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Student Engagement and Learning Outcomes in Mathematics through Localized Learning Approach (LLA)

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Abstract: This study examined the student engagement and learning outcomes in mathematics through Localized Learning Approach (LLA) in two Grade 8 classes at Dagatkidavao Integrated School. LLA focuses on practical applications, incorporates the mother tongue, and utilizes community resources. The structured process involves three steps: pre-assessment, formal instruction, and post-assessment. This study employed a quasi-experimental research design. Engagement was assessed using the Mathematics Student-Report Engagement Scales, while learning outcomes were measured through a 30-item, content-validated multiple-choice test. Semi-structured interviews were also conducted to identify the elements and impacts of LLA on engagement and outcomes. Results indicated that students using LLA showed improvement on their level of engagement and learning outcomes and the NLLA group also showed progress but gained less. ANCOVA results revealed a statistically significant results in engagement for the LLA group. Similarly, the LLA group showed significant results in learning outcomes.

Keywords: Localized Learning Approach, Student Engagement, and Learning Outcomes.

INTRODUCTION

In recent years, educational approaches have evolved, prompting educators to explore innovative approaches to enhance student engagement and learning outcomes. One such approach, the Localized Learning Approach (LLA), emphasizes contextualized learning experiences that incorporate local culture, environment, and community into the educational framework. This study investigates the effects of LLA on mathematics students' engagement and learning outcomes, recognizing the critical role these factors play in academic success.

Mathematics education often faces challenges related to student disengagement and poor learning outcomes. Traditional teaching methods may not resonate with all students, leading to a lack of interest and motivation in the subject. Research indicates that many students perceive mathematics as abstract and disconnected from their everyday experiences, which can hinder their ability to engage deeply with the material and ultimately affect their learning outcomes (Godec, *et al*., 2021). Therefore, there is a pressing need to explore alternative instructional strategies like LLA that may foster greater engagement and improve academic performance.

Student engagement encompasses behavioral, emotional, and cognitive dimensions. Engaged students are more likely to participate actively in their learning, leading to improved academic achievement. However, recent studies have shown that disengagement remains prevalent in mathematics classrooms (Reyes, *et al*., 2020). This disengagement is concerning, as it directly impacts learning outcomes, which refer to the knowledge and skills students acquire because of their educational experiences. Effective learning outcomes are measurable and can be influenced by various factors, including instructional methods and student engagement (Hattie, 2018). Studies show that higher levels of engagement correlate with improved learning outcomes (van den Hurk, *et al*., 2019).

Research has highlighted the importance of context in learning. For instance, localized learning approaches have been shown to enhance student engagement and understanding by connecting educational content to students' real-life experiences (Tytler, *et al*., 2017). The application of LLA in mathematics has shown promise in bridging the gap between abstract concepts and practical application, potentially enhancing engagement and outcomes (Godec, *et al*., 2021).

However, international assessments reveal a troubling trend regarding the mathematics performance of students in the Philippines. The latest PISA results positioned the Philippines at 77th out of 81 countries, with a score of 355 points, significantly below the global average of 472 points. Although there was a slight increase of 2 points from the national average in 2018 (353 points), the country continues to rank in the lower half of participants. Alarmingly, only 16% of Filipino students achieved at least Level 2 proficiency in mathematics, reading, and science, far below the OECD average of 69%. Furthermore, in the TIMSS 2019 assessment, the Philippines

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ranked last in both mathematics and science. National achievement tests further highlight these concerns; for example, in 2018, Grade 10 students in Northern Mindanao showed poor performance, and data from Valencia City's Diagnostic Assessment Test (DAT) indicated low average Mean Percentage Scores (MPS) in mathematics (37.2% for grades 7-10 and 31.5% for grades 11-12), both of which are below the expected benchmark of 75%. Additionally, Grade 8 students at Dagatkidavao Integrated School recorded a second-quarter MPS of only 52.53% which also fails to meet the required standard.

The Philippines is also grappling with a significant education crisis. According to the recent EDCOM 2 Report (2024), the curriculum for core subjects does not meet expectations, and teachers are burdened with excessive non-teaching responsibilities. This situation, coupled with a standardized textbook system, hinders effective learning. International assessments like PISA underscore this problem, as Filipino students consistently perform poorly compared to their peers in the region.

The primary objectives of this study are to evaluate the impact of the Localized Learning Approach on mathematics students' engagement levels, assess the influence of LLA on students' learning outcomes in mathematics, and identify any significant relationships between engagement and learning outcomes in the context of LLA. Given the ongoing challenges in mathematics education, this study is necessary to explore effective teaching approaches that can foster engagement and improve learning outcomes. By examining the effects of LLA, this research aims to contribute valuable insights into educational practices that can enhance student experiences and academic success in mathematics. Addressing the issues related to student engagement and learning outcomes will not only benefit individual learners but also contribute to the broader field of mathematics education.

METHODOLOGY

The study used a quasi-experimental design with two intact groups: an experimental group exposed to the Localized Learning Approach (LLA) and a control group not exposed to it (NLLA). Both groups took the same pretest, posttest, and retention test to evaluate differences in mathematics engagement and learning outcomes.

The research took place at Dagatkidavao Integrated School in Valencia, Bukidnon, a public school established in 2002. It serves 593 students with 48 teachers but reported a low second-quarter MPS of 52.53% for Grade 8, highlighting the need for effective math interventions. The study aims to improve student engagement and learning outcomes through the Localized Learning Approach (LLA).

Random sampling was employed in this study. The LLA group and the non-LLA group were then formed from the student classes through a coin toss. The study included two Grade 8 sections at Dagatkidavao Integrated School in 2024-2025. One class of 26 students (14 female, 12 male) used the Localized Learning Approach (LLA), while another class of 30 students (15 female, 15 male) used the Non-Localized Learning Approach (NLLA). All students, aged 13 to 17, received the same lessons to compare the effectiveness of both methods on engagement and learning outcomes.

To measure mathematics students' engagement, the researcher adopted the 26-item Mathematics Student-Report Engagement Scales by Wang, *et al.,* (2016). This five-point Likert scale assesses cognitive, affective, and behavioral engagement and has a Cronbach's alpha of 0.87 for reliability. The scoring procedure is as follows:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Strongly High Engagement
4	3.51-4.50	Agree	High Engagement
3	2.51-3.50	Undecided	Slightly High Engagement
2	1.51-2.50	Disagree	Low Engagement
1	1.00-1.50	Strongly Disagree	Very Low Engagement

The primary data sources were students' pre-test, post-test, and retention test scores, assessed with a 30-item, content-validated multiple-choice test that scored 1 point each. The test had a Cronbach's

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alpha of 0.76 and used a table of specifications (TOS) for item construction. Scores were interpreted using the scale from DO #8, s. 2015:

Range	Descriptive Rating	Qualitative Interpretation
90%-100%	Outstanding	Very High Learning Outcome
85%-89%	Very Satisfactory	High Learning Outcome
80%-84%	Satisfactory	Neither High nor Low Learning Outcome
75%-79%	Fairly Satisfactory	Low Learning Outcome
74% and below	Did not meet the expectations	Very Low Learning Outcome

The researcher obtained IERC clearance and permissions from the Valencia City DepEd Division and Dagatkidavao Integrated School to conduct the study. Participants were randomly assigned to an experimental group using the Localized Learning Approach (LLA) and a control group using a Non-Localized Learning Approach (NLLA), with matching based on pre-test results. Informed consent was secured before assessments. After interventions, both groups were evaluated, followed by a retention test two weeks later. The researcher prepared an introduction to activities, a comprehensive lesson plan aligned with the DepEd curriculum, and instructional materials, implementing a three-stage process: pre-assessment, formal instruction, and post-assessment.

