematics Teachers Association of the Philippines (MTAP). The results of the Programme for International Student Assessment (PISA, 2018) and Trends in International Mathematics and Science Study (TIMSS, 2019) indicated that in the Philippines students scored significantly below average (Santos, 2020). This predicament is true in the context of Luayon National High School in Makilala Central

District, Province of Cotabato where ninety-two percent (92%) of the Grade 10 students did not meet the expectations during the previous quarterly assessment specifically in solving math problems. There were hopes that students could regain their mathematical proficiency through intervention (Pentang, 2020, 2021; Azucena et al., 2022).

Although there were similar studies conducted in different parts of the globe (Altemueller & Lindquist, 2017; Smale-Jacobse, 2019), related studies in the Philippines (Ganal & Guiab, 2020; Guinocor et al., 2020; Mendiola & Estonanto, 2022; Nabayra & Sage, 2022; Patricio, 2023) that investigated innovative teaching strategies in Mathematics however, did not provide vivid details into the case of the Manobo-Tagabawa learners. Aside from that, the present study utilized the experimental method. In this regard, the gap in the study was asserted.

Furthermore, this study was formulated because of the perennial problem being experienced by the students. By exploring this, the researcher could provide the efficacy of innovations in teaching Mathematics, especially among the Manobo-Tagabawa and those belonging to other ethnolinguistic group learners. In this regard, the researcher was motivated to conduct this study.

**Statement of the Problem**

This study aimed to determine whether using innovative teaching strategies can improve the mathematics academic performance of the students in Luayon National High School. Further, it sought to answer the following questions:

What are the pretest and posttest scores between the control and experimental groups?

What is the mean gain score of the control and experimental groups?

Is there a significant difference between the pre-test and post-test scores of the control and experimental groups?

Is there a significant difference between the mean gain score of the control and the experimental group of Grade 10 students in mathematics?

**Significance of the Study**

This study shall be of great benefit to the following:

**Department of Education.** Typically, the department oversees teacher certification, training, and professional development programs. The quality of mathematics instruction and teachers' ability to teach mathematics effectively are essential factors in students' performance. The study could investigate the efficacy of teacher education programs on student outcomes.

**Mathematics Teachers.** Mathematics teachers who incorporate innovative strategies into their instruction are often more effective educators. It will teach them that innovative teaching strategies are much more effective for the students.

**Students.** Innovative mathematics teaching strategies can significantly result in improved learning outcomes, increased engagement, and the development of critical skills of the students.

**Future Researchers.** This will serve as a basis to conduct more studies in the future by exploring different methodologies. Aside from that, they can use the same approach to other ethnolinguistic groups. Thus, they could come up with a comparative analysis of the effectiveness of the said approach involving different types of learners.

**Researcher.** This study helped in improving the researcher’s pedagogy of teaching. To disseminate the study, the researcher may share the results to all mathematics teachers through Learning Action Cell (LAC) sessions, seminars, workshops, and other activities in line with teaching-learning mathematics. Also, the researcher will

publish this study to reputable academic journals or conferences in the field of mathematics education. This will help establish the credibility of the research and reach a scholarly audience.

**Scope and Limitation of the Study**

This quantitative research which utilized the quasi-experimental design was conducted to determine the efficacy of math hunting, peer learning, small group discussion, board work, and bingo card games to Grade 10 students at Luayon National High School, Makilala Central District.

Conversely, this study was limited to the twenty-six (26) Grade 10 students where in the pre-test and post-test scores were determined, covered the months of November and December. The identification of the significant difference between the two groups was the focus of this study. Equal distribution of each group was observed. The researcher encountered challenges particularly in the conduct of the pretest and posttest activities to ensure that the different innovative teaching strategies are properly implemented.

**Definition of Terms**

The following terms are lexically and operationally defined for clarity of purposes:

**Bingo Card Games**. This will allow students to choose different types of problems they prefer to have answered. Students in this strategy received an extra point for each correct answer, giving them an additional opportunity to gain points if incorrect, helping to motivate learners, improve their strategic and problem-solving abilities, or increase their computational fluency.

**Board Work**. This approach allows to quickly assist students in learning by maintaining appropriate way of answering independently math problems. Also, it develops the speed and accuracy of the students in solving problems.

**Control Group.** This refers to a group of participants or subjects who are selected or assigned in a way that is as similar as possible to the experimental group but who do not receive the treatment or intervention. The control group assesses and compares the outcomes or changes observed in the experimental group to determine if the treatment or intervention had a significant effect.

