An Experimental Study on Mathematics Teaching Strategies and Academic Performance of Students

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ABSTRACT

This study aimed to find how students' mathematics academic performance changed the impact of mathematics teaching strategies, specifically direct instruction, inquiry-based learning, collaborative learning, and technology integration, on students' academic performance in mathematics. It concentrated on analyzing the pre-test scores of students in mathematics before implementing mathematical teaching strategies, evaluating the post-test scores of students after applying mathematics teaching strategies, and examining the difference between the pre-test and post-test scores to assess the interventions' effectiveness. The research utilized a quasi-experimental design with a one-group pre-test-post-test design. The study was conducted at San Miguel National High School, San Miguel, Compostela, Davao de Oro. According to the results of the pre-test, students were found to have a "Fairly Satisfactory" grasp of mathematical concepts and skills, slightly higher than the minimum level of proficiency. This demonstrated the intervention's essential significance. The implementation of teaching strategies resulted in a significant increase in students' post-test scores, elevating their competency level to "Very Satisfactory." These results signify that the interventions facilitated an enhancement in students' academic performance in Mathematics. These results indicated that there is a significant difference between the pre-test and post-test scores of the experimental group, demonstrating that the applied mathematical teaching strategies were effective in improving students' academic performance. This implies that the use of direct instruction, inquiry-based learning, collaborative learning, and technology integration improved the academic performance of students in the experimental group.

Keywords: mathematics teaching strategies, direct instruction, inquiry-based learning, collaborative learning, technology integration, students' academic performance, quasi-experimental design.

INTRODUCTION

Mathematics is the foundation of understanding scientific knowledge and technology, as well as the basis for social and economic progress. The selection of productive instructional strategies is an important consideration in developing students' mathematical understanding and motivation. Innovative methodologies in the teaching of mathematics have been recommended as a crucial step towards remedying learning gaps and improving performance. El-Adl and Alkharusi (2020) found that mathematical achievement and motivation are higher when implementing student-centered approaches than traditional lecture-based methods. Similarly, interactive and participatory methods of teaching have been identified by Abdelrahman (2020) as some of the teaching methods that enhance the construction of meaning of mathematical concepts by students which inculcate in them an interest in the subject. Tambunan et al. (2021) also stress that differentiated instruction -an approach that is designed to cater to the students' different levels of readiness and interests- has in fact outperformed the rest.

Throughout the world there are currently challenges to teaching and learning mathematics as students are often being taught with conventional approach (including only rote memorization and drill) to learn mathematics that does not develop their reasoning abilities and problem-solving skills. In the UK, Karabatak and Polat (2020)

note that such traditional methodologies often lead to students becoming disengaged and having only a little understanding of the abstractness of mathematical calculations. A possible means of dealing with this issue has been to combine direct instruction and inquiry-based learning. In contrast, direct instruction provides an explicit and scaffolded exposure to fundamental content, whereas inquiry-based learning allows for the exploration and manipulation of ideas, which encourages a more profound comprehension of mathematics as a subject. Afgha (2024) in Saudi Arabia notes that outdated teaching methods, poor retention of mathematics facts and lack of interest are some of the factors that have continually inhibited mathematical performance among students. To overcome these obstacles, the use of direct instruction can help ensure students gain essential skills through structured lessons, while inquiry-based learning can spark curiosity and motivation, empowering students to apply their learning in practical situation.

In the Philippines, specifically Davao de Oro, models of education are either old-fashioned or curricula based on educational best practices and new technological forms should be implemented, these global and national problems are further compounded by the lack of investigators changing modern instructional styles for teachers. Many teachers are stymied in putting differentiated instruction into practice and adapting teaching methods to meet the needs of a diverse range of learners because there is limited scope for their professional development (Rebucas and Dales, 2002). For direct instruction, teachers need a stable framework from which to present mathematical materials, while with inquiry-based learning, they can create an environment that is interesting to learners and centers on the students themselves. Velez & Abuzo (2014) emphasize that this type of result in the academic sphere for differentiated instruction strategies based on such technological rearrangements is not only significant but also positive.

In several Mathematics classes in San Miguel National High School in Compostela, Davao de Oro, I have observed that students often sit silently, occasionally converse among themselves, or just listen without much enthusiasm. This seems to occur from the continuous application of conventional teaching strategies, such as lecture-based instruction and repetitive exercises. These strategies limit student active participation and cannot meet their diverse learning styles and abilities. Students thus have weak aptitude for critical thinking and problem-solving. Numerous students consistently regard Mathematics as a tedious and difficult subject, resulting in low motivation and declining academic performance.

