

Differentiated activities with physical modelling: An intervention to improve multiplication skills among Emerging grade two pupils of Pangil Elementary School

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Abstract

This research was conducted at Pangil Elementary School on School Year 2024-2025 to help improve the multiplication skills of grade two pupils through intervention program named Differentiated Activities with Physical Modelling. The respondents of the study composing of twenty-one (21) grade two pupils were identified using a purposive sampling technique. They were categorized as “Not Proficient” in task G of Rapid Mathematics Assessment which is Illustrating and Writing Multiplication as repeated addition, using a variety of concrete and pictorial models, and numerals. Using descriptive research method utilizing a one-group pre-test post-test as research instrument, this study found that the performance of grade 2 pupils in multiplying numbers before the intervention program is below desired level or “Not Proficient”. During the intervention program, they exhibited exemplary performance and were classified as “Highly Proficient” which indicated significant improvement. Their level of performance shifted from “Not Proficient” to “Nearly Proficient” after the intervention program. In a capsule, Differentiated Activities with Physical modelling can improve multiplication skills of grade two pupils and has practical effect in the task of multiplying numbers.

Keywords: differentiated activities, physical modelling, multiplication skills, intervention program, emerging learners

1. Context and Rationale

Differentiation describes the range of techniques that facilitators employ to better serve all needs of students in the classroom (Roiha & Polso, 2021). The facilitator's responsibilities are changing, and it's more important than ever to use pedagogies that effectively meet the requirements of all students by fostering an inclusive learning environment (Fountas & Pinnell, 2018). According to Pozas et al., (2020), and Sharp et al., (2020), differentiated education relates to addressing learners' various learning phases. That did increase students' capacity for improved academic performance. Differentiated instruction should be used in the mathematics classroom to accelerate student growth (Hackenberg et al., 2020). By applying this technique to the learning process, students can reach their goals in mathematics education on their terms. With differentiated instruction, students are allowed to learn subjects in a variety of ways, process ideas, and create products (Roiha & Polso, 2021). To account for the differences across learners, differentiated instruction can be. According to the learners' readiness, interests, and learning profiles, facilitators can differentiate the teaching through content, procedure, product, and environment research (Goddard et al., 2020).

In mathematics, there are four basic operations that students must master, namely addition, subtraction, multiplication, and division (Brumbaugh et al., 2020). Students must master these four operations from the

elementary school level. One operation that quite often causes problems for students is the multiplication operation (Tillema, 2020). The multiplication process involves multiplying two or more numbers to get the result (Kosko, 2019). During elementary school learning, students will hone their multiplication skills through exercises, problem-solving, and understanding basic mathematical concepts. Although multiplication is one of the basic concepts in mathematics taught in elementary schools, some students may experience some difficulties or misunderstandings in understanding it (Wong & Evans, 2020). Some common problems associated with multiplication in elementary schools are, as follows:

(1) Students may have difficulty understanding the concept that multiplication involves repeating a certain amount of one number (the multiplier) as many times as another number (the factor). This understanding can be key to understanding the significance of the multiplication operation (Lo et al., 2020).

(2) Calculation errors may occur due to a lack of focus or poor understanding of the concept of multiplication. These errors can occur in multiplying larger numbers or when students try to remember multiplication facts (Putri et al., 2023).

(3) Some students may face difficulties in applying the concept of multiplication in solving mathematical problems. This involves the ability to identify relevant information, formulate equations, and calculate multiplication results (Ilukena et al., 2020). This problem is also in line with the findings of a preliminary study conducted by researchers at Kepuhan, Bantul Public Elementary School, Yogyakarta. Based on the results of interviews with second-grade teachers, it was found that the multiplication problem experienced by students was students' difficulty in interpreting multiplication as repeated addition. Apart from that, teachers also experience misconceptions about the concept of multiplication, because they cannot differentiate between the multiplication operations " 3×4 " and " 4×3 ". The teacher considers the multiplication operation " 3×4 " to be " $3+3+3+3$ " even though the correct concept is " $4+4+4$ ". Responding to problems found in the field, researchers assume that to improve the multiplication learning outcomes of second-grade students to use hands-on activity media that can be operated directly by students. Hands-on activity media, or direct practice activities, is a learning approach that actively involves students in physical or interactive activities to understand certain concepts (Kanastren et al., 2023).