**Experimental Group**. In an experimental research study, it refers to a subset of the study's participants or subjects subjected to the treatment, intervention, or experimental condition being investigated.

**Innovative Teaching Strategies.** Proactively introducing new teaching strategies and methods into the classroom is known as innovative teaching. Implementing these new teaching strategies and methods aimed to improve academic outcomes and address real-world issues to promote equitable learning.

**Math Hunting**. It is a powerful way to facilitate independent and small-group learning. It aims to let the students use the mini library to find essential mathematical words and examples related to their topic based on their prior knowledge.

**Peer Learning**. It is the practice of students learning from and with one another. Activities for teaching and learning like student-led workshops, study groups, peer-to-peer learning partnerships, and group work are typically used to facilitate them.

**Post-Test**. As used in this study, this refers to the assessment conducted to the Grade 10 students of Luayon National High School to determine the effectiveness of innovative teaching strategies.

**Pre-Test**. As used in this study, this refers to the assessment conducted to the Grade 10 students of Luayon National High School as a basis for intervention.

**Small group discussion**. It is a student-centered methodology that enables students to actively participate and be partners in the teaching and learning process. Students discuss and exchange ideas while interacting with professors and their peers. They can foster collective consensus, as well as play specific games.

## Review of Literature and Theoretical Framework

This chapter presents related literature and studies, theory base, conceptual framework and hypotheses on innovation strategies in teaching mathematics.

## Related Literature and Studies

The following are the related literature and studies about innovation strategies in teaching mathematics. These have implications on the overall understanding of the fundamental notions of how these strategies improved learning in this study. These strategies focus on engaging students and encouraging them to take an active role in their learnings.

In today's diverse classrooms, the approach that considers learners' unique strengths and differences, providing hands-on learning opportunities, as emphasized by Civitillo et al. (2018), represents a pivotal shift in education. This student-centered approach recognizes the importance of tailoring instruction to individual needs, fostering a more inclusive learning environment. However, Deunk et al. (2018) rightly pointed out that the successful implementation of innovative teaching strategies is paramount for achieving the desired educational outcomes. The challenge lies not only in introducing these strategies but also in ensuring that the transition from fundamental to complex competencies is well-structured. Torres (2021) highlights the risk of learning gaps if essential skills are not adequately understood before progressing to advanced competencies. Despite these challenges, the value of innovation in instruction, particularly in mathematics, cannot be overstated, as it significantly contributes to enhancing student outcomes across various subjects.

In the context of mathematics, its pivotal role in fostering logical thinking skills and intellectual growth is underscored by Azucena et al., (2022); Kunhertanti and Santosa (2018). Teachers are tasked with the complex challenge of gauging students' mathematical confidence, considering factors such as their belief in mathematics and specific topics within the curriculum, as pointed out by Foster (2019). The difficulty in capturing the necessary level of mathematical confidence highlights the intricate nature of assessing students' perceptions of their own abilities. Despite these challenges, Mbugua and Muthomi (2018) shed light on the positive impact of mathematical innovation strategies in promoting increased student engagement and fostering meaningful interaction among classmates. This underscores the potential of innovative approaches to not only improve academic outcomes but also create a more dynamic and participatory learning environment, especially in the realm of mathematics.

## Level of Mathematics Achievement

Mathematics holds a significant role as the cornerstone of scientific-technological knowledge, playing a dynamic role in the economic growth of nations and serving as a crucial component for individual success, as underscored by Tomlinson (2019). However, a concerning trend has emerged over the years, indicating a decline in learners' achievement in mathematics, as evidenced by the results released by Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMMS) (OECD, 2019; Mullis et al., 2019). Various factors contribute to this decline, ranging from insufficient teaching and learning facilities to learners' negative attitudes towards mathematics and their struggles to relate and comprehend problems within the allotted time, as identified by Van Geel et al. (2019). In response to these challenges, there has been a paradigm shift in mathematics instruction, with educators exploring more practical methods such as the constructivist approach, mastery learning, and systematic approaches.

The global context is reflected in the studies, such as those focusing on Filipino students, revealing poor or unsatisfactory performance in mathematics (Azucena et al., 2022; Capuno et al., 2019; Pentang et al., 2020). Moreover, the National Achievement Test's mean percentage score in Mathematics falling below standards (DepEd, 2019) adds to the urgency of addressing these concerns. The adverse impact of the COVID-19 pandemic

has further exacerbated students' underachievement in mathematics, affecting both teachers and students. The proactive approach taken by this study at Tabon National High School, employing differentiated instruction, signifies a response to these multifaceted challenges, offering a potential solution to enhance mathematics learning outcomes and bridge the existing gaps.