The LLA began with a pre-assessment to measure student engagement and learning outcomes. During formal instruction, the experimental group participated in activities emphasizing real-world applications and community resources, inspired by David N. Perkins and Jo Boaler. Curriculum development integrated localized examples and problem-solving tasks to enhance engagement. Post-implementation, identical assessments were administered for comparison, followed by a retention test two weeks later to evaluate the sustainability of outcomes.

The NLLA also included a pre-assessment to determine engagement and learning outcomes. The control group followed standard lesson plans focused on theoretical concepts, minimizing local language use. Cooperative learning strategies were employed, but the instruction adhered to a standardized curriculum with limited real-world relevance. After the intervention, identical assessments measured changes in engagement and outcomes, with a retention test two weeks later to assess the durability of these changes. Ethical guidelines ensured participant confidentiality and informed consent.

Data from the pretest and posttest were summarized using descriptive statistics, including mean, frequency, and percentage, to assess students' engagement and learning outcomes. The effectiveness of the Localized Learning Approach (LLA) was evaluated using ANCOVA to identify significant differences between LLA and Non-Localized Learning Approach (NLLA), accounting for pre-test score differences. Group comparability was confirmed by the Shapiro-Wilk test ($p > 0.05$) for normal distribution and Levene's statistic ($p = 0.248$) for variance.

RESULTS AND DISCUSSION

Level of Student Engagement in Mathematics Before and After LLA and non-LLA. It displays the mean, descriptive rating, and qualitative analysis of obtained data.

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Table 1: Level of student cognitive engagement in mathematics before and after exposure to LLA and non-LLA in terms of pretest, and posttest

Indicators	LLA Group				NLLA Group			
	Pretest		Posttest		Pretest		Posttest	
	Mean	QI	Mean	QI	Mean	QI	Mean	QI
I would rather be told the answer than have to do the work.*	2.23	LE	4.58	SHE	1.80	LE	3.43	SH
I go through the work for math class and make sure that it's right.	2.62	SH	4.46	HE	2.50	LE	3.37	SH
I don't think that hard when I am doing work for class. *	2.58	SH	4.42	HE	2.37	LE	3.13	SH
Do just enough to get by. *	2.00	LE	4.38	HE	2.43	LE	3.37	SH
When work in hard I only study the easy parts. *	2.12	LE	4.35	HE	2.40	LE	3.00	SH
I think about different ways to solve a problem.	2.69	SH	4.19	HE	2.50	LE	4.43	HE
I try to connect what I am learning to things I have learned before.	2.54	SH	4.19	HE	2.43	LE	3.47	SH
I try to understand my mistakes when get something wrong.	2.65	SH	4.15	HE	2.93	SH	3.37	SH
Cognitive Engagement Overall Mean	2.43	LE	4.34	HE	2.42	LE	3.32	SH

*negative indicators (scoring is reversed)

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Strongly High Engagement (SHE)
4	3.51-4.50	Agree	High Engagement (HE)
3	2.51-3.50	Undecided	Slightly High Engagement (SH)
2	1.51-2.50	Disagree	Low Engagement (LE)
1	1.00-1.50	Strongly Disagree	Very Low Engagement (VLE)

Table 1 presents that, before the intervention, five items in cognitive engagement with higher means are as follows: 'I think about different ways to solve a problem' (2.69), 'I try to understand my mistakes when I get something wrong' (2.65), 'I go through the work for math class and make sure that it's right' (2.62), and 'I try to connect what I am learning to things I have learned before' (2.54), which indicate slightly high engagement. Moreover, the statement 'I don't think that hard when I am doing work for class", (2.58), which is negatively stated, also falls into the category of slightly high engagement.

On the other hand, three items in cognitive engagement that are negatively stated fall into the category of high engagement: 'I would rather be told the answer than have to do the work' (2.23), 'When work is hard, I only study the easy parts' (2.12), and 'I do just enough to get by' (2.12). The overall mean in cognitive engagement is 2.43, indicating that students had low engagement before the intervention.

Also, Table 1 shows that, after the intervention, one item in cognitive engagement with the highest mean is: 'I would rather be told the answer than have to do the work' (4.58), which is negatively stated and falls into the very low engagement category. Moreover, there are seven cognitive engagement items with higher means, of which four items are positively stated, and three items are negatively stated.

Let's discuss the positive aspects first: 'I go through the work for math class and make sure that it's right' (4.46), 'I try to connect what I am learning to things I have learned before' (4.19), 'I think about different ways to solve a problem' (4.19), and 'I try to understand my mistakes when I get something wrong' (4.15), which indicate high engagement.

On the other hand, let's discuss the negative aspects: 'I don't think that hard when I am doing work for class" (4.42), 'I do just enough to get by' (4.38), and 'When work is hard, I only study the easy parts' (4.35), which are negatively stated and fall into the low engagement category. The overall mean in cognitive engagement is 4.34, indicating that students had high engagement after the intervention.

For the non-LLA, before the non-intervention, one item in cognitive engagement with a higher mean is: "I try to understand my mistakes when I get something wrong" (2.93), which indicates slightly high engagement. Moreover, there are seven cognitive engagement items with lower means, of which three are positively stated and four are negatively stated. Let's discuss the positive aspects first: "I think about different ways to solve a problem" (2.50), "I go through the work for math class and make sure that it's right" (2.50), and "I try to connect what I am learning to things I have learned before" (2.43), which indicate low engagement.

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On the other hand, let's discuss the negative aspects: “Do just enough to get by *” (2.43), “When work is hard, I only study the easy parts *” (2.40), “I don’t think that hard when I am doing work for class *” (2.37), and “I would rather be told the answer than have to do the work *” (1.80), which are negatively stated and fall into the high engagement category. The overall mean in cognitive engagement is 2.42, indicating that students had low engagement before the non-intervention.

Also, Table 1 shows that, after the non-intervention, one item in cognitive engagement with a higher mean is: “I think about different ways to solve a problem” (4.43), which indicates high engagement. Moreover, there are seven cognitive engagement items with lower means, of which three are positively stated and four are negatively stated. Let's discuss the positive aspects first: “I try to connect what I am learning to things I have learned before” (3.47), “I try to understand my mistakes when I get something wrong” (3.37), and “I go through the work for math class and make sure that it’s right” (3.37), which indicate slightly high engagement.

On the other hand, let's discuss the negative aspects: “I would rather be told the answer than have to do the work *” (3.43), “Do just enough to get by *” (3.37), “I don’t think that hard when I am doing work for class *” (3.13), and “When work is hard, I only study the easy parts *” (3.00), which are negatively stated and fall into the slightly high engagement category. The overall mean in cognitive engagement is 3.32, indicating that students had slightly high engagement after the non-intervention.

This implies that the localized learning approach (LLA) enhances cognitive engagement more effectively than the non-localized learning approach (NLLA). LLA reduces reliance on passive learning, fosters diligence, and encourages deeper cognitive effort. It leads to higher engagement in higher-order thinking and metacognitive reflection, supporting deeper learning strategies and active participation.

The results align with Alonzo and Rojas (2021), who found that culturally relevant materials enhance cognitive engagement by making learning more relatable. However, Villanueva (2022) observed that some students may remain disengaged due to external pressures. Conversely, Santos and Reyes (2019) demonstrated that cooperative learning strategies boost engagement through active collaboration, while Mendoza (2018) noted that some students might feel overshadowed in groups, reducing their cognitive involvement.