The result of Grade Two Rapid Math Assessment (RMA) revealed many weaknesses in understanding multiplication. Even if pupils are intensively trained with illustrating and writing multiplication as repeated addition, using a variety of concrete and pictorial models, and numerals, the percentage of correct responses for illustrating and writing multiplication remained low.

The researcher found out from the pre-test result of Grade Two Rapid Math Assessment (RMA) for School Year 2024-2025, out of 157 pupils there are 21 pupils fall under for emerging category or not proficient in Mathematics who obtained 0.4 percentage score in illustrating and writing multiplication as repeated addition, using a variety of concrete and pictorial models, and numerals which is also the least learned competency among the skills measured in Rapid Math Assessment. It is with this situation the author would like to contribute help in assisting pupils how they will be able to treat this competency as a challenge on their part. Pupils might benefit from an intervention based on differentiated mathematics instruction with physical modelling that intends to develop their skills in multiplication.

Differentiated Activities with Physical Modelling aimed to improve the skills of grade 2 pupils in illustrating and writing multiplication as repeated addition, using a variety of concrete and pictorial models, and numerals and decrease the number of pupils who fall under emerging category or not proficient from 21 to 5 or 14.01 percent to 3.18% and attain the 75% improvement of pupils who will undergo the intervention

program

This action research measured the effectiveness of the implementation of Differentiated Activities with Physical Modelling on improving the multiplication skills of Grade 2 pupils in Pangil Elementary School for School Year 2024-2025.

2. Proposed Innovation, Intervention, or Strategy

This study helped pupils in becoming familiar with illustrating and writing multiplication as repeated addition through intervention program named Differentiated Activities with Physical Modelling. The planned solution was done per week. On the first week, the teacher shown real objects preferably localized which are familiar to pupils like banana. She asked how many banana are there in 1st group and in 2nd group? Pupils gave answer until they found out the given multiplication sentence and answer. Second week was an activity where in teacher called pupils in MIC (Multiplication is Cool) Frame and act out the given multiplication sentence which will be voiced out by the teacher and call another pupil from the audience to answer the given multiplication sentence. Third week was an activity to enhance learners' skill in literacy, the teacher conducted spelling activity where in learners write spelling of given multiplication sentence then gave their answer in words. On the fourth week, teacher grouped pupils into 5 then they collaboratively answer the multiplication sentence written on window card. On the second month of the intervention program, pupils answered the multiplication sentence written on window card individually. Their speed and accuracy was developed as they only have 20 minutes to answer their activity. Problem Solving Involving Multiplication was their activity on the third month of intervention. Pupils acted out in a role playing situation the given problem then follow the steps in answering problem solving.

Pupils' performance was recorded per learning session. Differentiated activities with physical modelling was conducted every day one hour after class in the afternoon at Grade 2-luntian classroom. The resources needed was 2 reams of A4 bond paper and one set of t664 epon ink for printing of learner's activity sheets.

3. Action Research Questions

1. What is the level of performance of grade two pupils before the implementation of Differentiated Activities with Physical Modelling: An Intervention to Improve Multiplication Skills among Grade Two Pupils of Pangil Elementary School?
2. What is the level of performance of grade two pupils during the implementation of Differentiated Activities with Physical Modelling: An Intervention to Improve Multiplication Skills among Grade Two Pupils of Pangil Elementary School?
3. What is the level of performance of grade two pupils after the implementation of Differentiated Activities with Physical Modelling: An Intervention to Improve Multiplication Skills among Grade Two Pupils of Pangil Elementary School?
4. Is there a significant difference between the pre-test and post test scores of grade two pupils of Pangil Elementary School?
5. What is the magnitude of the effect of the intervention program on multiplication skills as indicated by Cohen's d?

