

Examining Students' Mathematical Mastery through Localized Math Tutorials (LMT) On Integer Operations

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Abstract: This study, "Examining Students' Mathematical Mastery through Localized Math Tutorials (LMT) on Integer Operations," explores how bilingual (English and Visayan) video tutorials affect students' understanding of operations of integers. Using a quasi-experimental design, the research compared the pretest, post-test, and retention test scores of students using LMT against those receiving conventional instruction. Results showed that students using LMT scored higher in post-tests and retention tests, indicating better mastery and long-term retention of integer operations. These findings highlight the effectiveness of localized instructional materials in overcoming language barriers and enhancing engagement and comprehension in mathematics.

Keywords: mathematical mastery, localized math tutorials, bilingual instruction, integer operations, student motivation.

BACKGROUND OF THE STUDY

Mathematics is a fundamental discipline that underpins the development of logical reasoning, critical thinking, and problem-solving skills essential for both academic success and daily life (National Research Council, 2001; Kilpatrick, Swafford, & Findell, 2001). Within this domain, operations on integers—specifically addition, subtraction, multiplication, and division—form the bedrock for more advanced mathematical topics such as algebra, geometry, statistics, and trigonometry (NCTM, 2014). Early mastery of these skills is crucial, as difficulties at the foundational level often result in persistent learning gaps that hinder students' progression through the mathematics curriculum (Abedi, 2015; Siegler, *et al.*, 2012).

Several studies have highlighted that students across various educational contexts struggle significantly with integer operations, with challenges most pronounced in abstract operations involving negative numbers (Chesney, 2019; Hiebert & Grouws, 2007). This issue is particularly evident in developing countries, where systemic challenges—such as large class sizes, limited instructional resources, and language barriers—further exacerbate students' difficulties in acquiring mathematical mastery (UNESCO, 2017; Bautista, Bernardo, & Ocampo, 2020).

The 2018 Programme for International Student Assessment (PISA) revealed that the Philippines ranked 78th out of 79 participating countries in mathematical literacy, with Filipino students achieving an average score of 353—well below the OECD average of 489 (OECD, 2018). Alarming, only 16% of students reached at least Level 2 proficiency, the baseline indicating the ability to

solve basic mathematical problems, compared to 69% across OECD countries. Moreover, almost no Filipino students attained the highest proficiency levels (Levels 5 or 6), where the OECD average is 9%. These findings are consistent with the National Achievement Test (NAT) results, which indicated a continuous decline in mathematics performance, with average scores falling below national proficiency benchmarks (Department of Education [DepEd], 2018). This baseline data underscores a pressing need for innovative and culturally contextualized teaching strategies to address both the academic deficiencies and motivational gaps among Filipino learners.

In response, the Department of Education introduced the Matatag Curriculum, which emphasizes strengthening foundational skills and promoting academic excellence through contextually relevant, engaging, and innovative instructional approaches (DepEd, 2019a). Additionally, DepEd Memorandum No. 21, Series of 2020, specifically advocates for the development and use of culturally and linguistically contextualized learning materials as a means to enhance learning outcomes, particularly in multilingual regions (DepEd, 2020).

Research supports the positive impact of localized instructional materials on student learning. According to Villegas (2017) and Nolasco (2018), students who learn in their mother tongue demonstrate better understanding, increased confidence, and improved academic performance. Ball (2011) emphasized that language is not merely a vehicle of communication in education but also shapes cognitive processes, especially in the comprehension of abstract concepts like mathematics. In regions like Mindanao, where Visayan and Binukid are the prevalent dialects, the

integration of these languages into instructional materials can significantly bridge the comprehension gap (Garcia, 2019; Cabansag, 2020).

Moreover, Vygotsky's Sociocultural Theory (1978) argues that learning is deeply influenced by social interaction and cultural context. When instructional materials reflect the learner's own culture and language, they become more meaningful and facilitate deeper cognitive engagement (Lantolf & Thorne, 2006). This is echoed by Cummins' (2000) Linguistic Interdependence Hypothesis, which posits that skills learned in the first language can transfer to second-language learning, thereby enhancing academic achievement.

Beyond language, the use of multimedia tools in education has been shown to significantly improve students' comprehension and retention of concepts. Mayer's Cognitive Theory of Multimedia Learning (2017) states that learners benefit most from instructional designs that effectively combine text, visuals, and audio narration, as this optimizes cognitive load and supports dual-channel processing. Studies by Clark and Mayer (2016) and Moreno & Mayer (2007) found that well-designed multimedia materials enhance students' engagement, comprehension, and long-term retention of information.