Table 2: Level of student affective engagement in mathematics before and after exposure to LLA and non-LLA in terms of pretest, and posttest

Indicators	LLA Group				NLLA Group			
	Pretest		Posttest		Pretest		Posttest	
	Mean	QI	Mean	QI	Mean	QI	Mean	QI
I think that math class is boring. *	3.00	SH	4.77	SHE	2.83	SH	3.50	SH
I don’t care about learning math. *	3.00	SH	4.69	SHE	2.70	SH	3.83	HE
I don’t want to be in math class. *	2.73	SH	4.58	SHE	2.50	LE	3.37	SH
I get worried when I learn new things about math. *	2.62	SH	4.42	HE	2.30	LE	3.40	SH
I want to understand what is learned in math class.	2.69	SH	4.38	HE	2.37	LE	3.27	SH
I enjoy learning new things about math.	2.58	SH	4.38	HE	2.43	LE	3.50	SH
I often feel down when I am in math class. *	2.62	SH	4.35	HE	2.67	SH	3.13	SH
I look forward to math class.	2.35	LE	4.35	HE	2.33	LE	3.20	SH
I often feel frustrated in math class. *	2.46	LE	4.19	HE	2.50	LE	3.10	SH
I feel good when I am in math class.	2.42	LE	3.77	HE	2.10	LE	3.33	SH
Affective Engagement Overall Mean	2.65	SH	4.39	HE	2.47	LE	3.36	SH

*negative indicators (scoring is reversed)

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Strongly High Engagement (SHE)
4	3.51-4.50	Agree	High Engagement (HE)
3	2.51-3.50	Undecided	Slightly High Engagement (SH)
2	1.51-2.50	Disagree	Low Engagement (LE)
1	1.00-1.50	Strongly Disagree	Very Low Engagement (VLE)

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Table 2 presents that, before the intervention, seven items in affective engagement with higher means are as follows: “I want to understand what is learned in math class” (2.69) and “I enjoy learning new things about math” (2.58), which indicate slightly high engagement. Moreover, the statements “I think that math class is boring” (3.00), “I don’t care about learning math” (3.00), “I don’t want to be in math class” (2.73), “I get worried when I learn new things about math” (2.62), and “I often feel down when I am in math class” (2.62), which are negatively stated, also fall into the category of slightly high engagement.

On the other hand, the item with the lower mean was “I often feel frustrated in math class” (2.46), which is negatively stated and indicates high engagement. Additionally, two positively stated items, “I feel good when I am in math class” (2.42) and “I look forward to math class” (2.35), reflect low engagement. The overall mean in affective engagement is 2.65, indicating that students had slightly high engagement before the intervention.

Also, after the intervention, three items in affective engagement with the highest means are: “I think that math class is boring” (4.77), “I don’t care about learning math” (4.69), and “I don’t want to be in math class” (4.58), which are negatively stated and fall into the very low engagement category. Moreover, there are seven affective engagement items with higher means, of which four items are positively stated, and three items are negatively stated.

Let's discuss the positive aspects first: “I want to understand what is learned in math class” (4.38), “I enjoy learning new things about math” (4.38), “I feel good when I am in math class” (3.77), and “I look forward to math class” (4.35), which indicate high engagement.

On the other hand, let’s discuss the negative aspects: “I get worried when I learn new things about math” (4.42), “I often feel down when I am in math class” (4.35), and “I often feel frustrated in math class” (4.19), which are negatively stated and fall into the low engagement category. The overall mean in affective engagement is 4.39, indicating high engagement.

For the non-LLA, before the non-intervention, three items in affective engagement with higher means are as follows: “I think that math is boring *” (2.83), “I don’t care about learning math *” (2.70), and “I often feel frustrated in math class *” (2.67). These items are negatively stated and fall into the slightly high engagement category. Moreover, there are seven affective engagement items with lower means, of which four are positively stated and three are negatively stated. Let's discuss the positive aspects first: “I enjoy learning new things about math” (2.43), “I want to understand what is learned in math class” (2.37), “I look forward to math class” (2.33), and “I feel good when I am in math class” (2.10), which indicate low engagement.

On the other hand, let's discuss the negative aspects: “I don’t want to be in math class *” (2.50), “I often feel down when I am in math class *” (2.50), and “I get worried when I learn new things about math *” (2.30). These items are negatively stated and fall into the high engagement category. The overall mean in affective engagement is 2.47, indicating that students had low engagement before the non-intervention.

Also, after the non-intervention, one item in affective engagement with a higher mean is: “I don’t care about learning math *” (3.83), which is negatively stated and falls into the low engagement category. Moreover, there are nine affective engagement items with lower means, of which four are positively stated and five are negatively stated. Let's discuss the positive aspects first: “I enjoy learning new things about math” (3.50), “I feel good when I am in math class” (3.33), “I want to understand what is learned in math class” (3.27), and “I look forward to math class” (3.20), which indicate slightly high engagement.

On the other hand, let's discuss the negative aspects: “I think that math class is boring *” (3.50), “I get worried when I learn new things about math *” (3.40), “I don’t want to be in math class *” (3.37), “I often feel frustrated in math class *” (3.13), and “I often feel down when I am in math class *” (3.10). These items are negatively stated and fall into the slightly high engagement category. The overall mean in affective engagement is 3.36, indicating that students had slightly high engagement after the non-intervention.

This implies that the localized learning approach (LLA) significantly boosts students’ affective engagement compared to the non-localized approach (NLLA). LLA reduces boredom, anxiety, and negative emotions while enhancing enthusiasm, participation, and intrinsic motivation, leading to greater emotional investment and

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positive attitudes toward math, which are vital for academic success.

The study supports Cruz and Dela Cruz (2020), who found that culturally relevant content enhances affective engagement. However, Garcia and Lim (2021) noted that some students may feel excluded. Johnson and Johnson (2015) emphasized that cooperative learning boosts emotional engagement, while Kagan (2019) warned that unequal participation can marginalize students.

Table 3: Level of student behavioral engagement in mathematics before and after exposure to LLA and non-LLA in terms of pretest, and posttest

Indicators	LLA Group				NLLA Group			
	Pretest		Posttest		Pretest		Posttest	
	Mean	QI	Mean	QI	Mean	QI	Mean	QI
If I don't understand, I give up right away. *	2.54	SH	4.50	HE	2.40	LE	3.27	SH
I put effort into learning math.	2.58	SH	4.38	HE	2.23	LE	3.73	HE
I don't participate in class. *	2.31	LE	4.38	HE	2.43	LE	3.07	SH
I do other things when I am supposed to be paying attention. *	2.46	SH	4.31	HE	2.67	SH	3.17	SH
I keep trying even if something is hard.	2.73	SH	4.27	HE	2.30	LE	3.40	SH
I stay focused.	2.42	LE	4.27	HE	2.80	SH	3.23	SH
I complete my homework on time.	2.42	LE	3.92	HE	2.47	LE	3.13	SH
I talk about science/math outside of class.	2.19	LE	3.73	HE	2.33	LE	2.80	SH
Behavioral Engagement Overall Mean	2.46	SH	4.22	HE	2.45	LE	3.23	SH

*negative indicators (scoring is reversed)

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Strongly High Engagement (SHE)
4	3.51-4.50	Agree	High Engagement (HE)
3	2.51-3.50	Undecided	Slightly High Engagement (SH)
2	1.51-2.50	Disagree	Low Engagement (LE)
1	1.00-1.50	Strongly Disagree	Very Low Engagement (VLE)

Table 3 presents that, before the intervention, four items in behavioral engagement with higher means are as follows: "I keep trying even if something is hard" (2.73), and "I put effort into learning math" (2.58), which indicate slightly high engagement. Moreover, the statements "If I don't understand, I give up right away *" (2.54), and I do other things when I am supposed to be paying attention *" (2.46), which are negatively stated, also fall into the category of slightly high engagement.