Thus, this experimental study identifies the efficacy of employing different teaching strategies for improving the development of Mathematics instruction and learning. This method guarantees that every student, regardless of their ability level, stays actively involved and helps them grasp mathematical ideas. Teachers create an inclusive and exciting classroom where students' academic performance improves, and their view of Mathematics is as a fun and easily accessible subject.

Research Objectives

1. What is the class proficiency reflected in the students' pretest in Mathematics scores without using mathematical teaching strategies?

2. What is the class proficiency reflected in the students' posttest scores in Mathematics, utilizing mathematical teaching strategies?

3. Is there a significant difference between the class proficiency of the pretest and posttest scores reflected in the students in Mathematics utilizing Mathematics teaching strategies?

METHODOLOGY

A quasi-experimental approach was adopted in the collection of data for the study. The quasi-experimental design was first proposed by Donald T. Campbell in 1963 to extend the use of experiments to social science research. The research design was one group pre-test post-test, in which pretests were administered at the outset and post-tests at the conclusion of every time slot of interest (Beriong,& Ibojo (2023). These data were obtained from the pre- and post-test results collected for each of the topics discussed during the experimental time frame.

In this study, all participants were given the same set of different teaching strategies as intervention: direct Instruction, inquiry-based learning, collaborative learning and technology integration. This design was appropriate when randomization was unethical or impractical and it allowed the researcher to assess the effectiveness of integrating specific teaching strategies by comparing pre- and post-intervention on students' academic performance.

Population and Sample

The study's respondents were the selected Grade 11 students from San Miguel National High School in San Miguel, Compostela, Davao De Oro. The study included Grade 11 students from San Miguel National High School in San Miguel, Compostela, Davao De Oro, who were enrolled during the study's academic year. The selection of participants prioritized diversity, such as gender, socioeconomic background, and academic standing. Participants must regularly attend their Mathematics classes and actively engage in classroom activities and assessments. This is to assess the impact of different Mathematics teaching strategies on academic performance. The inclusion of students in the study was contingent upon obtaining informed consent, either directly from the students themselves or their guardians in the case of minors, to uphold ethical standards.

Respondents were selected using a convenience sampling technique, which is a non-probability method that selects participants based on their willingness to engage in the study, ease of accessibility, and closeness. This involves selecting samples that are easily accessible to the researcher, such as individuals from a specific location, organization, or group.

Statistical Tool

The following statistical tools were utilized for data analysis and interpretation.

Mean. This statistical tool was used to determine the levels of competency (based on the scores) of the students in each group in terms of reading comprehension and problem-solving ability.

T-Test. This statistical tool was employed to determine whether there exists a significant difference between the pre-test and post-test scores of the students in both groups; before and after administering the comprehension-oriented learning strategies as intervention in the experimental group; and between post-test scores of the two groups.

Paired T-Test. This statistical tool was utilized in computing the t-value of the pre- and post-test of each group to find whether there is a significant difference between the subjects' scores.

RESULTS

Competency Level on Students' Pretest-test Scores before the implementation of Mathematics Teaching Strategies

Table 1. Pre-test Competency Level before the implementation of Mathematics teaching strategies

Pre-test	No. of Students	Mean	Class Proficiency	Competency level
Group	64	19.38	79.38%	Fairly Satisfactory

Table 1 showed the competency levels based on the pre-test scores of the group before the implementation of the mathematics teaching strategies. The data indicated that out of 64 students, the group scored a mean of 19.38 in a 40-item standardized test in Mathematics with a class proficiency of 79.38%. The group's performance on the pre-test was above the minimum proficiency level, it still reflected room for improvement on mastery of mathematical concepts before the intervention, as a proficiency level 79.38% is usually classified as "Fairly Satisfactory" based on the Department of Education's grading guidelines.

Competency Level on Students' Post-test Scores after the Implementation of Mathematics Teaching Strategies

Table 2. Post-test Competency Level after the implementation of Mathematics teaching strategies

Post-test	No. of Students	Mean	Class Proficiency	Competency level
Group	64	26.16	86.16%	Very Satisfactory

Presented in Table 2 are the competency levels on the post-test scores of the group taught after the intervention. The data shows that out of 64 students, the group scored a mean of 26.16 in a 40-item standardized test in Mathematics with a class proficiency of 86.16%. This implied that students demonstrated significant improvement and developed mastery of the mathematical concepts discussed in the assessment after the intervention. Since the competency level is "Very Satisfactory" on the outlined proficiency scale.

