Enhancing the Level of Mastery of Grade 9 Learners in Parallelogram Competencies through Quadrigami as a Manipulative Material

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ABSTRACT

Quadrigami is devised to abbreviate the words Quadrilaterals and Origami. A commonly accepted method within the study of Geometry is through the instruction of Origami, the art of paper folding. This study aimed to determine the effectiveness of Quadrigami as a manipulative material in enhancing the level of mastery of Grade 9 learners of Don Eulogio de Guzman Memorial National High School for school year 2022-2023 in learning competencies in parallelograms. This study used a quasi-experimental particularly the one-group pretest-posttest design and qualitative research technique particularly the semi – structured interview. Twenty (20) high school learners from Grade 9-Corinthians class of DEGMNHS were taken as participants in this study. Results imply that quadrigami as a manipulative material significantly increase the level of mastery of the students. Most of the students in the study had a positive attitude and thoughts about quadrigami. This denotes that the quadrigami through the use of paper folding is an effective tool capable of strengthening students' mathematical abilities.

Keywords: Level of Mastery, Manipulative Material, Quadrigami

INTRODUCTION

One of the biggest issues and challenges for math teachers has been the quality of math instruction and learning (Goos, et. al, 2020). It is possible to solve issues with the effectiveness of teaching and learning mathematics through the use of instructional design. Making the greatest design choices necessitates having a thorough understanding of the variables influencing mathematics proficiency. The three most significant elements that were to be considered while making design decisions were instructional strategies and methodologies, teacher competency in mathematics education, and motivation or concentration (Rahman, 2021).

The Department of Education has implemented the K to 12 Basic Education Program in the Philippines since the school year 2012-2013. The program's updated mathematics curriculum introduces new approaches to teaching mathematics. This curriculum aims to foster students' critical thinking and problem-solving skills, necessitating the implementation of inclusive teaching strategies that align with a challenging curriculum, a clearly outlined set of advanced thinking skills, and a learning process that involves the use of suitable tools.

Geometry, as a component within the realm of mathematics, encompasses various aspects such as the characteristics of two- and three-dimensional shapes and their interconnections, the ability to mentally visualize spatial figures, the capacity for reasoning and constructing geometric models, and establishing proofs for theorems, axioms, and postulates, among other components (Gagatsis, 2021). In the Geometry content standards for Grade 9, students are expected to exhibit a grasp of fundamental concepts related to quadrilaterals, including parallelograms, trapezoids, and kites. Teaching and engaging students in these subjects often necessitates conveying abstract ideas. Given the inherently abstract nature of geometry, attaining a profound understanding requires the adept transition of classroom activities, tailoring them to each student's comprehension level. The use of suitable instructional tools is imperative in the teaching of mathematics, including the utilization of manipulative objects (Ramirez, 2020).

According to the Department of Education's plan, students will receive ample instructional time for subject-

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related tasks, ensuring their better readiness in all academic areas. Under the previous system, Filipino students consistently lagged behind in terms of achievement scores. To illustrate, in the Southeast Asia Primary Learning Metrics 2019, only 17 percent of Grade 5 Filipino students met the minimum standards in Mathematics. In the 2019 Trends in International Mathematics and Science Study (TIMSS), the Philippines also found itself at the bottom in both Mathematics and Science among 58 countries. Furthermore, based on the 2022 Programme for International Student Assessment (PISA), Filipino learners remained among the world's weakest in Mathematics and Science compared to students from 81 other countries

Academic performance in mathematics is positively associated not only with cognitive abilities, but also with emotional and motivational skills (Abin, et.al, 2020). To ensure the effectiveness of every instructional approach, it's imperative that teachers possess knowledge about the various levels of learning. This understanding equips them to devise teaching strategies tailored to foster the growth of these skills. (Bautista & Valtoribio, 2016).

Piaget's theory has proven that the use of concrete objects is very important to develop the concept of a skill or topic. With the establishment of the concept of the concrete material form the beginning was an opportunity to every child to enjoy the beauty of mathematics itself. Systematic management of concrete materials have shown the importance and effectiveness in the teaching and learning of mathematics (Othaman, et. al, 2017).