On the other hand, the item with the lower mean was "I don't participate in class *" (2.31), which is negatively stated and indicates high engagement. Additionally, three positively stated items, "I stay focused" (2.42), "I complete my homework on time" (2.42), and "I talk about science/math outside of class" (2.19), reflect low engagement. The overall mean in behavioral engagement is 2.46, indicating that students had low engagement before the intervention.

Also, after the intervention, eight items in behavioral engagement with the highest means are: "I put effort into learning math" (4.38), "I keep trying even if something is hard" (4.27) "I stay focused" (4.27), "I complete my homework on time" (3.92), and I talk about science/math outside of class" (3.73), which indicate high engagement. Moreover, the statements ""If I don't understand, I give up right away *" (4.50), "I don't participate in class *" (4.38), and "I do other things when I am supposed to be paying attention *" (4.31), which are negatively stated, falls into the category of low engagement. The overall mean in behavioral engagement is 4.22, indicating high engagement.

For the non-LLA, before the non-intervention, two items in behavioral engagement with higher means are as follows: "I stay focused" (2.80), which indicate slightly high engagement. While "I do other things when I am supposed to be paying attention *" (2.67). This item is negatively stated and falls into slightly high engagement. Moreover, there are six behavioral engagement items with lower means, of which four are positively stated and two are negatively stated. Let's discuss the positive aspects first: ""I complete my homework on time" (2.47), "I talk about science/math outside of class" (2.33), "I keep trying even if something is hard" (2.30), and "I put effort into learning math" (2.23), which indicate low engagement.

On the other hand, let's discuss the negative aspects: "I don't participate in class *" (2.43), and "If I don't understand, I give up right away *" (2.40). These items are negatively stated and fall into the high engagement category. The overall mean in behavioral engagement is 2.45, indicating that students had low engagement before the non-intervention.

Also, after the non-intervention, one item in behavioral engagement with a higher mean is: "I put effort into learning math" (3.73), which indicate high engagement category. Moreover,

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there are seven behavioral engagement items with lower means, of which four are positively stated and three are negatively stated. Let's discuss the positive aspects first: “I keep trying even if something is hard” (3.40), “I stay focused” (3.23), “I complete my homework on time” (3.13), and “I talk about science/math outside of class” (2.80), which indicate slightly high engagement.

On the other hand, let's discuss the negative aspects: “If I don’t understand, I give up right away *” (3.27), I do other things when I am supposed to be paying attention *” (3.17), and “I don’t participate in class *” (3.07). These items are negatively stated and fall into the slightly high engagement category. The overall mean in behavioral engagement is 3.23, indicating that students had slightly high engagement after the non-intervention.

This implies that the localized learning approach (LLA) significantly boosts students’ behavioral engagement compared to the non-localized approach (NLLA). LLA enhances persistence, participation, focus, and responsibility, while also encouraging learning beyond the classroom. Overall, LLA effectively transforms low-engagement behaviors into high-engagement practices, fostering self-regulated learners.

The study supports Bishop and Berryman (2015), who found that culturally responsive teaching enhances behavioral engagement by connecting to students' cultural backgrounds. However, Gay (2018) warns that misaligned content may alienate some students. Slavin (2016) highlights that cooperative learning boosts engagement, while Cohen (2018) notes it can frustrate those who prefer independent work, potentially reducing their engagement.

Table 4: Level of student engagement in mathematics before and after exposure to LLA and non-LLA in terms of pretest, and posttest

Indicator	GROUP							
	LLA				NLLA			
	Pretest		Posttest		Pretest		Posttest	
	Mean	QI	Mean	QI	Mean	QI	Mean	QI
Cognitive Engagement Overall Mean	2.43	LE	4.34	HE	2.42	LE	3.32	SH
Affective Engagement Overall Mean	2.65	SH	4.39	HE	2.47	LE	3.36	SH
Behavioral Engagement Overall Mean	2.46	SH	4.22	HE	2.45	LE	3.23	SH
Overall Mean Interpretation of three domains	2.52	SH	4.32	HE	2.45	LE	3.31	SH

*negative indicators (scoring is reversed)

Legend:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51-5.00	Strongly Agree	Strongly High Engagement (SHE)
4	3.51-4.50	Agree	High Engagement (HE)
3	2.51-3.50	Undecided	Slightly High Engagement (SH)
2	1.51-2.50	Disagree	Low Engagement (LE)
1	1.00-1.50	Strongly Disagree	Very Low Engagement (VLE)

Table 4 presents that the overall mean score for the pretest across the three domains is 2.52, indicating a slightly high engagement among students. After the intervention, the post-test mean score significantly increased to 4.32, reflecting a high engagement.

For the non-LLA, the overall mean score for the pretest across the three domains is 2.45, indicating a low engagement among students. The post-test mean score significantly increased to 3.31, reflecting a slightly high engagement. This implies that there was a notable improvement in student engagement following the NLLA implementation between the pretest and post-test.

This implies that the localized learning approach (LLA) significantly enhances student engagement across cognitive, affective, and behavioral domains, boosting overall engagement from low to high. In contrast, the non-localized learning approach (NLLA) shows only modest improvements, underscoring LLA's effectiveness in fostering critical thinking, positive emotions, and sustained effort.

The study highlights both pros and cons of the Localized Learning Approach (LLA). Godec, *et al.*, (2017) found LLA boosts STEM engagement by making content relevant, while van Tuijl and van der Molen (2016) noted implementation challenges. In contrast, Alqahtani, *et al.*, (2023) showed non-localized approaches enhance critical thinking, but Laeen, *et al.*, (2019) warned they can lead to superficial learning and disengagement.

Level of Student Learning Outcomes in Mathematics Before and After LLA and non-LLA. It presents the student learning outcomes exposed to LLA and non-LLA in terms of pretest, posttest and retention test, indicating the frequency and percentage of the scores and qualitative interpretation.

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Table 5: Level of student learning outcomes in mathematics exposed to LLA and non-LLA in terms of pretest, posttest and retention test

Range	QI	GROUP											
		LLA						NLLA					
		Pretest		Posttest		Retention		Pretest		Posttest		Retention	
		f	%	f	%	f	%	f	%	f	%	f	%
90%-100%		0	0%	14	54%	24	92%	0	0	2	7%	7	23%
85%-89%		0	0%	3	12%	2	8%	0	0	4	13%	1	4%
80%-84%		0	0%	5	19%	0	0%	0	0	6	20%	9	30%
75%-79%		0	0%	0	0%	0	0%	0	0	2	7%	3	10%
74% & below		26	100%	4	15%	0	0%	30	100%	16	53%	10	33%
Mean		11.35		26.19		28.92		11.10		22.57		24.77	
MPS		38		87.31		96.41		37.00		75.22		82.56	
		(VLLO)		(HLO)		(VHLO)		(VLLO)		(LLO)		(N)	

Legend:

Range	Qualitative Interpretation
90%-100%	Very High Learning Outcome (VHLO)
85%-89%	High Learning Outcome (HLO)
80%-84%	Neither High nor low Learning Outcome (N)
75%-79%	Low Learning Outcome (LLO)
74% & Below	Very Low Learning Outcome (VLLO)

Based on the pretest results, which show that both groups were classified as "Very Low" level learning outcomes learners, it appears that both groups initially had difficulties with learning outcomes. This implies that both groups of students had low scores before the intervention and may have needed a firm understanding of the ideas being tested in the subject. This is consistent with Bernardo (2021) and Alburo (2023), which found that Filipino students often enter new grade levels with insufficient mastery of prior competencies, particularly in mathematics, leading to low learning outcomes during pretests.

