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Investigating the Effectiveness of Learners' Performance in Mathematics using Trimodal Strategies

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Abstract

The objective of this research is to investigate the effectiveness of Trimodal Strategies in enhancing the mathematics performance of Grade 3 learners. Specifically, it focused on the integration of the Concrete Representational Abstract (CRA) approach, Real-World Problem Solving (RWPS), and Technology-Enhanced Learning (TEL). These instructional approaches are anchored in Constructivism, Cognitive Load Theory (CLT), and Vygotsky's Zone of Proximal Development (ZPD), providing a comprehensive theoretical foundation for instructional design and delivery.

A quasi-experimental pretest-posttest design was implored, involving 17 purposively selected Grade 3 learners from Quidaoen Elementary School during the academic year 2024–2025. The study aimed to determine learners' initial performance in mathematics, implement the three instructional strategies, and assess their effects on performance, engagement, and acceptance. Data collection tools included the SMART Project Tool for both pretest and posttest assessments, and a teacher-made survey questionnaire to evaluate levels of engagement and acceptance.

Findings showed a significant improvement in learners' mathematics performance, with the grand mean increasing from 69.12 ("Did Not Meet Expectations") in the pretest to 83.71 ("Satisfactory") in the posttest. The Real-World Problem Solving strategy yielded the highest academic gains, particularly in data collection and capacity-based problem-solving tasks. The CRA strategy effectively improved learners' understanding of time and measurement concepts and garnered the highest levels of engagement and acceptance among the three approaches. Meanwhile, Technology-Enhanced Learning showed positive effects, particularly in probability, though it reflected comparatively lower engagement, indicating a need for more effective integration of technology in instruction.

Statistical analysis using the dependent t-test revealed that the observed improvements were significant across all strategies, supporting the efficacy of the trimodal approach. Learners responded most positively to CRA, appreciating its hands-on, scaffolded structure, followed by moderate acceptance of RWPS and TEL.

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In conclusion, the study affirms that combining concrete, contextual, and technological strategies significantly improve mathematical understanding and engagement among Grade 3 learners. The results recommend that teachers adopt and refine Trimodal Strategies to address varied learner needs and foster a deeper, more meaningful mathematics learning experience.

Keywords: *Concrete Representational Abstract, Real-World Problem Solving, Technology-Enhanced Learning, Mathematics Performance, Instructional Strategies, T-Tests*

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I. INTRODUCTION

Mathematics is a core subject that develops learners' logical thinking and problem-solving skills, but it is also one of the most difficult subjects for many students. For Grade 3 learners, topics such as time conversion, measurement, and probability are often challenging because these concepts require both understanding and application. In this study, the pretest results revealed that learners obtained an overall mean score of 69.12, which falls under the "Did Not Meet Expectation" category. This shows a gap in their readiness to master more complex mathematics concepts and signals the need for new ways of teaching. To address this gap, there is a need for strategies that make lessons more engaging and relatable while supporting learners' gradual shift from basic to advanced thinking.

Research suggests that using interactive, hands-on, and technology-aided approaches helps learners understand abstract topics better. Miller and Sayers (2008) emphasized the importance of the Concrete-Representational-Abstract (CRA) approach as a way to help students move from concrete manipulation of objects to symbolic understanding. Ramos (2020) highlighted that real-world problem-solving motivates students because it connects mathematics to real-life experiences, making lessons meaningful and practical. Chang and Tsai (2019) also reported that Technology-Enhanced Learning (TEL) improves student motivation and participation when digital tools are integrated properly into lessons. Local studies by Cruz (2021) and Andaya (2022) confirmed that visual and interactive approaches significantly improve performance in topics like measurement and time conversion. These findings support the use of a combination of CRA, Real-World Problem Solving (RWPS), and TEL to strengthen learners' understanding and participation in mathematics.

This study seeks to determine the effectiveness of these three strategies—CRA, RWPS, and TEL—when used together to improve the mathematics performance of Grade 3 learners. Specifically, it aims to measure students' level of performance before and after the use of these strategies, determine whether there is a significant difference between their pretest and posttest results, and gather their feedback on the strategies applied. It is hypothesized that the use of these combined strategies will lead to a significant improvement in students' performance. This study hopes to provide evidence that using innovative, learner-centered strategies can make mathematics more meaningful, interactive, and effective for young learners.

II. MATERIALS and METHODS

Research Design:

This study used a quasi-experimental design with a pretest-posttest approach. It combined three strategies—Concrete-Representational-Abstract (CRA), Real-World Problem Solving (RWPS), and Technology-Enhanced Learning (TEL)—to teach selected mathematics topics. All Grade 3 learners in the class participated in the study.