Pre-test and Post-test Scores of the Group

Table 3. Significant Difference between the Pre-test and Post-test Scores of the Group

Experimental	Mean	p-value	Remarks
Pre-test	19.38	0.000	Significant
Post-test	26.16		

Table 3 elaborates on the significant difference between the pre-test and post-test scores of the group. During the pre-test, the group scored 19.38 on a 40-item test, while during the conduct of the post-test, the group got a mean score of 26.16. After applying a paired t-test on the data, the probability between both tests was found to be 0.000, which means it is lower than the set p-value and remarks that there is a significant difference between the pre-test and post-test scores of the group. Suggesting that the use of Mathematics teaching strategies contributed positively to the academic performance of the students in the group.

DISCUSSIONS

Competency Level of the Pre-test Scores Before the Implementation of Mathematical Teaching Strategies

This result correlates with recent evidence highlighting prolonged underachievement in Mathematics in students before evidence-based interventions. According to Xie et al. (2020), the poor academic performance of students in Mathematics is a result of typical teaching methods which do not appeal to students nor develop the minds of students. Similarly, Zheng et al. (2020) highlighted that the students in the Philippines tend to have poor performance in Mathematics, attributed to students' lack of interest, less application of different strategies, and rigid delivery of the curriculum. The low mean score and percentage confirm the assertion by Velez and Abuzo (2024), who reported that learners perform poorly when teaching-learning approaches do not fit their cognitive tendencies. Additionally, Wang et al. (2020) insisted that it is only when instruction meets the foundational gaps through multiple ways that math learning can be successful. This pretest data reinforces the fact that it is crucial for innovative pedagogical strategies to be incorporated into Mathematics instruction to help address learning deficiencies.

Competency Level of the Post-test Scores After the Implementation of Mathematical Teaching Strategies

The finding shows a significant rise in post-test scores when different math teaching methods were used. The students' math competence scores on the DepEd grading system went from "Fairly Satisfactory" to "Fairly Satisfactory." This rise is in line with what Ugwuanyi et al. (2020) found, which was that educational interventions can greatly improve students' academic paths, even if they don't instantly reach mastery levels. Vu et al. (2022) found that students who were taught using a variety of methods, like inquiry-based and collaborative

approaches, did better on post-assessments. Even if it is still in the "Did Not Meet Expectation" group, the progress shows what Süren and Kandemir (2020) called "incremental academic recovery" in groups that have trouble learning. Rodriguez et al. (2020) also showed that even little changes in test scores after an intervention are important, especially in communities that don't get enough help, because they show that people are more engaged and their brains are working better.

Significant Difference Between Pre-test and Post-test Scores of the Experimental Group

The rise in scores from the pre-test to the post-test is statistically significant. This result confirms the effectiveness of the instructional methods that were used. The substantial difference reflects the conclusions of Cayubit (2022), who highlighted that blended and differentiated education results in considerable improvements in performance. Awofala and Lawani (2020) also said that using evidence-based teaching methods consistently has a positive effect on how well students learn. BK and Hamna (2021) say that using a mix of different strategies meets different learning demands, which makes interventions more effective than just using standard methods. A recent meta-analysis conducted by Datu and Yang (2021) found that multimodal instruction in Mathematics leads to statistically significant enhancements in learners' assessment outcomes across various educational settings. The performance of the experimental group supports the conventional belief that integrated and responsive teaching methodologies produce quantifiable academic improvements.

CONCLUSION

Based on the findings of this study, before any teaching tactics were put into place, the first test of the experimental group showed that they were not very good at math. This indicates that the students had trouble understanding important ideas with just standard teaching methods, showing that there is a clear need for better and more interesting ways to teach arithmetic to enhance student outcomes.

After using different ways to teach math, the students' skills improved a lot. Even though they didn't reach the desired level, the progress shows that the tactics helped students learn and engage with the material better, which means they could help children grow academically. The comparison of performance before and after the implementation of teaching strategies showed a substantial enhancement, validating the efficacy of the interventions. This confirms that deliberate, student-centered methods can help students get better at mathematics.

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