Furthermore, Kuehn (2023) highlights the significance of earlier exposure to the subject under examination. Pretests intended to measure prior knowledge will likely yield low performance results from students who need to become more familiar with the subject. The poor pretest scores indicate insufficient prior knowledge, emphasizing the need for focused interventions to close the knowledge gap and improve learning outcomes.

The results of the students' post-test are shown in Table 5. The LLA group (mean score: 26.19) achieved a "High" level of learning outcome and the NLLA group (mean score: 22.57) achieved a "Low" level of learning outcome. Table 5 reveals a difference in learning outcomes between the groups following the intervention. While LLA group initially achieved a "High" level and NLLA group initially achieved "Low" level, a closer look at the data shows a more varied picture. Notably, 54% of the students in the LLA group achieved the "Very High" level after the intervention, (scores ranging from 90%-100%).

The results for the NLLA group highlight the need for cooperative instruction. While a significant portion (7%) achieved the "Very High" level, indicating the intervention's potential, a concerning number (53%) fell into the "Very Low" category. This suggests that the intervention provided a good foundation for some students, but it may have needed to be more effective for some. This could be due to individuals' learning styles, or the intensity of the intervention itself.

In contrast, the impressive results of the LLA group showcase the intervention's ability to foster a deep understanding of concepts. Their "High" level of learning outcomes signifies not just the effectiveness of the approach, but also its capacity to engage learners actively, and encourage the application of knowledge in real-world scenarios. This localized learning approach ensures that students can relate what they learn to their own experiences, making education more meaningful and impactful. The LLA group's success suggests that the intervention effectively enhances learning by fostering deeper engagement with the material. It demonstrates that a localized learning approach can lead to improved retention of concepts, ultimately resulting in higher academic achievement. This method not only connects theoretical knowledge to real-world applications but also empowers students to take ownership of their learning journey.

Overall, the post-test findings demonstrate progress for both groups. The intervention improved learning outcomes compared to their initial "Very Low" levels. However, the results also emphasize the importance of tailoring interventions to cater the individual needs and learning styles, ensuring all students reach their full potential.

The post-test results shown in Table 5 are consistent with the principles of Localized Learning Approach. According to Johnson and

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Smith (2018), the integration of localized contexts in education significantly enhances student engagement and leads to improved post-test outcomes, demonstrating that contextualized learning can effectively boost academic achievement.

The results of the retention exam, presented in Table 5, further solidify the positive impact of the intervention and reveal exciting insights into student learning. The LLA group had a "Very High" level of learning outcome (mean score: 28.92) compared to their initial "Very Low" level of learning outcome. This sustained performance indicates a firm grasp of the taught concepts and the ability to apply them even after some time. Impressively 92% of the LLA group scored within the "Very High" level of learning outcome category, showcasing a high degree of consistency in their understanding.

In contrast, the NLLA group's performance on retention exam shows a more nuanced picture. While the mean score of 24.77 suggests a "Neither High nor Low" level of learning outcome, which is still an improvement from their baseline, the distribution of scores is concerning. Only 23% of students achieved the "Very High" and 4% of the students achieved the "High" level, with remaining falling into the "Neither High nor Low, Low, and Very Low" category. This highlights a potential gap in the intervention's effectiveness for some learners in the NLLA group.

These findings suggest that the intervention design might be particularly well-suited for the learning styles of the LLA group, leading to learning outcomes and strong knowledge retention. The LLA group's results, on the other hand, indicate a need for further investigation into tailoring the intervention or providing additional support to ensure all students achieve a lasting understanding of the concepts.

The results of this study are consistent with previous studies on the LLA and its effect on long-term knowledge retention, especially the LLA group's better performance on the retention test. Thompson and Carter (2019), the use of localized contexts in instruction significantly improves knowledge retention, thereby enhancing overall learning outcomes and academic achievement.

In further detail, Thompson and Carter (2019) state that the Localized Learning Approach (LLA) not only enhances knowledge retention but also fosters deeper connections between students and the material, resulting in improved learning outcomes. They emphasize that contextualized learning experiences allow students to apply theoretical concepts in real-world situations, which significantly boosts their academic achievement.

Fundamentally, the Localized Learning Approach (LLA) extends beyond learning outcomes. It fosters retention of knowledge by creating meaningful connections between the material and real-world contexts. This approach includes ongoing support mechanisms that encourage students to engage with the content long after formal instruction has ended. According to Davis and Martin (2020), such support systems are crucial for reinforcing learning and ensuring that knowledge is retained and applied effectively.

While NLLA groups exhibited some decline in learning outcome scores between the post-test and retention test. The LLA group, increase in their mean score (from 26.19 to 28.92), from within the "High" level of learning outcome to "Very High" level of learning outcome on the retention test. This increase suggests strong knowledge retention. Notably, the high percentage (92%) of students in the LLA group scoring within the "Very High" category on the retention exam further reinforces this positive outcome.

In contrast, the NLLA group's performance on the retention exam reveals a more concerning trend. Their mean score increased (from 22.57 to 24.77), from the "Low" level on the post-test to "Neither" on the retention test. This suggests a weaker grasp of the underlying concepts. Additionally, the lack of students "Very High" or "High" level of retention exam in the NLLA group highlights a potential shortcoming in the intervention's effectiveness for some learners in this group.

This implies that the intervention may enhance long-term retention for students aligned with its design, as seen in the LLA group's strong performance. The NLLA group's results suggest a need for revisions to promote deeper understanding. LLA's success highlights the importance of real-world scenarios and tailored strategies to create a more inclusive learning experience.

Valderama and Oligo (2021) highlight the natural decline of learning and the need for ongoing engagement to enhance retention. The LLA group's higher retention shows that this strategy effectively promotes long-term mathematical knowledge, focusing on conceptual understanding

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and equipping students to succeed in exams and retain material.

Analysis of Covariance (ANCOVA) of Student Engagement in Mathematics. This delves into the ANCOVA analysis of mathematics students' engagement on the post-test. The reported data includes the means (average scores) and standard deviation (SD) for the LLA and non-LLA groups. The F-value and its associated significance level (sig.) are also presented. The F-value reflects the statistical difference between the group's post-test means, while the significance level indicates whether this difference is statistically meaningful.

Table 6: Comparison of Student Cognitive Engagement in Mathematics on Posttest Scores

Group		N	MEAN	SD
LLA		26	4.3442	.27587
NLLA		30	3.3230	.46349
TOTAL		56	3.7971	.64185

SOURCE	SS	Df	MS	F-Value	Sig.	Partial Eta Squared
GROUP	14.528	1	14.528	94.710	.000 **	.641
PRETEST (Covariate)	.002	1	.002	.015	.902 ns	.000
Error	8.130	53	.153			
Total	830.083	56				

Note * – significant at 0.05 level
ns – not significant at 0.05 level

Table 6 compares the posttest scores of cognitive engagements between two groups: the localized learning approach (LLA) and the non-localized learning approach (NLLA). The LLA group showed a higher average score of 4.3442, indicating greater consistency in their commitment to learning. In contrast, the NLLA group had a lower average score of 3.3230, suggesting it is perceived as less effective in fostering cognitive involvement. These statistics highlight a significant difference in cognitive engagement between the two learning approaches. The total mean score of 3.7971 represents the overall cognitive engagement across both groups. This average indicates that, when considering all participants, the level of cognitive engagement is moderate but lower than that of the LLA group.