Hypotheses

1. There is no statistically significant difference between the pre-test and post test scores in the task of multiplying numbers of grade two pupils after the implementation of the intervention program.
2. The intervention has no practical effect in the task of multiplying numbers. In terms of the effect size, this means Cohen's $d = 0$ (i.e. any observed difference is negligible).

4. Action Research Methods

A. Participants and/or other Sources of Data and Information

The subject of this action research were 21 grade two pupils in Pangil Elementary School who fall under emerging or not proficient category for S.Y. 2024-2025. This is based on the Pre-Test result of Rapid Math Assessment (RMA).

B. Data Gathering Methods

At the onset of data collection, the researcher asked permission to conduct the research. After the approval, the researcher started to conduct the research with the permission of the school head. The researcher oriented learner respondents with their corresponding parents. The researcher gathered the result of Rapid Math Assessment (RMA) to determine grade 2 pupils who fall under emerging or not proficient category. On the first week, the teacher shown real objects preferably localized which are familiar to pupils like banana. She asked how many banana are there in 1st group and in 2nd group? Pupils gave answer until they found out the given multiplication sentence and answer. Second week was an activity where in teacher called pupils in MIC (Multiplication is Cool) Frame and act out the given multiplication sentence which will be voiced out by the teacher and call another pupil from the audience to answer the given multiplication sentence. Third week was an activity to enhance learners' skill in literacy, the teacher conducted spelling activity where in learners write spelling of given multiplication sentence then gave their answer in words. On the fourth week, teacher grouped pupils into 5 then they collaboratively answer the multiplication sentence written on window card. On the second month of the intervention program, pupils answered the multiplication sentence written on window card individually. Their speed and accuracy was developed as they only have 20 minutes to answer their activity. Problem Solving Involving Multiplication was their activity on the third month of intervention. Pupils acted out in a role playing situation the given problem then follow the steps in answering problem solving. Pupils' performance was recorded per learning session. To determine the improvement of learners in the intervention program, the researcher conducted Post Test.

After data gathering, the results of the pre-test, intervention assessment and post-test, was analyzed using appropriate statistical tools. Both descriptive (mean, standard deviation, frequency distribution) and inferential statistics (paired-t-test, Cohen's d) are used to determine the effect of the intervention program.

A copy of research instrument which was a 5-item test per week was submitted to school research committee for validation and pilot-testing prior to actual administration. The result of pilot testing shown that week 5, 9, 10, 13 and 14 have lowest mean percentage score of 71% which was below the desired 75% mastery level for specific skill.

C. Data Analysis Plan

Quantitative research design was utilized in this study. This study employs a one-group pre-test post-test design within an action research framework. The study utilized purposive sampling. The data were analyzed and interpreted and reported using two (2) score range: 5-item tests (Pre-test and Post test) and 5-item tests (per-test).

Score Range for 5-item tests

(Reference: DepEd Rapid Mathematics Assessment and <https://www.researchgate.net/post/Which-method-should-I-use-to-present-the-Mean-of-a-5-point-Likert-scale>)

Score Range	Performance Level	Descriptive Rating
4.01-5.00	At Grade Level	Highly Proficient
3.01-4.00	Transitioning	Proficient
2.01-3.00	Developing	Nearly Proficient
1.01-2.00	Emerging	Low Proficient
0.01-1.00	Emerging	Not Proficient

Activities	Data to be Collected	Statistical Treatment
1. Administer the pre-test	Result of the pre-test	Mean, Standard Deviation
2. Conduct Weekly Intervention	Monthly test result	Mean, Standard Deviation, Mode, Skewness, Kurtosis
3. Administer the post-test	Result of the post-test	Mean, Standard Deviation

5. Discussion of Results and Reflection

Level of performance of grade two pupils in multiplying numbers before the Implementation of the Intervention Program

The pre- test score is presented in Table 1. The 5-points test given to pupils was evaluated and a mean of 0.48 connotes “Not Proficient” in multiplying numbers. This further suggests that the performance is below the desired level. Furthermore, the pre-test result also shows a standard deviation of 0.51 which indicates low variability in the test scores which means that most pupils performed similar.