A pretest was given first to measure the students' initial performance. Then, the lessons were taught using the combined strategies over several weeks. After the intervention, a posttest was administered to measure improvement in students' performance.

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Both quantitative and qualitative data were collected. Quantitative data came from pretest and posttest scores, which were analyzed to find differences in performance. Qualitative data came from student reflections and feedback to know their level of engagement and acceptance of the strategies.

Participants:

The study will focus on Grade 3 learners from Quidaoen Elementary School who are currently enrolled in the academic year 2024 - 2025. The participants will be selected using a purposive sampling method from one class. The sample will consist of a total of 17 Grade 3 learners, with 8 males and 9 females, representing a balanced mix of genders. These learners will be drawn from one Grade 3 class at the school, ensuring that the group reflects a diverse range of learners, potentially including students from different family backgrounds, socio-economic statuses, and varying levels of parental educational attainment.

Instruments:

The study used two main instruments to collect data on the effectiveness of the trimodal strategies: the SMART Project Tool and a Teacher-Made Survey Questionnaire.

The SMART Project Tool, developed by the Regional Office, was used as both the pretest and posttest to measure learners' conceptual understanding and math performance before and after the intervention. This tool ensures that learning outcomes are measured consistently.

Teacher-Made Survey Questionnaire was created by the researcher to measure learners' level of engagement and acceptance of the trimodal strategies. It used Likert-scale items to capture students' attitudes and experiences. To ensure its validity, the questionnaire was reviewed and validated by three Master Teachers from the San Juan District.

Procedure:

Researcher will first ask permission from the Schools Division Supervisor to conduct the study at Quidaoen Elementary School. Once approved, the researcher will coordinate with the school principal and the Grade 3 class adviser to identify the participants.

After the instruments (SMART Project Tool and Teacher-Made Survey Questionnaire) have been revised, modified, and validated by experts, the researcher will begin data collection. A pretest using the SMART Project Tool will be administered to assess learners' prior knowledge in Mathematics. The intervention using the trimodal strategies (CRA, Real-World Problem Solving, and Technology-Enhanced Learning) will then be implemented.

Next to the intervention, a posttest using the same tool will be given to measure learners' improvement in performance and cognitive skills. The Teacher-Made Survey Questionnaire will also be distributed to gather learners' feedback and level of engagement. The researcher expects

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a 100% response rate. All data collected will be tallied, analyzed, and interpreted to determine the effectiveness of the strategies.

Data Analysis:

Data that will be gathered in the study will be analyzed using the following statistical tools:

1. The mean will be used to determine the level of the mathematics performance of the Grade 3 learners before and after the implementation of the instructional strategies. It will also use to show the general level of engagement and acceptance of grade 3 learners in the trimodal strategies;
2. T-test for dependent samples will be used to determine the significant difference between the pretest and posttest performance of learners expose the instructional strategies;
3. Standard Deviation: Indicates the consistency of responses (a lower SD means responses are more similar);
4. Frequency and Percentage: Useful for showing how many students selected each option.

III. RESULTS

Table 1. The level of the mathematics performance of Grade 3 learners before the implementation of the instructional strategies

Learning Competencies	Pretest	DR
visualizes, represents, and converts time measures: a. from seconds to minutes, minutes to hours, and hours to a day and vice versa b. days to a week	76.35	FS
solves problems involving the conversion of time measures	69	DNME
visualizes, and represents, and converts common units of measure from larger to smaller unit and vice versa: meter and centimeter, kilogram and gram, liter and milliliter.	74.12	DNME
visualizes, and represents, and solves routine and non-routine problems involving conversions of common	71.06	DNME
solves routine and non-routine problems involving capacity measures.	69.65	DNME
visualizes, represents, and measures area using the appropriate unit.	65.18	DNME
collects data on one variable using existing records.	78.59	FS
sorts, classifies and organizes data in tabular form and presents this into a vertical or horizontal bar graph.	76.94	FS
infers and interprets data presented in different kinds	72.71	DNME

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solves routine and non-routine problems using data presented in a single-bar graph.	67.59	DNME
tells whether an event is sure, likely, equally likely, unlikely, and impossible to happen.	64.88	DNME
describes events in real-life situations using the phrases "sure to happen, "likely to happen", "equally likely to happen", "unlikely to happen", and "Impossible to happen".	63.29	DNME
Overall	69.12	DNME

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 2. The mathematics performance of the learners exposed in trimodal strategies