**Innovative Teaching Strategies in Mathematics**

The adoption of innovative instructional techniques, particularly through the application of differentiated instruction, plays a crucial role in elevating mathematics achievement. Kyriakides et al. (2018), Schleicher (2017), and United Nation Educational, Cultural Organization (2017) emphasize the efficacy of differentiated instruction as a means of tailoring educational strategies to meet the unique needs of individual students, advocating for a departure from a uniform curriculum to one that adapts to diverse learning styles. As highlighted by Wilkinson and Penney (2018) and Smale-Jacobse et al. (2019), teaching innovation involves a comprehensive approach, influencing subject matter, procedures, outputs, and the overall student experience. Tomlinson (2014, 2015) underscore the transformative nature of differentiated instruction, shifting the responsibility from students conforming to the curriculum to the curriculum adapting to the unique needs of each student. Mbugua and Muthomi (2019) further stress the importance of adaptability and flexibility in teaching methods, curriculum, and informational delivery within the differentiated instruction framework.

On the other hand, innovative teaching practices extend beyond the confines of the classroom, as Algani (2019) suggests connecting mathematics to daily life experiences, providing tangible examples and applications. It emphasizes the importance of creativity in selecting examples relevant to student's daily lives and connecting mathematics to abstract thought and real-world experiences, fostering an appreciation for the subject. This approach not only aids students' integration into society but also nurtures critical thinking skills.

Meanwhile, Coe's (2018) proposal to teach mathematics alongside engaging techniques like magic squares, crossword games, and decoding aligns with the growing acknowledgment of game-based learning as an effective motivator for enhanced performance, as indicated by research findings. His emphasis on the application of mathematical principles in real-world situations underscores the significance of demonstrating how mathematics relates to various aspects of life, thereby increasing motivation and understanding.

Furthermore, Peteros et al. (2020) highlighted the impact of teaching strategies and the systematic use of differentiated instruction in mixed-ability classrooms to promote equity, optimize quality, and enhance teaching effectiveness. The implementation of the K-12 mathematics curriculum, guided by primary learning objectives for critical thinking, logic, and positivity, underscores the deliberate efforts to enhance students' mathematics understanding and learning through differentiated instruction (Bhagat et al., 2018; Janssen et al., 2017; Schmid & Petko, 2019). Despite the existing studies on differentiated instruction, the call for more research to explore specific strategies and approaches that prove most effective for improving mathematical achievement within the local context reinforces the ongoing need for a tailored and nuanced understanding of differentiated instruction's impact on mathematics education.

Finally, the diverse array of effective, innovative teaching strategies mentioned, including math hunting, peer learning, small group discussions, board work, and bingo games, highlights the multifaceted approaches available to educators in their pursuit of enhancing mathematics learning outcomes.

**Math hunting**

The concept of "gamification" in education, as explored by scholars such as Deterding et al. (2021); DeSouza and Ozment (2020), entails the incorporation of game elements into non-game spaces, with notable applications in fields such as mathematics education. One prominent example of this integration is the use of specialized online platforms such as LearningApps.org and Kahoot.com, as discussed in studies by Pereira et al. (2018). These platforms allow teachers to create engaging games tailored to specific subjects, while retaining the essential characteristics of didactic games and offering operational feedback. Despite the lack of elements such as a storyline or multiple levels in teacher-created games, they serve as an effective tool for reinforcing learned concepts in an interactive setting.

Moreover, the success of such gamification efforts, as highlighted by Karl Kapp's (2012) comprehensive overview, is dependent on collaboration between teachers and programmers to align game content with educational program requirements, thereby increasing their practical relevance. As various scholars have discussed, games are recognized as conceptual models that operate in both formal and informal learning contexts in mathematics education. Educational games, when designed to be enjoyable and motivating, have the potential to improve the learning process, providing a promising method for students to acquire and apply constructive knowledge in familiar settings. Therefore, the use of gamification in education, particularly in the context of mathematics, as one of the innovation strategies, represents an innovative approach to enhance engagement, motivation, and learning outcomes among students.

### Peer Learning

Peer tutoring, also known as peer-assisted learning, has become increasingly common in mathematics education. This development has been well-documented in recent research (Alegre et al., 2019; Moliner & Alegre, 2020). According to Alegre et al. (2020), peer tutoring in math has comparable positive effects on students' academic performance in elementary and secondary education. Extensive evidence indicates the positive impact of peer-assisted learning on academic success, mathematics self-concepts, mathematics anxiety, attitude, and social behaviors (Moliner & Alegre, 2020b; Song et al., 2018). This method transcends traditional teaching techniques by creating an atmosphere in which students achieve academic success and a greater sense of mathematical self-efficacy.