One operation that quite often causes problems for students is the multiplication operation (Tillema, 2023). The multiplication process involves multiplying two or more numbers to get the result (Kosko, 2020). During elementary school learning, students will hone their multiplication skills through exercises, problem-solving, and understanding basic mathematical concepts. Although multiplication is one of the basic concepts in mathematics taught in elementary schools, some students may experience some difficulties or misunderstandings in understanding it (Wong & Evans, 2020). Responding to problems found in the field, researchers assume that to improve the multiplication learning outcomes of second-grade students to use hands-on activity media that can be operated directly by students. Hands-on activity media, or direct practice activities, is a learning approach that actively involves students in physical or interactive activities to understand certain concepts (Kanastren et al., 2023).

To combat low numeracy levels, schools implemented various programs. Valiente (2023) suggest

that targeted interventions like Project PINT can effectively bolster mathematical problem-solving abilities among students struggling with numeracy. The study underscores the importance of collaborative efforts among educators and school administrators in addressing learning gaps intensified by the pandemic. It also highlights the necessity for innovative teaching strategies and tools to enhance student engagement and comprehension in mathematics. The success of Project PINT implies that with appropriate interventions, it is possible to mitigate the negative impacts of the pandemic on education and improve foundational skills among learners.

The result further implied that pupils need more attention on developing skills in multiplication and intervention programs will develop their performance.

Table 1 Pre-Test Score of students in Task G Multiplying Numbers

	Pre-Test Scores
Mean	0.48
Standard Deviation	0.51

Level of Performance in multiplying numbers of Grade 2 Pupils during the Implementation of the Intervention Program

The per-test scores are presented in Table 2. The results recorded the highest mean score of 4.95 which indicates a “Highly Proficient” in week 8, week 19 and week 20 of the intervention program. This further suggests that overall, the pupils performed well on those weeks. On the other hand, the per test result shows a standard deviation of 0.22 which indicates that scores are very consistent, and most pupils performed similarly. Likewise, 5 as the value of the mode indicates that this score appears more frequently than the other numbers in the test scores. In addition, the result shows an extremely high kurtosis which means that the distribution of scores has many extreme outliers far from the mean. Furthermore, the value of 21.00 in Kurtosis indicates that majority of the pupils performed exceptionally well and only few performed in an average level.

In a capsule, the general result of intervention program reflected 84.90 mean score which indicates “Highly Proficient” which indicated exceptional performance of pupils during the intervention program. The standard deviation 7.96 which indicates a high variability indicating diverse levels of understanding among students. Likewise, 5 as the value of the mode indicates that most pupils got the highest score. On the other hand a skewness of -0.75 indicates that the distribution of scores is moderately left skew or slightly skewed to the left meaning most pupils score high. A kurtosis of 2.37 indicates slightly platykurtic meaning most pupils ‘scores are relatively evenly distributed with fewer extreme high or low scores compared to a normal bell curve.

In the study conducted by Fuchs et al. (2020). examine the impact of an intensive, individualized intervention program aimed at students struggling with mathematics, including multiplication. The study found that targeted interventions significantly improved students' fluency in multiplication and overall math performance, particularly when tailored to students' specific learning needs. The results support the idea that structured, evidence-based interventions are crucial for improving mathematical outcomes in students with

difficulties.

Furthermore, (Insorio, 2024), explored how differentiated instruction (DI) could be effectively used to enhance students' performance in mathematics by accommodating their diverse learning needs. He concludes that differentiated instruction is a highly effective approach to improving mathematics outcomes. It not only supports academic success but also promotes a more engaging and inclusive learning environment that caters to the diverse needs of pupils.

The practical implications of these findings are significant since result showed strong evidence that intervention programs focusing on multiplication can have a positive impact, especially when personalized to address individual challenges.