According to Bungao-Abarquez (2020), concrete manipulatives can increase the relevance of mathematical material for students. Rather than immediately tackling an abstract concept, employing hands-on engagement with tangible manipulatives provides a level starting point for students of all mathematical abilities when commencing instruction. Accessibility for students is of utmost importance: students must be able to connect and engage with the mathematical concepts through direct and hands-on participation

For these reasons, the researcher found a way to help the students using concrete manipulatives by means of applying paper folding activities as a means of class instructions. Therefore, to make this a reality, the researcher resolved to conduct an action research on how effective Quadrigami as a manipulative material in teaching parallelograms to enhance the mastery level of Grade 9 students in Mathematics.

Research Questions

This study aimed to determine the effectiveness of Quadrigami as a manipulative material in enhancing the level of mastery of Grade 9 learners of Don Eulogio de Guzman Memorial National High School for school year 2022-2023 in learning competencies in parallelograms.

Specifically, the study sought to answer the following questions:

1. What is the level of mastery of the learners in the learning competencies of parallelograms before and after the intervention?

2. Is there a significant difference in the level of mastery of the learners in the learning competencies of parallelograms during the pretest and posttest?

3. How does the Quadrigami as a manipulative material enhanced level of mastery of the learners in the learning competencies of parallelograms as perceived by the participants?

METHODOLOGY

Research Design

This study used a quasi-experimental particularly the one-group pretest-posttest design. The one-group pretest-posttest design is a type of quasi-experiment in which the outcome of interest is measured 2 times: once before and once after exposing a non-random group of participants to a certain intervention/treatment (Alvarez, et. al, 2022).

Furthermore, the study also used the unstructured interview to gather data. An unstructured interview is a data

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collection method that relies on asking participants questions to collect data on a topic. Also known as non-directive interviewing, unstructured interviews do not have a set pattern and questions are not arranged in advance. In research, unstructured interviews are usually qualitative in nature, and can be very helpful for social science or humanities research focusing on personal experiences (Monday, 2020).

Participants

Twenty (20) high school learners from Grade 9-Corinthians class of Don Eulogio de Guzman Memorial National High School SY 2022 – 2023 were taken as participants in this study. The researcher determined the participants by their grade in Mathematics (third quarter) during their Grade 8 with fair (75-79) and satisfactory (80-84) grade.

Intervention

Quadrigami is devised to abbreviate the words Quadrilaterals and Origami. Within the study of Geometry in high school is the natural development of spatial ability. A widely embraced approach involves teaching Origami, the craft of folding paper. Development of such skills is through hands-on experience. Origami offers many opportunities. While the earliest origami artifacts have been discovered in ancient China, with its strongest historical ties residing in ancient Japan, origami can also have a meaningful influence in modern education.