## SMALL GROUP DISCUSSION

The student-centered methodology of small-group discussions demonstrates a dynamic approach that actively engages students in the teaching and learning process, fostering collaboration and interaction. Wester (2022) emphasized the importance of incorporating small-group discussions as a planned component of whole-class instruction, which expands the learning space and improves students' chances of grasping the intended lesson objectives. Students engage in small-group discussions to exchange ideas not only with their peers but also with the teacher, allowing for a more thorough exploration of the learning material. The effectiveness of small-group discussions is determined not only by their use but also by how they are strategically integrated into whole-class instruction, providing valuable insights into different ways of experiencing the subject matter.

Another strategy that aligns with collaborative learning is trail-based group work, as discussed by Barbosa and Vale (2021), as well as Vale et al. (2019). This approach engages students in a variety of activities, including writing, measuring, and discussing, as well as movement through exploration of specific sites and observation of elements in their surroundings. Such problem-solving activities encourage students to think critically about appropriate strategies for arriving at a solution. The collaborative nature of this strategy improves students' understanding by encouraging them to collaborate, promoting not only academic development but also the development of observational and analytical skills. The combination of small-group discussions and trail-based group work exemplifies an integrated and multifaceted approach to teaching mathematics, creating an environment that promotes active participation and critical thinking among students.

### Board Work

Maintaining effective study habits is an important part of facilitating student learning and using the board work as a strategy can greatly improve the learning process. According to the constructivist theory of learning, discussed by Lie (2022), meaningful learning is based on prior knowledge. The board work is an instructional scaffold strategy that visually sequences mathematical concepts, which promotes math learning by providing a clear structure for students to follow. Lie, C.M (2022), claim that the board effectively connects multiple mathematical concepts emphasizes its role in fostering coherence within lessons. This visual aid helps students organize their thoughts, understand the connections between various components of a lesson, and comprehend the overall progression of the material.

Russell (2017) emphasized the board's interactive nature as a catalyst for student engagement and critical thinking. Working at the board encourages students to actively participate in problem-solving, resulting in a

dynamic learning environment. Russell observed that students who work at the board are not only more likely to be engaged, but they also exhibit less helplessness than when they work alone at their desks. This demonstrates the collaborative and empowering potential of board work in mathematics education. As a shared space for collective problem-solving, the board work encourages students to think collaboratively, fostering a sense of involvement and efficacy in the educational process.

**Bingo Card Games**

Implementing a Bingo game instructional strategy in mathematics education has demonstrated notable success, as evidenced by the study conducted by Tella, and Fatoki (2021). This innovative approach allows students the flexibility to choose the types of problems they prefer to tackle, fostering a sense of autonomy and engagement in their learning. The introduction of an extra point system, where students receive additional points for correct answers and even opportunities for points if incorrect, serves as a powerful motivational tool. This strategy not only motivates learners but also enhances their strategic thinking, problem-solving abilities, and computational fluency, contributing to a comprehensive development of mathematical skills.

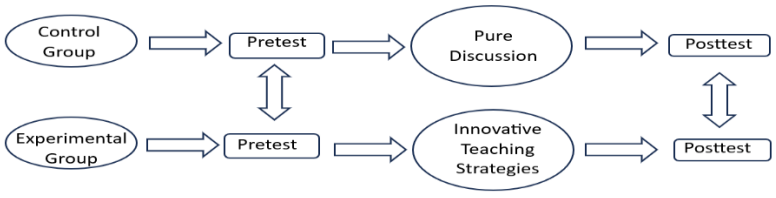
The research findings revealed a significant improvement in students' quantitative abilities, specifically in length, perimeter, shapes, and figures. The promising outcomes suggest that the Bingo game instructional strategy has the potential to bring about positive changes in students' overall performance. With a focus on enhancing pupils' achievement in mathematics, the study advocates for primary school mathematics teachers to consider adopting this strategy in their teaching delivery. By incorporating such interactive and game-based methods, educators can create a dynamic and engaging learning environment that aligns with the expectations of teachers, parents, and school authorities, ultimately contributing to improved student performance in mathematics (Tella & Fatoki, 2021).