Table 2. Per-test Score of Grade 2 Pupils in Multiplying numbers

	Mean	SD	Mode	Skewness	Kurtosis
Week 1	3.48	1.08	3	-0.33	-0.03
Week 2	3.90	0.83	4	-0.39	-0.15
Week 3	4.14	0.73	4	-0.23	-0.94
Week 4	4.67	0.58	5	-1.60	1.89
Week 5	2.62	1.53	2	-0.11	-1.04
Week 6	3.67	1.43	5	-0.60	-1.00
Week 7	4.71	0.46	5	-1.02	-1.06
Week 8	4.95	0.22	5	-4.58	21.00
Week 9	1.48	1.86	0	1.02	-0.37
Week 10	2.71	1.42	2	0.56	-0.99
Week 11	4.67	0.48	5	-0.76	-1.58
Week 12	4.90	0.30	5	-2.97	7.56
Week 13	1.00	1.22	0	0.72	-1.17
Week 14	2.48	0.98	2	0.25	-0.83
Week 15	4.38	0.59	4	-0.30	-0.61
Week 16	4.86	0.36	5	-2.20	3.14
Week 17	3.52	1.08	4	-0.46	0.06
Week 18	4.62	0.80	5	-2.34	5.30
Week 19	4.95	0.22	5	-4.58	21.00
Week 20	4.95	0.22	5	-4.58	21.00
Week 21	3.57	1.12	3	-0.43	-0.19
Week 22	4.67	0.58	5	-1.60	1.89
AWM	84.90	7.96	5	-0.75	2.37

Level of Performance in multiplying numbers of Grade 2 Pupils after the Implementation of the Intervention Program

The pre-test and post-test scores are presented in Table 3. The results indicate a notable increase in mean scores, from 0.48 in the pre-test to 2.90 in the post-test. This improvement corresponds to a shift from “Not Proficient” to “Nearly Proficient” level. The 2.42-point gain suggests that the intervention program substantially influenced the pupils’ multiplication skills. This improvement is further reflected in standard deviation wherein 0.51 indicates some pupils scored higher than the average and 0.44 indicates pupils performed consistently around the mean while the class collectively progressed, individual performance varied to a greater extent after the intervention.

Toledo et al (2023) exemplified how targeted, resource-efficient interventions can significantly enhance pupils' multiplication skills, providing a model that can be adapted and implemented across various educational settings to improve mathematical proficiency. Furthermore, Emnace, Umalay, and Maculbe (2024), concluded that manipulative significantly enhanced the multiplication skills of Key Stage 1 learners. The study demonstrated a notable improvement in students' mastery of multiplication, with overall percentage scores increasing from 65% in the initial weeks to 87% in the final weeks, and pre-test scores rising from 20% to post-test scores of 80%.

Considering these findings, broader implementation of manipulative in similar educational contexts to further support and enhance multiplication skill development among young learners are highly recommended.

Table 3. Post-test Score of Grade 2 Pupils in Multiplying Numbers

	Post-Test Score
Mean	2.90
Standard Deviation	0.44

Difference in the Pre-test and Post-test Score of Grade 2 Pupils

The study’s inferential statistics as shown in Table 4, strongly indicate that the intervention program had a notable impact on the pupils’ performance. The paired t-test yielded a p-value of 4.19806E-14, far below the conventional significance threshold of 0.05. Such a result suggests that the observed difference in pre-test and post-test scores is highly unlikely to be attributable to chance, thus providing strong evidence for the intervention program’s effectiveness. In educational research, this level of statistical significance highlights a reliable improvement that warrants further attention and replication.

Luna et al (2020) revealed that students exposed to the Differentiated Intervention Model exhibited significantly higher retention scores compared to those in the Re-teaching Model and performed comparably to those in the Modularized Model. Furthermore Adams (2021) underscores the importance of selecting appropriate instructional strategies based on specific educational goals. While traditional drills may offer a time-efficient solution for immediate fact acquisition, methods like incremental rehearsal could provide benefits for longer-term retention, despite requiring more instructional time. Differentiated Activities contributes valuable insights into the comparative effectiveness and efficiency of different drill-based interventions, guiding educators in tailoring instruction to enhance multiplication fact mastery among students with mathematical difficulties.