In the Philippine context, localized digital materials, such as video tutorials in local dialects, have shown promise. Garcia and Santos (2019) found that students exposed to bilingual math videos demonstrated higher achievement and engagement levels compared to those receiving traditional instruction. Similarly, Bautista, *et al.* (2020) emphasized that technology-integrated learning materials, especially when localized, improve both motivation and performance in mathematics.

RATIONALE OF THE STUDY

Given these findings, this study titled "Examining Students' Mathematical Mastery through Localized Math Tutorials (LMT) on Integer Operations" aims to develop and evaluate bilingual instructional videos in English and Visayan, designed to be both culturally relevant and pedagogically sound. The focus on integer operations stems from their critical role in shaping students' overall mathematical competence. The use of localized multimedia addresses both the linguistic

challenges and the engagement barriers that hinder students' success in mathematics.

To ensure validity and reliability, the test instrument will undergo pilot testing among Grade 8 learners, with reliability confirmed via Cronbach's Alpha. Pretests will establish baseline competency levels, followed by the implementation of the localized tutorials. Posttests will assess immediate learning gains, and a retention test administered two weeks later will evaluate the long-term impact of the intervention. This retention test is critical to measure whether the students have internalized and retained the concepts over time, reflecting true mathematical mastery rather than short-term memorization (Brown, Roediger, & McDaniel, 2014).

The study, conducted in a community where Visayan and Binukid are the dominant dialects, aims to contribute valuable insights into the efficacy of localized multimedia instruction. It aligns with the goals of the Matatag Curriculum and seeks to inform future educational policies that prioritize context-sensitive, technology-enhanced learning interventions. Ultimately, the findings may serve as a model for localized instruction in multilingual settings, with potential scalability to other regions facing similar educational challenges.

MATERIALS AND METHODS

This study adopts a quantitative non-equivalent pretest-posttest quasi-experimental design to assess the impact of Localized Math Tutorials (LMT) on the academic performance and motivation of Grade 7 learners at Basac Integrated School, located in P-2 Basac, Lantapan, Bukidnon, Philippines. This design is appropriate for real-world educational settings where random assignment is not feasible, allowing the researcher to evaluate instructional interventions while maintaining ecological validity (Creswell & Creswell, 2018).

Two intact Grade 7 classes, comprising a total of 70 students, were divided into two heterogeneous sections: Grade 7-A (control group) and Grade 7-B (experimental group). Both groups received standard classroom instruction on operations on integers, a foundational topic in mathematics critical for progression to higher-order concepts such as algebra and trigonometry (Abedi, 2015). The control group supplemented their learning with English-language video tutorials sourced from YouTube, while the experimental group

utilized teacher-developed localized video tutorials in the Visayan dialect—a language predominantly spoken in the region alongside Binukid (Nolasco, 2018). The use of Visayan aimed to promote linguistic accessibility and cultural relevance, aligning with DepEd Memorandum No. 21, s. 2020, which mandates the use of contextualized learning resources to improve learner engagement and outcomes (Department of Education [DepEd], 2020).

To measure mathematical mastery, both groups undertook pretests and posttests adapted from *The Integer Test of Primary Operations* developed by Julie Nurnberger-Haag, *et al.*, containing 27 objective questions focusing on integer operations. The instrument's reliability was confirmed through Cronbach's Alpha, ensuring internal consistency. A pilot test was conducted among Grade 8 learners to validate clarity and appropriateness of test items prior to administration (Creswell & Creswell, 2018).

The pretest was utilized to establish the learners' initial competency levels, ensuring baseline equivalence between the two groups. Following the instructional intervention, a posttest was administered to assess immediate learning gains. To measure long-term retention, a retention test was conducted two weeks post-intervention. This retention phase was critical in evaluating sustained understanding, as true mastery of mathematical concepts involves not only short-term recall but also long-term retention (Brown, *et al.*, 2014; Mayer, 2017). According to Mayer's (2017) Multimedia Learning Theory, integrating visual and auditory content in the learners' native language reduces cognitive load and enhances comprehension and memory retention.

Furthermore, qualitative data from students' reflection notebooks indicated a strong preference for localized tutorials, citing better comprehension and engagement. This anecdotal evidence complements findings by Cummins (2000) and Garcia, *et al.* (2017), who assert that mother tongue instruction can significantly improve learner outcomes by mitigating language-related barriers.

Ethical considerations were observed throughout the study. Informed consent was secured from all participants and their guardians, while coordination with the school head, teachers, and parents ensured systematic implementation and compliance with institutional policies.