**Theory Base**

The integration of various educational theories is critical when developing innovative secondary mathematics teaching strategies. However, Gardner's Multiple Intelligences Theory is an excellent framework for mathematics teaching innovation because it emphasized recognizing and accommodating diverse learning styles and strengths. According to research, students have different cognitive strengths and preferences when it comes to learning mathematics. Educators can create inclusive learning environments that meet the needs of all learners by recognizing diversity and tailoring instructional methods to individual students' intelligences (Gardner, 1999). In mathematics education, this approach enables teachers to present concepts using a variety of modalities, including visual representations, auditory explanations, and kinesthetic activities, allowing students to engage with the material in ways that are relevant to their strengths and preferences (Armstrong, 2009).

Furthermore, incorporating Gardner's Multiple Intelligences Theory into mathematics teaching strategies helps students feel empowered and in control of their learning. When students see that their individual talents and modes of comprehension are valued and accommodated in the classroom, they are more likely to feel motivated and confident in their mathematical abilities. This can result in increased engagement, deeper understanding, and improved mathematical performance (Gardner, 2011). Furthermore, by tapping into students' diverse intelligences, educators can foster creativity, critical thinking, and problem-solving abilities, all of which are required for success in mathematics and beyond (Kaufman & Sternberg, 2006). Overall, Gardner's Multiple Intelligences Theory serves as a solid foundation for developing innovative teaching strategies that emphasize inclusivity, personalized learning, and the holistic development of students' mathematical abilities.

**Conceptual Framework**



This study conceptualized that the pretest and the posttest of the control and experimental groups can be compared. The control group is the group that receives instruction using the traditional or "pure discussion" method. It served as a benchmark for comparison since it represents the standard or conventional method of teaching mathematics. Math hunting, peer learning, small group discussions, board work, and bingo games were among the innovative teaching strategies employed in the experimental group. These were tested to determine if there was a significant difference between the variables being compared.

**The Conceptual Framework of the Study**

The teacher employed various teaching strategies in the experimental group, whereas the control group was only given pure lecture-discussion sessions. The students in the experimental group were the primary focus of the study. The mathematics teacher facilitated the learning process. The teacher in this study used topics presented throughout the second quarter of the School Year 2023-2024. Once the topics were discussed, a post-test was conducted, and their scores were assessed and compared to their pre-test scores. This was done to acquire concrete information on the impact of the innovative learning strategy compared to the pure lecture and discussion method.

**Hypotheses**

$Ha_1$: The researcher hypothesized that there is a significant difference between the pre-test and post-test scores of the control and experimental groups of Luayon National High School students using innovative teaching strategies.

$Ha_2$: The researcher hypothesized that there is a significant difference between the mean gain scores of the control and the experimental group of Grade 10 students in mathematics.

# METHODOLOGY

This chapter discusses the method used, sources of data, data gathering instrument, population and sampling technique, procedure, and the statistical treatment of the study.

**Method Used**

This study employed a quantitative research design, particularly a quasi-experimental design. This allowed the researcher to use a match-pairing selection of participants from the total population since there were only a small size of students. It aimed at identifying the pre-test individual scores for comparing the outcomes of the pre-and post-tests for participants who were exposed to innovation strategies and those who were not (Mbugua & Muthomi, 2018). Moreover, pre-tests and post-tests were administered to the groups at the start and end of the study, respectively. The experimental group underwent treatment involving the application of different innovative teaching strategies. They were assessed after exposure to innovative approaches, while the control group did not receive any intervention. Consequently, the main gain scores were used in this study to compare the control and experimental groups' pre-test and post-test results.

**Sources of Data**

This study utilized the primary data which were taken from the responses of the students. Primary sources are authentic materials that offer direct firsthand evidence about specific subjects or historical eras (Creswell, 2018). The pretest scores of the twenty-six (26) Grade 10 students from Luayon National High School were utilized for the match-pairing method. These students were divided into two groups: the control and experimental group.

**Data Gathering Instrument**

The researcher used an adapted pretest and posttest questionnaire from the division-wide second quarter Grade 10 Mathematics, particularly from the Curriculum and Implementation Division (CID) through the Education Program Supervisor in Mathematics. The adapted test questionnaire comprised forty (40) multiple-choice

examination items covering second-quarter topics. The examination presented queries, statements, or problems the students needed to address or answer. This part assessed the test-taker's knowledge or understanding of the subject matter.

A list of answer options was provided, consisting of multiple potential answers, with one being the correct or best response and the others being incorrect or distractor choices. The students had to choose the solution they believed to be correct from the provided options by writing the corresponding letter on the answer sheet provided by the teacher. In scoring, the students received a score based on the number of correct answers.

**Population and Sampling Technique**

The participants were divided into two groups: the experimental group, composed of thirteen (13) students who received different innovative strategies, and the control group with thirteen (13) students who did not receive any innovative teaching strategies.