The standard deviation for the LLA is 0.27587, which indicates that the scores are closely clustered around the mean, reflecting a high level of agreement among participants about its effectiveness. This consensus likely stems from the structured and context-rich nature of the localized approach, leading to uniformly positive responses. Conversely, the NLLA has a higher standard deviation of 0.463449, suggesting greater variability in responses. This variability implies that while some participants may find the NLLA engaging, others do not, which could be attributed to differences in individual learning preferences or the perceived relevance of non-localized content. The standard deviation of 0.64185 for the total suggests a wider variability in scores among all participants. This means that while some participants may have engaged more fully, there are others who engaged less, highlighting a diverse range of experiences in cognitive involvement across both learning approaches.

The Partial Eta Squared values provide important insights into the effect size of group differences in cognitive engagement. The value for the group is 0.641, indicating a large effect size, which means that the type of learning approach (localized vs. non-localized) accounts for approximately 64.1% of the variance in cognitive engagement scores. This strong effect size underscores the significant impact of the localized learning approach in enhancing cognitive engagement compared to the non-localized approach. In contrast, the Partial Eta Squared value for the pretest covariate is 0.000, suggesting that the pretest scores do not significantly contribute to explaining the variance in posttest cognitive engagement scores. This indicates that prior engagement levels, as measured by the pretest, do not influence the outcomes following the learning interventions. Overall, the analysis highlights the substantial effect of the learning approach on cognitive engagement while showing that the pretest does not play a significant role in this context.

To account for potential beginning differences between the groups, an analysis of covariance (ANCOVA) was performed, with pretest scores as a covariate. This statistical strategy helps isolate the influence of the intervention (LL approach) on cognitive engagement while accounting for any pre-exiting disparities across the groups at the start of the study.

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The result of the ANCOVA analysis statistically confirmed the observed improvement in cognitive engagement among students who participated in the LLA intervention. This is evidenced by significant F-value (94.710) and a p-value less than 0.05. In simpler terms, the observed difference in cognitive engagement between the LLA and control groups is doubtful to be due to chance. This statistically significant effect suggests that the LLA intervention genuinely and positively impacted students' cognitive engagement.

Overall, Table 6's data provides persuasive evidence that the LLA significantly improves students' cognitive engagement compared to the NLLA group. This demonstrates the success of the LLA in fostering greater mental involvement and active participation in the learning process.

This implies that the localized learning approach (LLA) significantly enhances cognitive engagement, as shown by the LLA group's score of 4.3442. LLA fosters deeper engagement, and ANCOVA confirms that improvements are due to the intervention.

These findings support adopting localized strategies to boost engagement, aligning with Gonzales and Reyes (2018), which noted that culturally relevant content increases student interest. The results align with Dela Cruz and Santos (2020), who found that localized curricula enhance cognitive engagement. Villanueva and Bañares (2021) noted that culturally relevant materials boost involvement, while Alonzo and Velez (2021) found increased interest from local culture. Torres and Lim (2022) showed that local resources promote active learning, supporting the positive outcomes in the LLA group.

Table 7: Comparison of Student Affective Engagement in Mathematics on Posttest Scores

Group		N	MEAN	SD	
LLA		26	4.3885	.27177	
NLLA		30	3.3633	.44527	
TOTAL		56	3.8393	.63580	
SOURCE	SS	Df	MS	F-Value	Sig.	Partial Eta Squared
GROUP	13.864	1	13.864	101.099	.000 **	.656
PRETEST (Covariate)	.328	1	.328	2.395	.128 ns	.043
Error	7.268	53	.137			
Total	847.680	56				

Note * – significant at 0.05 level
ns – not significant at 0.05 level

Table 7 presents an analysis of affective engagement, revealing distinct differences between the localized learning approach (LLA) and the non-localized learning approach (NLLA). The mean score for the LLA is 4.3885, indicating a high level of affective engagement among participants, suggesting that this approach is perceived positively and fosters strong emotional involvement. In contrast, the NLLA has a mean score of 3.3633, reflecting lower engagement levels and indicating that this approach may be less effective in promoting emotional connections among learners. The overall mean of 3.8393, situated closer to the NLLA score, suggests that the lower engagement from this approach significantly impacts the average across both groups.

The standard deviation further highlights these differences. The LLA has a standard deviation of 0.27177, which indicates that participants' responses are closely clustered around the high means, demonstrating consistency in their positive affective engagement. Conversely, the NLLA shows a larger standard deviation of 0.44527, signifying greater variability in responses. This suggests that while some participants may find the NLLA engaging, others do not, leading to a wider range of experiences and less consensus on its effectiveness.

The Partial Eta Squared values provide important insights into the effect size of group differences in affective engagement. The value for the group is 0.656, indicating a large effect size, which means that the type of learning approach (localized vs. non-localized) accounts for approximately 65.6% of the variance in affective engagement scores. This strong effect size underscores the significant impact of the localized learning approach in enhancing affective engagement compared to the non-localized approach. In contrast, the Partial Eta Squared value for the pretest covariate is 0.043, suggesting that the pretest scores have a minimal contribution to explaining the variance in posttest affective engagement scores. This indicates that

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prior engagement levels, as measured by the pretest, do not significantly influence the outcomes following the learning interventions. Overall, the analysis highlights the substantial effect of the learning approach on affective engagement while demonstrating that the pretest has a relatively minor role in this context.

To account for potential beginning differences between the groups, an analysis of covariance (ANCOVA) was performed, with pretest scores as a covariate. This statistical strategy helps isolate the influence of the intervention (LL approach) on affective engagement while accounting for any pre-exiting disparities across the groups at the start of the study.

The result of the ANCOVA analysis statistically confirmed the observed improvement in affective engagement among students who participated in the LLA intervention. This is evidence of significant F-value (101.099) and a p-value less than 0.05. In simpler terms, the observed difference in affective engagement between the LLA and control groups is doubtful to be due to chance. This statistically significant effect suggests that the LLA intervention genuinely and positively impacted on students' affective engagement.

Overall, Table 7's data provides persuasive evidence that the LLA significantly improves students' affective engagement compared to the NLLA group. This demonstrates the success of LLA in fostering greater emotional involvement and motivation among students.

This implies that the localized learning approach (LLA) significantly enhances affective engagement, with a mean score of 4.3885 versus 3.3633 for the non-localized approach (NLLA). LLA's lower standard deviation of 0.27177 indicates consistent positive feelings, while NLLA's higher standard deviation of 0.44527 shows varied responses. ANCOVA confirms LLA's effectiveness, highlighting the need for localized methods to boost motivation and deepen learning connections.

The LLA group improved in affective engagement compared to the non-LLA group, aligning with Torres (2020) on the benefits of local culture. Santiago (2022) noted that localized teaching strengthens connections, while Smith and Johnson (2019) emphasized supportive environments boost motivation. Nguyen and Tran (2021) found that localized strategies promote positive emotional responses. These findings support the LLA group's success.

Table 8: Comparison of Student Behavioral Engagement in Mathematics on Posttest Scores

Group		N	MEAN	SD	
LLA		26	4.2238	.40293	
NLLA		30	3.2287	.41328	
TOTAL		56	3.6907	.64394	
SOURCE	SS	Df	MS	F-Value	Sig.	Partial Eta Squared
GROUP	13.786	1	13.786	85.035	.000 **	.616
PRETEST (Covariate)	.420	1	.420	2.588	.114 ns	.047
Error	8.592	53	.162			
Total	785.603	56				

Note * – significant at 0.05 level
ns – not significant at 0.05 level

Table 8 presents an analysis of behavioral engagement, revealing distinct differences between the localized learning approach (LLA) and the non-localized learning approach (NLLA). The mean score for the LLA is 4.2238, indicating a high level of behavioral engagement among participants. This suggests that this approach is perceived positively and effectively encourages active participation. In contrast, the NLLA has a mean score of 3.2287, reflecting lower levels of behavioral engagement and suggesting that this approach may be less effective in promoting active involvement among learners. The overall mean of 3.6907 indicates a moderate level of engagement across both approaches, influenced significantly by the lower engagement of the NLLA.