Instructional Strategies	Learning Competencies	Posttest	Description
Concrete Representational Abstract (CRA)	visualizes, represents, and converts time measures: a. from seconds to minutes, minutes to hours, and hours to a day and vice versa b. days to a week,	89.47	VS
	solves problems involving the conversion of time measures.	85.71	VS
	visualizes, represents, and converts common units of measure from larger to smaller units and vice versa: meter and centimeter, kilogram and gram, liter, and milliliter.	85.18	VS
	visualizes, represents, and solves routine and non-routine problems involving conversions of common	80.71	S
	Composite Mean	83.12	S
Real-World Problem Solving	solves routine and non-routine problems involving capacity measures.	89.47	VS
	visualizes, represents, and measures area using the appropriate unit.	82.35	S

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	collects data on one variable using existing records.	95.06	O
	sorts, classifies and organizes data in tabular form and presents this into a vertical or horizontal bar graph.	80.00	S
	infers and interprets data presented in different kinds	78.59	FS
	Composite Mean	88.71	VS
Technology-Enhanced Learning	solves routine and non-routine problems using data presented in a single-bar graph.	77.82	FS
	tells whether an event is sure, likely, equally likely, unlikely, and impossible to happen.	85.88	VS
	describes events in real-life situations using the phrases "sure to happen, "likely to happen", "equally likely to happen", "unlikely to happen", and "Impossible to happen".	85.06	VS
	Composite Mean	82.12	S
Grand Mean		83.71	S

Scale	DR
90-100	Outstanding (O)
85-89	Very Satisfactory (VS)
80-84	Satisfactory (S)
75-79	Fairly Satisfactory (FS)
Below 75	Did Not Meet Expectation (DNME)

Table 3. Comparison of the significant difference between the pretest and post-test of mathematics performance of learners after the implementation of trimodal strategies

Strategies	Learning Competencies	Posttest	Posttest	Mean Gain	T-value	T-Prob
Concrete Representational Abstract (CRA)	visualizes, represents, and converts time measure: a. from seconds to minutes, minutes to hours, and hours to a day and vice versa b. days to a week,	76.35	89.47	13.12	4.47	<0.001
	solves problems involving conversion of time measure.	69	85.71	16.71	4.53	<0.001

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visualizes, and represents, and converts common units of measure from larger to smaller unit and vice versa: meter and centimeter, kilogram and gram, liter and milliliter.	74.12	85.18	11.06	2.97	0.009
visualizes, and represents, and solves routine and non- routine problems involving conversions of common	71.06	80.71	9.65	2.29	0.036
Composite Mean	69.88	83.12	13.24	9.18	<0.001
Real-World Problem Solving					
solves routine and non-routine problems involving capacity measure.	69.65	89.47	19.82	5.61	<0.001
visualizes, and represents, and measures area using appropriate unit.	65.18	82.35	17.17	4.01	0.001
collects data on one variable using existing records.	78.59	95.06	16.47	3.92	0.001
sorts, classifies, and organizes data in tabular form and presents this into a vertical or horizontal bar graph.	76.94	80.00	3.06	1.67	0.114
infers and interprets data presented in different kinds	72.71	78.59	5.88	2.33	0.033
Composite Mean	75.18	88.71	13.53	5.54	<0.001
Technology-Enhanced Learning					
solves routine and non-routine problems using data presented in a single-bar graph.	67.59	77.82	10.23	3.19	0.006
tells whether an event is sure, likely, equally likely, unlikely, and impossible to happen.	64.88	85.88	21.00	7.33	<0.001
describes events in real-life situations using the phrases “sure to happen, “likely to happen”, “equally	63.29	85.06	21.77	7.64	<0.001

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likely to happen", "unlikely to happen", and "Impossible to happen".					
Composite Mean	64.76	82.12	17.36	6.54	<0.001
Grand Mean	69.12	83.71	14.59	8.10	<0.001

Table 4a. Level of engagement of the learners in the Trimodal strategies in Mathematics

Indicators of Engagement	Concrete Representational Abstract (CRA)		Real-World Problem Solving		Technology-Enhanced Learning	
1. I listened carefully during the lesson.	4.00	HE	3.59	HE	3.35	ME
2. I actively participated in the activities.	3.88	HE	3.82	HE	2.94	ME
3. I found the activities interesting and fun.	3.88	HE	3.00	ME	2.94	ME
4. I was excited to answer and solve the problems.	4.00	HE	3.00	ME	3.00	ME
5. I worked well with my classmates during activities.	4.00	HE	3.00	ME	2.94	ME
Overall	3.95	HE	3.28	ME	3.04	ME

Scale Interpretation

3.50-4.00 -Highly engaged (HE)