This intervention addresses integer operations due to its centrality in mathematics education and the observed challenges Filipino learners face in mastering this competency, as highlighted in the National Achievement Test (DepEd, 2018) and PISA 2018 Results (OECD, 2018). The study aims to contribute evidence on the effectiveness of localized, culturally contextualized instructional materials in enhancing mathematical performance and motivation among learners in linguistically diverse settings.

RESULTS AND DISCUSSIONS

A t-test for two independent samples assuming unequal variances was conducted to analyze the differences between the control group (Group A) and the experimental group (Group B) across three testing phases: Pretest, Posttest, and Retention Test. All statistical tests were evaluated at a 0.05 level of significance ($\alpha = 0.05$).

Table 1: Pretest Results

Group	Mean	Variance	n	t Stat	P(T<=t) one-tail	t Critical one-tail	Significance
A	9.23	21.01	30	-1.50	0.0693	1.6720	Not Significant
B	11.17	28.70	30				

The pretest results showed no statistically significant difference between Group A ($M = 9.23$) and Group B ($M = 11.17$), with a p-value of 0.0693, which exceeds the threshold of 0.05. This establishes baseline equivalence between the two groups, indicating that both cohorts possessed comparable initial knowledge and skills

concerning integer operations. As recommended by educational researchers (Creswell & Creswell, 2018; Fraenkel, Wallen, & Hyun, 2015), such equivalence is essential in quasi-experimental designs to ensure that observed differences post-intervention are attributable to the treatment rather than pre-existing disparities.

Table 2: Posttest Results

Group	Mean	Variance	n	t Stat	P(T<=t) one-tail	t Critical one-tail	Significance
A	9.40	16.59	30	-2.09	0.0209	1.6787	Significant
B	12.53	50.67	30				

The posttest findings revealed a statistically significant difference between Group A ($M = 9.40$) and Group B ($M = 12.53$), with a p-value of 0.0209, below the 0.05 alpha level. This indicates that the intervention applied to the experimental group—specifically, the use of localized math tutorials (LMT)—resulted in measurable improvements in performance. The mean score gain of 3.13 points in Group B reflects a moderate

learning effect, supporting the notion that culturally and linguistically relevant materials can positively influence student engagement and comprehension (Villegas, 2017; Nolasco, 2018). This is aligned with Mayer's Multimedia Learning Theory (2017), which highlights the cognitive benefits of integrating visual, auditory, and textual modalities, particularly when materials are contextually meaningful to learners.

Table 3: Retention Test Results

Group	Mean	Variance	n	t Stat	P(T<=t) one-tail	t Critical one-tail	Significance
A	9.30	12.36	30	-3.29	0.00097	1.6787	Significant
B	13.60	38.94	30				

Two weeks following the posttest, a retention test was conducted to assess the long-term learning effects of the intervention. The results demonstrated a highly significant difference between Group A ($M = 9.30$) and Group B ($M = 13.60$), with a p-value of 0.00097, far below the 0.05 threshold. The mean difference of 4.3 points highlights the sustained impact of the localized tutorials, suggesting that students in Group B retained the learned content more effectively over time.

Conducting a retention test is essential for determining whether knowledge acquisition translates into long-term mastery rather than transient recall. According to Brown, Roediger, and McDaniel (2014), retention assessments are more reliable indicators of deep understanding, particularly in subjects like mathematics where conceptual transfer and application are vital. The significant improvement in Group B's retention scores implies that localized instructional strategies may enhance cognitive processing, memory consolidation, and learning engagement.

CONCLUSION

The data across the Pretest, Posttest, and Retention phases indicate that while both groups began with comparable baseline knowledge, the experimental group—exposed to teacher-developed, localized Visayan math tutorials—demonstrated significantly higher academic performance and better long-term retention of content related to integer operations.

In contrast, the control group, which relied on standard English-language YouTube tutorials,

exhibited lower gains in both immediate and sustained assessments. These findings underscore the pedagogical value of localized materials, which likely helped reduce linguistic barriers, increase student engagement, and promote deeper comprehension.

Furthermore, the sustained performance gains in the retention test suggest that localized and culturally relevant materials not only support immediate learning but also lead to lasting educational outcomes. These outcomes are consistent with Vygotsky's Sociocultural Theory (1978) and Cummins' (2000) findings on linguistic interdependence, both of which affirm that students learn more effectively when instruction is aligned with their linguistic and cultural backgrounds.

In conclusion, this study provides empirical support for the integration of localized math tutorials as a viable and effective educational strategy in multilingual contexts. It further emphasizes the need for context-sensitive instructional innovation aligned with the goals of the Matatag Curriculum and DepEd's advocacy for culturally contextualized learning materials. Future research is recommended to assess the scalability of such interventions across other subject areas and learner populations.

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