The standard deviation further highlights these differences. The LLA has a standard deviation of 0.40293, indicating that participants' responses are relatively consistent and closely clustered around the high mean. This consistency suggests that most participants experience similar levels of behavioral engagement with the LLA. Conversely, the NLLA has a standard deviation of 0.41328, which reflects greater variability in responses. This suggests that while some participants may find the NLLA engaging, others do not, leading to a wider range

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of experiences and less consensus regarding its effectiveness.

The Partial Eta Squared values provide important insights into the effect size of group differences in behavioral engagement. The value for the group is 0.616, indicating a large effect size, which means that the type of learning approach (localized vs. non-localized) accounts for approximately 61.6% of the variance in behavioral engagement scores. This strong effect size underscores the significant impact of the localized learning approach in promoting behavioral engagement compared to the non-localized approach. In contrast, the Partial Eta Squared value for the pretest covariate is 0.047, suggesting that the pretest scores have a minimal contribution to explaining the variance in posttest behavioral engagement scores. This indicates that prior engagement levels, as measured by the pretest, do not significantly influence the outcomes following the learning interventions. Overall, the analysis highlights the substantial effect of the learning approach on behavioral engagement while demonstrating that the pretest has a relatively minor role in this context.

To account for potential beginning differences between the groups, an analysis of covariance (ANCOVA) was performed, with pretest scores as a covariate. This statistical strategy helps isolate the influence of the intervention (LL approach) on behavioral engagement while accounting for any pre-exiting disparities across the groups at the start of the study.

The result of the ANCOVA analysis statistically confirmed the observed improvement in behavioral engagement among students who participated in the LLA intervention. This is evidence by significant F-value (85.035) and a p-value less than 0.05. In simpler terms, the observed difference in behavioral engagement between the LLA and control groups is doubtful to be due to chance. This statistically significant effect suggests that the LLA intervention genuinely and positively impacted students' behavioral engagement.

Overall, Table 8's data provides persuasive evidence that the LLA significantly improves students' behavioral engagement compared to the NLLA group. This demonstrates the success of the LLA in fostering greater active participation and involvement among students.

This implies that the localized learning approach (LLA) significantly boosts behavioral engagement, with a mean score of 4.2238 compared to 3.2287 for the non-localized approach (NLLA). The LLA shows consistent high engagement (0.40293), while the NLLA has more variability (0.41328). ANCOVA confirms the LLA's effectiveness, highlighting the need for further development of localized strategies to enhance student participation.

The LLA group showed significant improvement in behavioral engagement compared to the non-LLA group, consistent with López (2021), who found that local culture enhances participation. Mendoza (2022) noted increased involvement, and Bautista (2021) observed greater participation. Chen and Huang (2020) confirmed that cultural connections boost engagement. These findings support the LLA group's success.

Table 9: Comparison of Student Engagement in Mathematics on Posttest Scores

Group		N	MEAN	SD	
LLA		26	4.3231	.24719	
NLLA		30	3.3067	.37950	
TOTAL		56	3.7786	.60443	
SOURCE	SS	Df	MS	F-Value	Sig.	Partial Eta Squared
GROUP	14.063	1	14.063	137.022	.000 **	.721
PRETEST (Covariate)	.265	1	.265	2.578	.114 ns	.046
Error	5.440	53	.103			
Total	819.639	56				

Note * – significant at 0.05 level
ns – not significant at 0.05 level

Table 9 presents an analysis of overall engagement, revealing significant differences between the localized learning approach (LLA) and the non-localized learning approach (NLLA). The mean score for the LLA is 4.3231, indicating a high level of overall engagement among participants. This suggests that the LLA is perceived positively and effectively encourages active involvement. In contrast, the NLLA has a mean score of 3.3067, reflecting lower levels of overall engagement and indicating that this approach may be less effective in fostering participation among learners. The overall mean of 3.7786 indicates a moderate level of engagement

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across both approaches, influenced significantly by the lower engagement of the NLLA.

The standard deviation provides further insight into these differences. The LLA has a standard deviation of 0.24719, indicating that participants' responses are closely clustered around the high mean. This low variability suggests that most participants experience similarly high levels of overall engagement with the LLA, demonstrating consistency in their positive experiences. Conversely, the NLLA has a higher standard deviation of 0.37950, which reflects greater variability in participant responses. This suggests that while some individuals may find the NLLA engaging, others do not, leading to a wider range of experiences and less consensus about its effectiveness.

Partial Eta Squared provide important insights into the effect size of group differences in overall engagement. The value for the group is 0.721, indicating a large effect size, which means that the type of learning approach (localized vs. non-localized) accounts for approximately 72.1% of the variance in overall engagement scores. This strong effect size underscores the significant impact of the localized learning approach in enhancing overall engagement compared to the non-localized approach. In contrast, the Partial Eta Squared value for the pretest covariate is 0.046, suggesting that the pretest scores have a minimal contribution to explaining the variance in posttest overall engagement scores. This indicates that prior engagement levels, as measured by the pretest, do not significantly influence the outcomes following the learning interventions. Overall, the analysis highlights the substantial effect of the learning approach on overall engagement while demonstrating that the pretest has a relatively minor role in this context.

To account for potential beginning differences between the groups, an analysis of covariance (ANCOVA) was performed, with pretest scores as a covariate. This statistical strategy helps isolate the influence of the intervention (LL approach) on mathematics students' engagement while accounting for any pre-exiting disparities across the groups at the start of the study.

The result of the ANCOVA analysis statistically confirmed the observed improvement in mathematics students' engagement among students who participated in the LLA intervention. This is evidenced by significant F-value (137.022) and a p-value less than 0.05. In simpler terms, the observed difference in mathematics students' engagement between the LLA and control groups in doubtful to be due to chance. This statistically significant effect suggests that the LLA intervention genuinely and positively impacted mathematics students' engagement.

Overall, Table 9's data provides persuasive evidence that the LLA significantly improves mathematics students' engagement compared to the NLLA group. This demonstrates the success of the LLA in fostering greater enthusiasm and motivation in their mathematics learning activities.

This implies that the localized learning approach (LLA) significantly boosts engagement in mathematics, with a mean score of 4.3231 compared to 3.3067 for the non-localized approach (NLLA). The LLA demonstrates consistent positive experiences, while the NLLA shows greater variability. ANCOVA confirms the LLA's effectiveness, supporting the continued use of localized strategies to enhance student motivation.

The LLA group significantly improved mathematics engagement compared to the non-LLA group, supporting Santillán, *et al.*, (2021) on localized learning boosting motivation. Thompson and Bennett (2019) noted increased STEM interest, while Oppermann, *et al.*, (2020) confirmed better engagement. Garcia and Lim (2022) highlighted the value of context-based learning, and Nguyen and Martinez (2023) found local contexts enhance interest. These findings affirm the LLA group's success.

Analysis of Covariance (ANCOVA) of Student Learning Outcomes in Mathematics. This delves into the ANCOVA analysis of students' learning outcomes on the post-test. The reported data includes the means (average scores) and standard deviations (SD) for the LLA and non-LLA groups. The F-value and its associated significance level (sig.) are also presented. The F- value reflects the statistical difference between the group's post-test means, while the significance level indicates whether this difference is statistically meaningful.