The match-pairing method was utilized in the selection of participants who met the study's requirements, ensuring that the results accurately reflected the effects of the intervention on the targeted group. Additionally, the study divided the participants into control and experimental groups with an equal number of students to compare the effectiveness of teaching innovations to traditional instruction, allowing for a precise evaluation of the intervention's impact.

**Procedure of the Study**

The researcher sent and secured approval request letters and consent from the public school district supervisor, school head, parents, and the participants for their participation and cooperation. Data was collected over 8 weeks in the months of November and December 2023.

During the first day of the week of the study, the researcher conducted a pretest with the adapted questionnaire. The pretest's scores were recorded and were utilized for match pairing. Thereafter, the participants were divided into two composed of 13 students for both control and experimental groups.

On the second day of same week, the researcher started the teaching and learning to the experimental group with the application of math hunting innovative teaching strategy for the topic about polynomial functions. Following days of the same week, the researcher discovered that the combination of different innovative teaching strategies like math hunting, group discussion, peer tutoring and board works were possible for the active engagement of the students to acquire the needed competencies about the polynomial functions.

On the second week until the fourth week, math hunting, group discussion and board work were actively used to acquire the needed competencies about terms related to circles, proves theorems on circles and solves problems on circles. These innovative teaching strategies developed students in illustrating and conceptualizing the different terms, theorems and problem solving on circles.

To improve the students' ability in solving problems involving the distance and midpoint between the two points during the fifth week, the researcher utilized the combination of bingo games and board works. These strategies developed the students' independent learning and appreciate mathematics while having fun with learning.

On the sixth week, math hunting, group discussion, peer learning and board work were utilized to acquire the needed competency for center-radius of the circle. Furthermore, the same strategies were utilized on the seventh week until the first four days of the eight week; the math hunting, group discussion, peer learning and board work for graphing and solving involving circles and other geometric figures on the coordinate plane.

On the last day of the eight week, the posttest was conducted and utilized the same adapted questionnaire during the pretest after the competencies were completely taught and delivered to the students. Thereafter, results were compared between the participants' performance levels before and after the intervention implementation and determined the improvement level they gained.

### Statistical Treatment

The following statistical tools were used in this study. To determine the pretest and posttest as well as the mean gain score of the control and experimental group, descriptive statistics were employed: frequency distribution and the weighted mean were utilized. To determine the significant difference between variables, non-parametric tests were employed. Specifically, the Wilcoxon Signed Rank test was used to determine if there was a significant difference between the pretest and posttest scores of the control and experimental groups. This test is a counterpart of a paired t-test. To determine if there was a significant difference between the mean gain score of the control group and the experimental group, the Mann-Whitney test was used. This is the counterpart of the independent t-test. All interpretations were based on a five percent (5%) level of significance.

## PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter contains the presentation, analysis, and interpretation of the data gathered for the study, arranged according to the stated problems.

### The Pretest and Posttest Scores of the Control and Experimental Groups

The first research problem was to determine the pretest and posttest scores of the control and experimental groups. The 40-item test was administered to the Grade 10 students of Luayon National High School before the lesson started for the second quarter SY:2023-2024.

Table 1 showed the pretest and post-test scores performance of the comparative groups. Out of 40-item tests, the mean scores for the pretest and posttest of the control group were 10.31 and 21.69 respectively. For the experimental group, the mean score for the pretest was 10.92 and 28.38 for the posttest. On the other hand, the highest scores for the pretest and posttest of the control group were 15 and 34 respectively. For the experimental group, the highest score for the pretest was 17 and 36 for the posttest. Moreover, the lowest score of the control group during the pretest was 5 and 14 for the posttest. The lowest score of the experimental group was 5 for the pretest and 21 for the posttest.

Table 1 The Pretest and Posttest of the Comparative Groups

| | **Control (N=13)** | | | | **Experimental (N=13)** | | | |
|---|---|---|---|---|---|---|---|---|
| | Pretest | | Posttest | | Pretest | | Posttest | |
| Score | f | % | f | % | f | % | f | % |
| 0 - 7 | 4 | 10 | 0 | 0 | 3 | 7.5 | 0 | 0 |
| 8 - 15 | 9 | 22.5 | 2 | 5 | 9 | 22.5 | 0 | 0 |
| 16 - 23 | 0 | 0 | 6 | 15 | 1 | 2.5 | 2 | 5 |
| 24 - 31 | 0 | 0 | 4 | 10 | 0 | 0 | 8 | 20 |
| 32 – 40 | 0 | 0 | 1 | 2.5 | 0 | 0 | 3 | 7.5 |
| Minimum | 5 | | 14 | | 5 | | 21 | |
| Maximum | 15 | | 34 | | 17 | | 36 | |
| Mean | 10.31 | | 21.69 | | 10.92 | | 28.38 | |
| Variance | 12.9 | | 39.23 | | 13.08 | | 16.92 | |

| Legend: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 - 7 | | Did Not Meet Expectations | | | | | | |
| 8 - 15 | | Fair | | | | | | |
| 16 - 23 | | Satisfactory | | | | | | |
| 24 - 31 | | Very Satisfactory | | | | | | |
| 32 - 40 | | Outstanding | | | | | | |