Results showed intervention program had a significant impact on the pupils’ performance and

employing varied intervention models, particularly the Differentiated Intervention Model, effectively enhances students' retention in mathematics.

Table 4. Difference in the Pre-test and Post-test Score of Grade 2 Pupils in Multiplying Numbers

	Mean	p-value	Interpretation	Decision
Pre-test	0.476190476	4.19806E-14	Significantly Different	Reject HO
Post Test	2.904761905			

Effect of the Intervention program to Multiplication Skills of Grade 2 Pupils

As reflected in Table 5, beyond statistical significance, the intervention program's practical importance is demonstrated by a Cohen's *d* value of 1.90, which is substantially above the conventional benchmark of 0.8 for a large effect. This means that the improvement in the pupil's performance in multiplying numbers is not only measurable but can be meaningfully observed in the classroom. When the effect sizes are this large, they typically reflect an intervention program that has the potential to be transformative for a broad range of learners. While these results are highly encouraging, it is also important to acknowledge that a one group pre-test post-test design lacks a control group. Consequently, external factors such as maturation, test familiarity, or other environmental influences cannot be ruled out. Future research employing more rigorous experimental or quasi-experimental designs would help confirm the causality of these findings and further substantiate the intervention program's efficacy.

Many learning tasks do not fully exploit physical capabilities. In the study of Tatarian (2020) Differentiated Activities aim to bridge learning gaps by leveraging the physical movements and multimodal behaviors to teach positive and negative multiplication along a number line. The study seeks to enhance student engagement and comprehension by making abstract mathematical concepts more tangible through embodied learning experiences. In 2020, the Philippine Department of Education (DepEd) implemented the Early Language, Literacy, and Numeracy Program (ELLN) to address low numeracy levels among young learners. This initiative aimed to enhance the teaching skills of Kindergarten to Grade 3 educators in foundational subjects, focusing on literacy and numeracy, and establishing school-based mentoring for continuous professional development. Department of Education.

The result further implied that pupil's improvement in multiplying numbers suggest that the intervention was not only statistically significant but also practically meaningful in enhancing pupils' performance in multiplying numbers. In classroom setting, such a large effect implies that most learners benefited to a degree that would be evident even without formal statistical tests. This underscores the potential value of adopting or refining the instructional methods used in this study.

Table 5. Effect Size of the Intervention Program to the Multiplication skills of Grade 2 Pupils

	Mean	D	Interpretation	Decision
Pre-Test	0.476190476	1.90	Significantly Large Effect	Reject HO
Post Test	2.904761905			

Summary of Findings

From the interpretation of the data obtained, the following results were extracted as follows:

1. The performance of grade 2 pupils in multiplying numbers before the intervention program is below desired level or “Not Proficient”
2. Grade Two Pupils were classified as “Highly Proficient” which indicated exceptional performance during the intervention program.
3. The level of performance of grade two pupils shifted from “Not Proficient” to “Nearly Proficient” level after the intervention program.
4. Pre-Test and post Test Scores post Significant difference.
5. The intervention has significant practical effect in the task of multiplying numbers.

The findings gathered led to the formulation of the following conclusions:

1. Differentiated activities with Physical modelling can improve multiplication skills of grade two pupils
2. The intervention program has practical effect in the task of multiplying numbers.

Reflection

Numeracy is one of the DepEd’s top priorities in early grades particularly among disadvantage pupils. Interventions are necessary to allow learners develop skills in numeracy in a manner and strategies which they learn best. This project is significant for teachers to conduct practical significant learning programs to improve pupils’ numeracy skills. Replication of Differentiated Activities with Physical modelling in similar classroom contexts may confirm its effectiveness and adaptability. Further research should be undertaken on Differentiated Activities with Physical Modelling and its impact on improving multiplication skills which will be beneficial to teachers and pupils who are willing to invest to acquire higher mastery level on multiplying numbers.

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