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Table 10: Comparison of Student Learning Outcomes in Mathematics on Posttest Scores

Group	N	MEAN	SD
LLA	26	26.1923	2.41693
NLLA	30	22.5667	2.75034
TOTAL	56	24.2500	3.15796

SOURCE	SS	Df	MS	F-Value	Sig.	Partial Eta Squared
GROUP	181.191	1	181.191	26.400	.000 **	.332
PRETEST (Covariate)	1.655	1	1.655	.241	.625 ns	.005
Error	363.750	53	6.863			
Total	33480.000	56				

Note * – significant at 0.05 level
ns – not significant at 0.05 level

Table 10 presents an analysis of learning outcomes, highlighting significant differences between the localized learning approach (LLA) and the non-localized learning approach (NLLA). The mean score for the LLA is 26.1923, indicating a high level of learning outcomes among participants. This suggests that the LLA is effective in promoting academic success and knowledge retention. In contrast, the NLLA has a mean score of 22.5667, reflecting lower learning outcomes, which may indicate that this approach is less effective in facilitating learning. The overall mean of 24.2500 shows a moderate level of learning outcomes across both approaches, but it is heavily influenced by the higher performance in the LLA group.

The standard deviation provides additional context for these findings. The LLA has a standard deviation of 2.41693, indicating that participants' scores are closely clustered around the high mean. This low variability suggests that most participants achieved similar, high learning outcomes with the LLA, demonstrating consistent effectiveness across the group. On the other hand, the NLLA has a higher standard deviation of 2.75034, reflecting greater variability in responses. This indicates that while some participants performed well, others did not, leading to a wider range of learning outcomes and less agreement on the approach's effectiveness.

The Partial Eta Squared values provide important insights into the effect size of group differences in learning outcomes. The value for the group is 0.332, indicating a moderate effect size, which means that the type of learning approach (localized vs. non-localized) accounts for approximately 33.2% of the variance in learning outcome scores. This effect size suggests a noteworthy impact of the localized learning approach on improving learning outcomes compared to the non-localized approach. In contrast, the Partial Eta Squared value for the pretest covariate is 0.005, indicating that the pretest scores make a negligible contribution to explaining the variance in posttest learning outcomes. This suggests that prior knowledge, as measured by the pretest, do not significantly influence the outcomes following the learning interventions. Overall, the analysis highlights the meaningful effect of the learning approach on learning outcomes while demonstrating that the pretest plays a minimal role in this context.

To account for potential beginning differences between the groups, an analysis of covariance (ANCOVA) was performed, with pretest scores as a covariate. This statistical strategy helps isolate the influence of the intervention (LL approach) on students' learning outcomes while accounting for any pre-exiting disparities across the groups at the start of the study.

The result of the ANCOVA analysis statistically confirmed the observed improvement in students' learning outcomes among students who participated in the LLA intervention. This is evidenced by significant F-value (26.400) and a p-value less than 0.05. In simpler terms, the observed difference in students' learning outcomes between the LLA and control groups is doubtful to be due to chance. This statistically significant effect suggests that the LLA intervention genuinely and positively impacted students' learning outcomes.

Overall, Table 10's data provide persuasive evidence that the LLA significantly improves students' learning outcomes compared to the NLLA group. This demonstrates the success of the LLA in fostering greater understanding and retention of mathematical concepts among students.

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This implies that the localized learning approach (LLA) significantly enhances student outcomes, achieving a mean score of 26.1923 compared to 22.5667 for the non-localized approach (NLLA). The LLA's low standard deviation indicates consistent performance, while the NLLA shows greater variability. ANCOVA confirms the LLA's effectiveness, advocating for localized strategies to improve understanding and retention in mathematics.

The LLA group significantly improved learning outcomes compared to the non-LLA group, supporting Alonzo (2021) on enhanced problem-solving skills. Navarro (2022) found similar gains in Grade 5 students, while Morales (2021) highlighted better engagement with local resources. Santos and Dela Cruz (2023) noted improvements in elementary students, and Reyes and Alonzo (2022) reported enhanced performance in urban settings, affirming the LLA group's effectiveness.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The findings of the study highlight the impact of the Localized Learning Approach on mathematics students' engagement and learning outcomes. First, the evidence demonstrates that this approach markedly enhances student engagement across cognitive, affective, and behavioral dimensions. Specifically, cognitive engagement transitions from low to high levels post-intervention, indicating that students are not only more involved but also more intellectually stimulated by the localized content. Similarly, affective engagement improves from slightly high to high, suggesting that students develop a stronger emotional connection to the material. Behavioral engagement also shows an increase from slightly high to high, reflecting greater participation and interaction in classroom activities. In contrast, the Non-Localized Learning Approach yields only modest improvements, emphasizing the effectiveness of localized methods in fostering a deeper connection to the subject matter.

Moreover, the Localized Learning Approach influences students' learning outcomes. Initially, students exhibit very low learning outcomes, but these dramatically improve to high levels in the posttest and reach very high levels in the retention test. This progression starkly contrasts with the Non-Localized Learning Approach, where students exhibit only slight advancements in learning outcomes. Such results underscore the importance of contextual relevance in education, as students who engage with material that resonates with their local experiences and knowledge tend to achieve better academic results.

Additionally, the analysis reveals a significant difference in engagement levels when comparing students exposed to the Localized Learning Approach with those in the Non-Localized Learning Approach, using pretest scores as a covariate. The localized approach fosters substantial improvements in cognitive, affective, and behavioral engagement, suggesting that students are not only more involved but also more positively influenced by the localized context of their learning experience. This finding reinforces the notion that educational strategies should be tailored to the cultural and social contexts of the students to maximize engagement and learning.

Furthermore, when examining learning outcomes, a significant difference is again observed, with the Localized Learning Approach leading to significantly improved results compared to the Non-Localized Learning Approach. This highlights the effectiveness of localized methods in promoting not just engagement but also meaningful learning outcomes that students can retain over time.

RECOMMENDATIONS

In today's diverse educational landscape, it is essential for educators to adopt teaching strategies that resonate with students' cultural backgrounds and personal experiences. One such strategy is the Localized Learning Approach (LLA), which integrates culturally relevant materials and local examples into the mathematics curriculum. This approach not only enhances cognitive, affective, and behavioral engagement but also fosters a deeper connection between students and the mathematical concepts being taught.

To enhance cognitive, affective, and behavioral engagement, educators should incorporate culturally relevant materials and local examples into their mathematics curriculum. This approach will help students connect mathematical concepts to their own experiences, fostering deeper understanding and motivation. By making the content more relatable, students are likely to feel more invested in their learning, which can lead to increased participation and enthusiasm in the classroom.

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Additionally, administrators may implement professional development programs for teachers focused on the Localized Learning Approach. Training educators to effectively integrate localized content into their teaching practices can significantly improve students' learning outcomes and knowledge retention. Equipping teachers with the necessary tools and strategies will enable them to create more engaging and effective learning environments that cater to the needs of their students.

To address the differences in engagement levels between students exposed to the Localized Learning Approach (LLA) and those in the Non-Localized Learning Approach (NLLA), educational institutions may conduct regular assessments of student engagement and learning outcomes. Analyzing this data will allow for instructional adjustments that better meet the needs of students in both approaches, ensuring that all learners receive the support and encouragement they require to succeed.

Furthermore, administrators may prioritize the adoption of the LLA in their curricula. Emphasizing this method can enhance students' academic performance and ensure that learning experiences are not only meaningful but also relevant to their lives. By integrating localized content, schools can foster a deeper connection between students and their learning, ultimately leading to better educational outcomes.

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