Based on the pretest and post-test scores, the control group showed from the category of fair to satisfactory. While the pretest and posttest scores of the experimental group showed from the category of fair to very satisfactory, results implied that the experimental group showed much improvement as compared to the control group.

The pretest performance of the control and experimental groups which was described as fair could be attributed to the fact that the lessons covered on the pretest were not yet taught to them when the test was conducted. In the same vein, this implied the necessity of teaching the concept of the lesson for the students to have a total understanding. There is also a need to present a specific strategy that could increase their performance.

In line with this, a problem with the non-teaching of the topic could have a detrimental impact on students' performance. Introducing a specific strategy could have helped students to improve their performance. This aligned with the findings of Pentang et al. (2020) that an intervention addressed the gaps in mathematics. With that, the posttest results of both the control and experimental groups improved but the experimental group had a very satisfactory performance which was a greater improvement than the satisfactory performance of the control group. The result of this study conformed with the findings of Azucena et al. (2022), who concluded that instructional intervention could enhance students' performance in mathematics.

**The Mean Gain Scores of the Control and the Experimental Groups**

The second research problem was to determine the mean gain score of both the experimental and the control groups. Table 2 showed the gain score of the control and experimental groups. It can be gleaned from the table that the experimental group had a greater mean gain score of 17.46 while the control group with 11.38. Also, the table showed that the experimental group had the highest gain score of 23 as compared to 21 for control group and the lowest gain scores for the experimental and control groups were 12 and 6 respectively.

Table 2 Mean Gain Scores of Both the Control and the Experimental Group

| | **Control (N=13)** | **Experimental (N=13)** |
|---|---|---|
| Minimum | 6 | 12 |
| Maximum | 21 | 23 |
| Mean | 11.38 | 17.46 |
| Variance | 19.92 | 17.27 |

The result showed that both groups had improvements based on the mean gain scores of both control and experimental groups, but the experimental group had a greater improvement compared to the control group. More importantly, this explained that the strategy employed by the teacher has made a significant change in the learning capabilities of the students. Indeed, the approach used manifested to have helped students to have a grasp of the concepts of the lessons.

This entails that teachers' interventions in teaching mathematics did not only increase students' scores but also their interest in the course (Vale & Barbosa, 2023). It can be associated with the mere fact that teachers can give students the capacity to explore their skills in understanding mathematical concepts (Farhani et al., 2023). However, there could be some external factors that may have a significant influence on students' performance as mentioned by Kumar (2023).

**The Significant Difference in the Pretest and Posttest Scores Between the Control Group and Experimental Group**

The third research problem was to determine the significant difference between the pretest and the posttest scores of the control group and the experimental group.

Tables 3 showed that the control group's Z-value was -3.183 while the experimental group's Z-value was -3.187. In addition, the P-value between the pretest and posttest scores of the control group and experimental group was 0.001.

Table 3 The Significant Difference of the Pretest and Posttest Scores Between the Control Group and Experimental Group

| Groups | N | Z-value | P-value |
|---|---|---|---|
| Pretest and Posttest (Control) | 13 | -3.183 | .001 |
| Pretest and Posttest (Experimental) | 13 | -3.187 | .001 |

The result of this study revealed that the control and the experimental group's Z-value was with a negative value which means that the posttest scores of the control and the experimental group increased as compared to their pretest scores. Meanwhile, as compared to the Z-value versus the P-value between the pretest and posttest scores of the control group, it indicated that there was a significant difference between the pretest and posttest of the control and experimental groups. Therefore, the hypothesis was accepted.

It can be inferred that both the control and experimental groups showed a significant increase in their post-test scores. However, the post-test mean scores of the experimental group were significantly higher than the post-test of the control group. This means that the intervention provided by the teacher greatly helped them to have a grasp of the mathematical concepts. Furthermore, a significant increase in the posttest scores of the experimental group manifested the diverse strategies used by the teacher.

