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Research Paper

Effectiveness of Model Drawing Approach (MDA) in Enhancing the Problem-Solving Skills of Grade 9 Learners

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Abstract

The purpose of this study was to evaluate how effective a Drawing Model Approach was at improving the problem-solving skills of Grade 9 students of Palo Alto Integrated School. It; sought to answer if the said approach could enhance the skills of students, specifically in problem identification and solving. In; year 2018 National Achievement Test (NAT), result revealed that students' score compared to the previous year indicating only a Mean of 0.51 which can still be classified as "low mastery" level in the said examination (Albano, 2019). International test results in the Trends in International Math and Sciences Study (TIMSS), showed a gloomy poor performance of Filipino students in the said subject. Out of 45 countries who participated in the conference, the Philippines ranked at the lowest places- 41st in Math and 42nd in science, respectively (Torres, et al., 2020). Similarly; report of Programme for International Student Assessment (PISA) in 2018 coming from the website of Organization for Economic Co-operation and Development (OECD), showed the Filipino students left behind in terms of performance ranking in areas of Reading, Science and Math compares with its 79 counterparts' nations. In result, Sec. Briones promoted an immediate order to review the country's basic education curriculum to identify the root cause of the problem and what key areas of intervention must be placed accordingly (Luz, 2018). Utilizing quasi-experimental research design, the study involved a total of 25 pairs of students from the experimental and comparison group selected based on the result of the pre-test; from the population of 88 students in the two sections of Grade 9, namely Carnation and Hyacinth. Participants; were randomly assigned either to the experimental group or to the control. The; statistical tools used in this study were mean, standard deviation, independent t-test, and Cohen's d. Paired; t-test measured the significant difference between the pre-test; and post-test scores. The results of a pre- and post-test mean scores revealed a highly significant difference between the examined mean scores. The learners' post-test means scores performance, as well as the learners' pre-test and post-test mean scores performance, all indicated rejection of the null hypotheses. The group of participants who used the Drawing Model Approach also performed much better in terms of score than the control group. Using this approach, it develops student's critical and creative thinking skills enabling him to solve problem with ease and confidence.

Keywords *Model Drawing Approach, Visualization, Problem-solving skills, Effectiveness, Teaching Style*

INTRODUCTION

The vital importance of Mathematics in everyday life is beyond any doubt. It is notable to say that improvement and progress in all areas of scientific inquiry would be impossible. Hence; its competencies and principles, especially for students, should not be underestimated

According to Kitta (2014), mathematics is a branch of science that deals with reasoning and computation, which allows us to see the world in its relationships, describe phenomena, and make the invisible visible. In; other words, Math is not just only a subject to be taught in school just for

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academic purposes. Instead, its function and extent transcend from the four-wall classroom helping us in solving a complex problem in pushing the frontiers of knowledge (Michael, 2015).

Given this significance, learning and acquiring its fundamentals cannot be undermined and must be thoroughly mastered. Although; the importance of math in everyday life cannot be overstated, the majority of students struggle to acquire, comprehend, and even apply math theories and principles that are useful in everyday skill application. Many Filipino students consider Math to be not only a complicated subject but also one of their greatest weaknesses (Ganal & Guiab, 2014).

One of these inquiry-based learning techniques is the Model Drawing Approach (MDA). Other progressive countries highly value the Bar Model for converting mathematical ideas into a simple and visual explanation that learners can easily follow. As a result, the effectiveness of said approach to facilitating students' problem-solving skills was investigated in this paper.

LITERATURE REVIEW

Accordingly, although students excel in knowledge-based instructions, nevertheless, they fail considerably in higher and critical analysis skills required for Mathematical operations. In; the study conducted by Aguinaldo (2001), Ayap (2007), Balbosa (2010), and Valdez (2016), wherein the performance of students in Math for the previous years has been disturbingly consistently low, whether in national, international or even in local achievements level. This; confirmed by a study by Alcantara and Bacsa (2017), which illustrates that mastering problem-solving abilities is difficult because it entails a variety of skills and competencies that consider for higher-order reasoning.