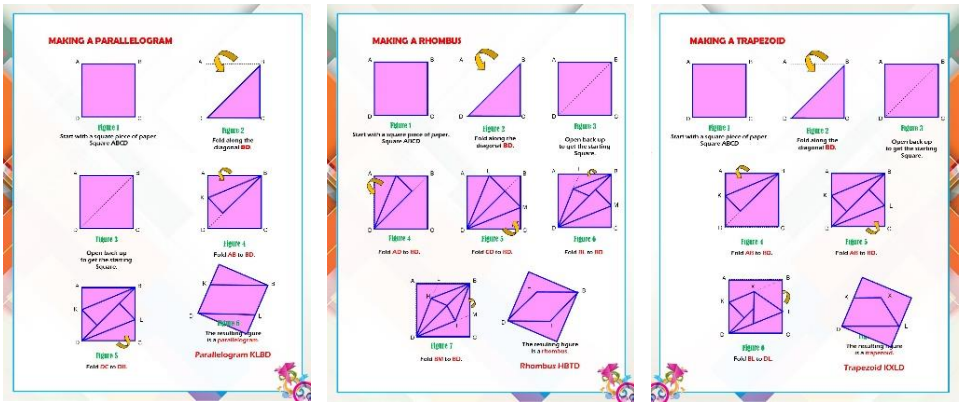

Fig. 1. Quadrigami as a Manipulative Material

Figure 1 presents the quadrigami as a manipulative material. The researcher formed the term “quadrigami” as a manipulative material used as an instructional strategy. The material had been helpful to supplement demonstrations with directions and diagrams. The inclusion of paper-folding activities in mathematics can offer an appealing and creative means of addressing some of the goals for teaching and learning mathematics; namely: engaging students effectively in mathematical modelling, visualizing, algebraic thinking and problem-solving. The researcher strongly believed that Mathematics is not limited to learning from textbook, lessons, or testing strategy. Given the diversity in students' learning styles, it is essential to provide lessons that enhance various learning approaches in order to achieve optimal results.

Instrumentation and Data Collection

The conduct of this study had gone through four (4) key stages.

Stage 1: Development and Validation of Quadrigami. The instructional aid had developed by the researcher based on the learning competencies involving parallelograms (learning competency 1: determine the conditions that make a quadrilateral a parallelogram; and learning competency 2: use properties to find measures of angles, sides and other quantities involving parallelogram). Before writing the learning material, the researcher examined the learning competencies in third quarter Grade 9 Mathematics specifically quadrilaterals (parallelograms). Topics on different learning competencies had been outlined. The researcher will gather information from various learning sources material. A draft had made and presented to experts for more input. Five (5) expert evaluators in the field of Mathematics validated the manipulative material as to face validity, content validity and usability.

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Stage 2: Administration of Pre-test. The researcher administered the pre-test before the conduct of experiment and prior to the start of the learning competencies involving parallelogram. The researcher adopted the 15 – item pre-test on the Self-Learning Module (SLM), Mathematics Quarter 3 – Week 1 – Module 1: Properties and Measures of Parallelogram authored by Mary Ann B. Leonen and edited by SDO La Union, Learning Resource Quality Assurance Team.

Stage 3: Employment of the Intervention. Each day, the participants of the study received 50 minutes of instruction with their classroom teacher, the researcher. These group of learners had utilized techniques using paper folding activities.

Stage 4: Administration of Post-test. The researcher will administer the post-test instrument after covering all the learning competencies included in the study. The valid and reliable 15 – item post-test was taken also in the self-learning module.

The actual exposure of the intervention of the participants was completed with the following allotment of days.

Day 1 : Administration of Pre-test

Day 2 - 5 : Employment of the Intervention (Learning Competency 1)

Day 6 – 9 : Employment of the Intervention (Learning Competency 2)

Day 10 : Administration of Post-test

Data Analysis

MS Excel was used to analyze the data. Mean was used to determine the level of validity of the quadrigami as a manipulative material. Percentage score was used to determine the level of mastery of the participants in the pre – test and post – test.

Furthermore, to determine the effectiveness of the intervention, the researcher used the t – test for the comparison of the performance of the participants in the pre – test and post – test.

To address the third question, the researcher used unstructured interviews to determine how the Quadrigami enhanced the level of mastery of the learners in the learning competencies of quadrilaterals as perceived by the participants.

RESULTS

Level of Mastery of the Learners in the Learning Competencies of Parallelograms

Table 1 shows the mastery level of the participants in the pre-test and post-test in the learning competencies of parallelograms.

Table 1. The Pre-test – Post-test Results of the Participants

Participants	Pre-test	Post-test
1	4 (Low Mastery)	10 (Moving Towards Mastery)
2	3 (Low Mastery)	11 (Moving Towards Mastery)
3	5 (Low Mastery)	13 (Closely Approximating Mastery)
4	3 (Low Mastery)	12 (Moving Towards Mastery)
5	5 (Low Mastery)	10 (Moving Towards Mastery)