In summary, the results showed that students performed well in answering mathematics problems even without innovation strategies, which supported the findings of Azucena et al. (2022) and Udofia and Uko (2018). The performance gap in the other group that received innovation strategies is significantly different. However, the control group was significantly lower than the experimental group's performance. Despite not being exposed to an intervention, the students may have used other approaches on their own. According to Pentang et al. (2020), any method can help students learn mathematics.

**The Significant Difference Between the Mean Gain Scores of the Experimental Group and the Control Group**

The fourth research problem was to determine the significant difference between the mean gain scores of the experimental group and the control group of grade 10 students in mathematics.

Table 4 showed that the control group's mean rank is 9.23 compared to the experimental group of 17.77. Also, the Z-value and P-value between the mean gain scores of the control and experimental groups were -2.857 and 0.003 respectively.

Table 4 The Significant Difference Between the Mean Gain Scores of the Control Group and the Experimental Group

| Groups | N | Mean Rank | Z- value | P-value |
|---|---|---|---|---|
| **Mean Gain Score (Control)** | 13 | 9.23 | -2.857 | 0.003 |
| **Mean Gain Score (Experimental)** | 13 | 17.77 | | |

The result showed that the experimental group had a much higher mean gain score as compared to the control group. As a result, there was a significant difference between the mean gain scores of the control group and the experimental group. Therefore, the hypothesis was accepted. This implied that the strategies employed by the experimental group significantly increased their mean group score. It explained that the innovative strategies employed in teaching mathematics exemplified that it allowed students to perform better in their mathematics classes.

The findings of Azizah et al. (2021), Azucena et al. (2022), and Pentang (2021 highlighted that the innovation strategies significantly improved the learner's mathematics achievement. The intervention through innovative teaching strategies was an effective measure for assisting students in developing and improving their mathematical performance, which the school can keep. Still, more innovation can be made to achieve excellent math qualities that are appreciated by students. The teachers involved must comprehend the other factors that contributed to the students' improved performance.

## SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary of findings, conclusions, and recommendations based on the data gathered for the study.

### Summary of Findings

This quantitative study employing the quasi-experimental research design aimed at determining the efficacy of the innovative strategies in teaching mathematics. Specifically, it sought to determine the pretest and posttest scores between the control and the experimental groups as well as the mean gain scores of the control and experimental groups. Finally, it aimed to determine whether there is a significant difference between the pre-test and post-test scores of the control and experimental groups as well as a significant difference between the mean gain scores of the control and the experimental group of Grade 10 students in mathematics. There were twenty-six (26) Grade 10 students from Luayon National High School who served as the subjects of the study. Results revealed that both the control and experimental groups had the same lowest score during the pretest. However, the post-test results revealed the experimental group had a higher maximum score than the control group. Meanwhile, the experimental group had a greater mean gain score than the control group. There was a significant difference between the pretest and posttest scores of the control group and the experimental group. Finally, there was a significant difference between the mean gain score of the control group and the experimental group.

## CONCLUSIONS

Based on the results of this study, the researcher concluded that innovative strategies in teaching mathematics were useful tools for closing students' gaps in mathematical understanding especially when it comes to solving problems involving polynomial functions and circles. With this teaching strategy, teachers can adjust their lessons to each student's specific needs while considering their individual learning preferences and skill levels. Students in the experimental group outperformed the control group in terms of math proficiency and self-assurance because of different innovative teaching strategies. This is because the students in the experimental group were able to receive different innovative teaching strategies that were specially tailored to meet their unique learning needs and learning styles, which enabled them to interact more deeply with the subject matter and gain a deeper comprehension of the ideas being covered.

## RECOMMENDATIONS

From the foregoing findings and conclusion of this study, the researcher recommends that the school can somehow help to improve the teaching and learning process by offering innovative teaching strategies through professional development training, seminars, and workshops for teachers. It is critical to encourage and support teachers in implementing innovative teaching strategies regularly to improve students' higher-order thinking skills, which can be achieved by exposing them to more complex problems. On the other hand, to facilitate effective teaching and learning, teachers may focus on strategies that promote knowledge acquisition and content mastery.

It is recommended further that activities may cover different levels of Bloom's Taxonomy, a system of thinking skills ranging from lower-order to higher-order thinking. Using this framework, teachers can assist students in effectively understanding the lesson's content. Moreover, individual and group work may be supported by a flexible classroom layout with various seating arrangements. Teachers may also use effective classroom discipline techniques that promote a psychologically positive and safe learning environment. Future researchers may consider the study's limitations and devote enough time to their research to obtain more comprehensive results.

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