At the start of the pandemic, teachers' instructional strategies were also redefined to meet the needs of the students. Teaching math in the new normal requires a variety of strategies to keep students motivated and interested in the subject. Since; the havoc caused by the pandemic affected all aspects of the learner, the pedagogical styles of the teachers must still essentially enhance the learner’s weaknesses in problem-solving, primarily if manifested dilemma exists previously in the traditional face-to-face approach. Hence, distance or remote learning posed a challenge yet a promising avenue for learning to revisit its applicability and effectivity, particularly in learner’s engagement and participation in given tasks. According; to Kalogeropoulos et al. (2021), teachers in the new normal faced several challenges such as the struggle to maintain the students’ motivation, loss of identity, and stress-related concerns resulting in burnout, and limited resources from the various social and economic backgrounds. Hence; with the correct approach will eventually eradicate challenges in the teaching-learning process.

Some of the pedagogical styles employed by teachers in the new normal utilized include educational games, manipulation tools, and an inquiry-based approaches. According to Ekonesi and Ekwueme (2011), educational games are a very effective way to remove any negative attitude among students by introducing math concepts in a fun and interactive way. Meantime; for manipulative tools involve the use of objects that can be discovered in any household, such as a chairs, fruit, balls, and like, which learners can directly manage to express basic operational skills including addition and subtraction.

Finally, inquiry-based learning entails contextualizing math abstract concepts into practical reasoning through authentic real-life situations in which learners gain significant learning experiences through exploration, observation, and manipulation with the goal of resolving any uncomfortable situations (Kalogeropoulos, et al., 2021).

RESEARCH METHOD

The study employed the quasi-experimental research design that allows the use of intervention to predict future outcomes of the study. Quasi-experimental research attempts to establish a cause-and-effect relationship between variables using a quantitative approach, with methods emphasizing objective measurements and statistical, mathematical, or numerical analysis of data collected through the use of questionnaires using computational techniques (Chiang, 2015). Specifically; it utilized the pre-test, post-test non-equivalent; control group design. There is a treatment group in the pre-test, post-test non-equivalent groups design that is given a pre-test, a treatment, and then a post-test. However; there is a non-equivalent control group that receives a pre-test, does not undergo treatment, and then obtains a post-test.

In the current study, two groups were the participants of the study. One group has experimental with MDA intervention, while the other has a traditional teaching style of discussion. A; total of 25 pairs of students from the practical and comparison group were selected based on the result of the pre-test from the population of 88 students in the two sections of Grade 9 level of Palo Alto Integrated School, namely Carnation and Hyacinth. Participants; were randomly assigned to either the experimental group, section Carnation, which utilizes the MDA, or the control group, section Hyacinth, which uses the modular approach.

The researcher used five instruments to guide data processing, including a pre-test, post-test, formative test, portfolio, classroom observation checklist, and lesson exemplar. By doing a pre-test; the need was determined to establish the foundation of the study and serve as guiding principles on the areas to be measured and improved.

This formative assessment is integrated in a particular part of the Lesson Plan and serves to determine whether or not the students have acquired problem-solving skills. A portfolio, according to Hyland (2003), these are a compilation of a student's written work over time and is carefully selected from various genres of topics and lessons that serve as the best representation of students' progress, improvements, and areas that need immediate attention from the teacher. It;is the collection of students' written work for two (2) weeks to obtain an accurate picture of students' progress and performance in writing in a natural and non-threatening environment.

The researcher adopted an observation Checklist standard from the Department of Education to constantly check and monitor the lesson's progress for the entire duration of the study. To ensure the smooth delivery of instructions, Math teachers have followed the Lesson Exemplar, especially on the study duration, which covered two weeks.

All instruments were affirmed by subject-matter experts with the skills and competencies to teach mathematics at the Junior High School level. The; researcher's thesis adviser checked the construct of the question items to ensure that it was free from grammatical flaws, which could lead the respondents to interpretations different from what was originally intended. The Master Teacher, Head Teacher, or Principal validated the question items to ensure that these would generate responses that are relevant, essential, and useful in developing conclusions and recommendations. They; were tapped not only for their knowledge and competencies in teaching, but also for their recognition of the level of students enrolled in Palo Alto Integrated School based on data reflected on the LESF (Learner's Enrolment Survey Form). Suggestions and feedback were carefully considered and incorporated into the instruments.

Mean and standard deviation were used to calculate the mean scores of student participants in formative, pre-test, and post-test assessments. An independent t-test was used to determine whether there was a significant difference between the two groups' formative tests. Similarly; dependent t-tests were utilized to determine the important difference between the pre-test and post-test; of each group. In case the test of difference showed significance, Cohen's d was employed to measure the effect size.

FINDINGS AND DISCUSSION

This table shows the mean scores of the experimental and comparison groups on their formative tests.