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6	5 (Low Mastery)	9 (Moving Towards Mastery)
7	6 (Average)	11 (Moving Towards Mastery)
8	3 (Low Mastery)	12 (Moving Towards Mastery)
9	4 (Low Mastery)	9 (Moving Towards Mastery)
10	6 (Average)	10 (Moving Towards Mastery)
11	4 (Low Mastery)	8 (Moving Towards Mastery)
12	5 (Low Mastery)	13 (Closely Approximating Mastery)
13	3 (Low Mastery)	10 (Moving Towards Mastery)
14	5 (Low Mastery)	10 (Moving Towards Mastery)
15	4 (Low Mastery)	8 (Moving Towards Mastery)
16	1 (Low Mastery)	9 (Moving Towards Mastery)
17	4 (Low Mastery)	10 (Moving Towards Mastery)
18	4 (Low Mastery)	12 (Moving Towards Mastery)
19	5 (Low Mastery)	11 (Moving Towards Mastery)
20	5 (Low Mastery)	13 (Closely Approximating Mastery)
Mean	4.20	10.55
% of Mastery	28.00% (Low Mastery)	70.33% (Moving Towards Mastery)
Standard Deviation	1.17	1.53
t-stat	|-10.87608|	
P (T<=t) two tail	0.00000	
t Critical two tail	2.09302	
Remark	Significant	

Comparison of the Level of Mastery of the Learners in the Learning Competencies of Parallelograms

Table 1 also presents the comparison of the pre-test – post-test mastery level of the participants in the study. The table reveals that the learners improved their performance with 6.35 increased. It is evident that students 3 and 12 have highly improved their mastery level in the pre-test and post-test of an increase of 8 points. They both garnered a closely approximating mastery level in the post-test.

DISCUSSION

Level of Mastery of the Learners in the Learning Competencies of Parallelograms

The pre-test mean of the participants was 4.20 with a low mastery level. The low mean scores of the pre – test indicates that initially, students have less acquired information regarding the lessons. Although, there are some of the learning competencies in quadrilaterals were introduced in Grade 7.

The Department of Education (DepEd) implemented the K to 12 Program with spiral curriculum design. This design is simply understood as a curriculum in which students repeat the study of a subject at different grade levels, each time at a higher level of difficulty.

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Therefore, the low mastery level in the pre-test resulted to a low retention of the students. Furthermore, the spiral curriculum design can also develop in students' lesser adaptability and coping skills in discussion for higher and complicated learning.

It also reveals that the post-test of the participants was 10.55. A moving towards mastery level in the post-test revealed that the students learned noticeably with the teaching strategy used in the study. According to Piaget, children require concrete experiences to "lay the foundation for more advanced mathematical thinking" in their learning of mathematics. Manipulatives can assist pupils who already have the capacity for abstract thought in addition to helping them reach greater levels of cognitive development.

Comparison of the Level of Mastery of the Learners in the Learning Competencies of Parallelograms

Learning is enhanced and yield better mastery level of the participants in the study. This assumption can be interpreted that quadrigami has an impact in students' ability. In other words, this teaching strategy could be regarded as one of the appropriate instructional methods which can enhance the level of mastery of the students in the learning competencies in parallelograms.

According to Boaler (2022), students have the chance to learn concepts while they were actively involved in the process and see everything visually. This is in parallel with Dewey as seen as the proponent of learning by – doing rather than learning by passively receiving. The educational theorist John Dewey believed that "learning is active". He felt that students learn best through hands-on activities. Dewey supported the idea that all students have the capability to learn if provided the proper means such as hands-on activities; and origami is one of an examples.

Perception of Learners in Quadrigami as a Manipulative Material in Enhancing the Level of Mastery in the Learning Competencies in Parallelograms

Most of the students in the study had a positive attitude and thoughts about quadrigami instruction in geometry. Students found it interesting and enjoyable. According to them, they had a fascinating activity and challenging experience even they had some difficulties in folding some parts. This denotes that the quadrigami through the use of paper folding is an effective tool capable of strengthening students' mathematical abilities.

CONCLUSION

Quadrigami effectively integrates the art of paper folding into the study of Geometry to enhance learning. This demonstrate that using Quadrigami as a manipulative material significantly improved students' performance in Geometry, particularly in understanding parallelograms. The analysis also revealed a marked difference between pre-test and post-test scores, indicating substantial learning gains in the targeted competencies. Additionally, most students expressed positive attitudes towards Quadrigami, suggesting that this innovative approach not only aids in comprehension but also fosters a more engaging and enjoyable learning experience in Geometry.

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