2.50-3.49 -Moderately engaged (ME)

1.50-2.49 -Slightly engaged (SE)

1.00-1.49 -Not engaged at all (NEA)

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Table 4b. Level of acceptance of the learners in the Trimodal strategies in Mathematics

Indicators of Acceptance	Concrete Representational Abstract (CRA)		Real-World Problem Solving		Technology-Enhanced Learning	
1. I liked the way I learned math today.	4.00	HA	3.41	MA	3.06	MA
2. This way of learning math helped me understand the lesson better.	4.00	HA	3.47	MA	3.00	MA
3. I would like to use this strategy again in other math lessons.	4.00	HA	3.00	MA	3.24	MA
4. I feel more confident solving math problems after this lesson.	3.82	HA	3.00	MA	2.82	MA
5. I think this strategy makes learning math easier for me.	3.59	HA	3.00	MA	2.88	MA
Overall	3.88	HA	3.18	MA	3.00	MA

Scale Interpretation

3.50-4.00 -Highly accepted (HA)

2.50-3.49 -Moderately Accepted (MA)

1.50-2.49 -Slightly Accepted (SA)

1.00-1.49 -Not Accepted at All (NAA)

IV. DISCUSSION

In table 1, the pretest results showed that Grade 3 learners had a low average score of 69.12, which means they did not meet expectations in mathematics. Although they did best in data handling, their scores in time conversion and probability were still weak. This result agrees with other studies showing that many students find these topics difficult. This means teachers need to give more focus on these lessons, using fun and hands-on activities to help students understand better. This result is only based on one class, so it might not be the same for other schools.

The posttest results showed a big improvement, with learners reaching an average score of 83.71, which is satisfactory. They improved most in problem-solving and time conversion after using the new teaching strategies. This supports other studies that found real-life problems and hands-on learning effective in teaching math. Teachers should continue using these

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strategies, along with careful use of technology, to keep students engaged. However, the result may be affected by how much access students had to devices and internet.

The results of the paired t-test showed a significant increase in scores after the intervention, proving that the trimodal strategies worked well. This is similar to other research that says using a mix of teaching strategies improves learning outcomes. This means schools can adopt these strategies to help students who struggle with math. However, this study only measured short-term results, so we do not know if students will retain what they learned for a long time.

Students reported that they were highly engaged with the CRA approach and moderately engaged with Real-World Problem-Solving and Technology-Enhanced Learning. This means students enjoyed lessons more when they were doing hands-on activities. Other studies also say that students become more active when they can manipulate and visualize objects. Teachers should use CRA often to keep students interested, while improving technology activities to make them more interactive. Engagement levels, however, are based only on what students reported and may be affected by their mood.

Students highly accepted CRA, while they moderately accepted Real-World Problem-Solving and Technology-Enhanced Learning. This means students preferred hands-on learning compared to other strategies. This matches findings from other research that students like learning when it is interactive. Teachers and schools should focus more on using CRA and improve the design of technology activities so students will like them more. Students' answers may have been affected by the newness of the strategies, so a follow-up study would help confirm these results.

V. CONCLUSION

In conclusion, the study found Grade 3 learners initially had low performance in mathematics, particularly in time conversion and probability, as shown in the pretest results. After the implementation of the **Trimodal Strategies**—Concrete-Representational-Abstract (CRA), Real-World Problem-Solving (RWPS), and Technology-Enhanced Learning (TEL)—their posttest scores significantly improved, reaching a satisfactory level. Among the three strategies, CRA had the highest level of learner engagement and acceptance, followed by RWPS and TEL. Statistical analysis using a paired sample t-test confirmed a significant difference between pretest and posttest results, proving that the combination of strategies was effective in improving learners' mathematics performance. Student feedback also showed that the strategies made learning more meaningful, interactive, and enjoyable.

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Recommendations

After the careful analysis on the findings of this study, following recommendations were presented:

1. Implement trimodal strategies in mathematics classrooms;
2. Prioritize the CRA approach for its effectiveness;
3. Emphasize real-world connections in mathematics;
4. Refine the use of technology for better integration;
5. Utilize differentiated instruction to meet diverse needs;
6. Engage in ongoing assessment to inform instruction;
7. Recognize the importance of a balanced approach to mathematics instruction;
8. Refine technology integration in mathematics instruction;
9. Conduct longitudinal studies to assess the long-term impact of trimodal strategies;
10. Replicate the study with diverse learner populations;
11. Incorporate qualitative research methods for deeper insights;
12. Investigate specific technology tools and platforms;
13. Explore combinations of trimodal strategies with other instructional approaches.

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