As gleaned on Table 4, reveals how each group performed in the formative test. For the experimental group achieved a (M = 3.32, SD=3.41), which is interpreted as proficient. In contrast, the comparison group, it attained a developing result of a (M = 31.08, SD=4.30). These findings indicate that drawing model approach, when integrated into all lessons, significantly improved the formative scores of the experimental group that received this treatment.

Table 5 presents the mean scores of experimental and comparison groups on their post-test.

Table 5. Posttest Mean Scores of Experimental and Comparison Groups

Group (n=25)	Mean	SD	DI
Experimental	21.88	6.14	P
Comparison	16.12	4.20	B

Legend: 22.38- 25.00 or 90-100% Advanced (A); 21.00-22.37 or 85-89% Proficient (P); 19.87 -20.99 or 80-84% Approaching Proficiency (AP) 18.62-19.86 or 75-79% Developing (D); and 18.61 or 74% & below Beginning (B)

Table 1 reflects the result of post-test; mean scores in which the experimental group attained a (M = 21.88, SD = 6.14) which is interpreted as Proficient, while the comparison group only indicates a (M = 16.12, SD = 4.20), which is classified only as a beginning. It can be inferred that the drawing model approach is not only effective in student comprehension in identifying the concept of basic problem techniques, but also allows the teacher to directly connect to the learners' mental and affective domains, gaining more advantages on their academic performance in terms of their Math subject scores. According to Liu and Soo (2014), the model drawing approach teaches and reinforces principles of multiplicative thought and proportional reasoning that many struggling mathematics students do not understand.

The result further strengthens other related studies of Osman, et al. (2018), Thiyagu (2013), & Himawan & Wilujeng (2020), which indicated that Model Drawing approach guides the students to attain the explicit knowledge, understanding, and application of the stated learning competencies, thus eventually improved their mathematical skills in the areas of problem comprehension, devising a plan, carrying out the plan, and looking for alternative choices.

Table 6 presents the test of significant difference between the formative test mean scores of the two groups.

Table 6. Test of Significant Difference between the formative test mean scores of the two groups

Test	Group	Mean	Mean Difference	t-value	Cohen's d
Formative	Experimental Comparison	33.32 31.08	2.24	2.115*	.657 (Medium)

*df = 48; *Significant at .05 level; Cohen's d: 0.20 (Small); 0.50 (Medium); 0.80 (Large)*

The results in Table 6 show that there is a highly significant difference between the formative mean scores of the participants in this study, with the Experimental group achieving a mean rating of 33.32 and its Comparison group counterpart achieving a mean rating of 31.08, resulting in a [t (48) = 2.115, Mean Difference = 2.24, p-value < 0.05]. The outcome simply indicated that the null hypotheses were rejected and the alternative hypotheses were accepted.

This implies that drawing model approach not only helped the experimental group improve their academic scores across the board, but it also significantly improved students' visualization, creativity, and analytical thinking skills. As a result, it assists students in transitioning from concrete manipulative work with word problems to the theoretical phase of creating an equation to solve conceptual problems (Jackson, 2010). Because the students are given enough visual examples of how to solve a problem, all of the lessons allow teachers and students to explore the benefits of drawing model approach through scaffolding.

Table 7 presents the test of significant difference between the post-test mean scores of experimental and comparison groups.

Table 7. Test of Significant Difference between the Posttest Mean Scores of Experimental and Comparison Groups

Group	Mean	Mean Difference	Df	t-value	Cohen's D	Effect size
Experimental	21.88					
Comparison	16.12	5.76	48	5.175**	1.10	Large

Legend: df = Degrees of Freedom
***Highly Significant at .01 level*

Table 7 shows a highly significant difference between the performance of the experimental group and the comparison group with a [t (48) = 5.175, p-value < 0.01], indicating that the null hypothesis stating that there is no significant difference between the post-test mean scores of the two groups was rejected.

The research results support the findings of Osman et al. (2018), who found that using the Drawing Model Approach or Visualization in the experimental group helps students grasp the coverage of the topic better than using no intervention in the comparison group. In the four-lesson scope of the paper, the study found evidence that drawing model can significantly improve students' mathematical skills. After determining the highly significant difference between the computed mean differences of the control and experimental groups, it became clear that the latter, which was exposed to the model drawing, scored higher in Direct and Inverse Constant Variations.

Table 8 presents the test of significant difference between the pre-test and post-test mean scores of each group.

Table 8. Test of significant difference between the pretest and posttest mean scores of each group

Group	Test	Mean	Mean Difference	df	t-value	Cohen's d	Effect size
Experimental	Pretest	11.88	10.00	24	14.586**	1.75	Large
	Posttest	21.88					
Comparison	Pretest	11.88	4.24	24	4.997**	0.89	Large
	Posttest	16.12					

Cohen's d: 0.20 (Small); 0.50 (Medium); 0.80 (Large)
***Significant at .01 level*

According to the results in Table 8, there are highly significant differences between the post-test and pre-test mean scores of each group of participants. For the experimental group with [t (24) = 14.586, Mean Difference = 10, p-value < 0.01, Cohen's d = 1.75, large effect size] while comparison group with [t (24) = 4.997, Mean Difference = 4.24, Cohen's d = 0.89, large effect size], indicating that both groups improved their performance after the experimental process. The improvement of the comparison group could be attributed to several factors, including the students' condition, particularly their level of intelligence, given that their match pairing was done randomly, giving a chance that some superior students could be in the comparison group, or such parental support and assistance, which can be a basis for future research given the limitations of this study. The researcher carefully examined variables that might have a direct impact on the class during the conduct of the study, so this improvement cannot be directly attributed to the use of drawing model.

This also supported the research by Himawan & Wilujeng (2020) and Arcavi (2003), which found that MDA aids students in visualizing abstract mathematical concepts by allowing them to connect those concepts to their own senses of manipulation. Similar results revealed a highly significant difference between the performance of the experimental group and the comparison group with a t-value of 5.175 and a p-value less than 0.01 level of significance, indicating that the null hypothesis stating that there is no significant difference between the post-test mean scores of the two groups was rejected.

Finally, the results revealed that there are highly significant differences in each group of

participants' post-test and pre-test mean scores. The experimental group had a computed t-value of 14.586 with a Cohen's d of 1.75 and a large effect size, while the comparison group had a t-value of 4.997 and a Cohen's d of 0.89, both with p-values less than 0.01 level of significance, indicating that both groups improved their performance after the experimental process. However, the experimental group has a greater mean difference of 10.00 than the comparison group, which has a mean difference of 4.24

CONCLUSIONS

The overall mean rating for the formative test for the experimental group was 33.32 (SD=3.41), which is interpreted as Advanced, while the comparison group received a starting result of 31.08 (SD=4.30), indicating that the experimental group performed better than the comparison group. The; results also revealed that the experimental group that used the Model Drawing Approach received a mean rating of 21.88 (SD=6.14), which is classified as proficient, whereas the comparison group only received a mean rating of 16.12 (SD=4.20), which is classified as beginning. It; can be inferred that the drawing model is not only effective in student comprehension in identifying the concept of basic problem techniques, but also allows the teacher to directly connect to the learners' mental and affective domains, gaining more advantages on their academic performance in terms of their Math subject scores. Another intriguing finding was that there is a highly significant difference between the formative mean scores of the respondents in this study, with the Experimental group achieving a mean rating of 33.32 and the Comparison group achieving a mean rating of 31.08, resulting in a mean difference of 2.24 and a t-value of 2.115. The outcome simply indicated that the null hypotheses were rejected and the alternative hypotheses were accepted. This meant that MDA not only helped the experimental group improve their academic scores in the subject, but it also helped students improve their visualization, creativity, and analytical thinking skills

Since there is a highly significant difference between the mean scores that were tested, the null hypothesis that there is no significant difference between the formative test mean scores performance of the learners was rejected. The null hypothesis, which stated that there is no significant difference between the post-test mean scores of the learners, was also rejected because the results revealed a highly significant difference between the mean scores of the two groups of participants. The null hypothesis stating that there is no significant difference between the pre-test and post-test mean scores performance of each group of learners was also rejected because the results indicate a highly significant difference between the mean scores of each group before and after the implementation of this study. The results showed that both groups of participants used K-12 materials to help improve their mean score performance; however, the group of participants who used the Drawing Model Approach achieved significantly higher score performance than its counterpart group.

LIMITATION & FURTHER RESEARCH

Drawing Model Approach is highly recommended as a teaching approach in any given Math topic because it provides students with comprehensive knowledge, particularly in problem-solving skills. School administrators can help with training and reskilling seminars/webinars on how to use the drawing model effectively in any math topic where the teacher can easily apply the principles that cater to all learners' needs and interests. Math teachers are encouraged to localized the practical application with the inclusion of the lessons, especially with the least learned competencies where students find it challenging. Further study may be conducted on other relevant Math lessons since the paper delimits only competencies in Grade 9 under Direct and Inverse Constant Variation.

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