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# EFFECT OF CODE-SWITCHING INSTRUCTION ON ERROR REDUCTION IN INTEGER OPERATIONS AMONG GRADE 7 LEARNERS

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## ABSTRACT

*This study determined the effect of code-switching on errors in integer operations among Grade 7 learners at Crisanto M. Ciriaco Integrated School, Concepcion, Iloilo, during the School Year 2025–2026. A quasi-experimental non-equivalent control group pretest–posttest design was employed, involving sixty (60) learners, with thirty (30) assigned to the experimental group and thirty (30) to the control group. The experimental group received instruction through intentional code-switching (English–Hiligaynon), while the control group was taught using English-only instruction. A validated 40-item researcher-made test was used to gather data. Descriptive and inferential statistics were applied at a 0.05 level of significance. Results revealed that both groups had comparable pretest performance at the Low Proficiency level. After the intervention, the experimental group improved to Nearly Proficient, while the control group remained at Low Proficiency. A statistically significant difference in posttest performance was found in favor of the experimental group. Moreover, only the experimental group showed significant improvement from pretest to posttest. In terms of error reduction, the experimental group demonstrated a substantially greater decrease in errors compared to the control group. The findings indicate that teacher-led code-switching is an effective instructional strategy for improving mathematics performance and reducing errors in integer operations. The study recommends the integration of code-switching in mathematics instruction to enhance learners' comprehension and learning outcomes.*

**KEYWORDS**: *code-switching, integer operations, mathematics performance, error reduction, Grade 7 learners*

## I. INTRODUCTION

Mathematics Mathematics is a core subject in basic education, yet many junior high school learners continue to struggle with foundational skills, particularly in integer operations. In several public schools in Iloilo, including island communities, Grade 7 learners consistently commit errors despite repeated instruction and remediation. These persistent difficulties are also reflected in regional assessment results such as the Enhanced Regional Unified Numeracy Test (ERUNT), which shows low performance in basic mathematical operations.

One factor that may contribute to these challenges is the language of instruction. In the Philippines, Mathematics is taught in English as mandated by the Department of Education (DepEd, 2019). However, many learners are multilingual and may have limited proficiency in English, which can hinder comprehension of mathematical concepts and procedures.

Previous studies suggest that code-switching can support understanding in multilingual classrooms. It has been found to improve comprehension, reduce confusion, and enhance classroom participation (Maluleke, 2019; Garcines & Alvarez, 2017; Yusob et al., 2018). In the Philippine context, code-switching is commonly used as an instructional strategy to clarify difficult concepts (Borlongan, 2012; Bravo-Sotelo, 2020).

Despite these findings, there is limited empirical evidence on whether code-switching can specifically reduce computational errors in Mathematics, particularly in integer operations. In addition, quasi-experimental studies focusing on English–Hiligaynon code-switching in actual classroom instruction remain scarce in Western Visayas.

This study, therefore, investigates the effect of code-switching instruction on error reduction in integer operations among Grade 7 learners at Crisanto M. Ciriaco Integrated School, an island public junior high school in Concepcion, Iloilo. It aims to provide empirical evidence on whether structured use of code-switching can improve learners' accuracy in Mathematics.

## II. LITERATURE REVIEW

### A. Code-Switching in Mathematics Instruction

Code-switching, defined as the use of two or more languages within a single discourse (Gumperz, 1982), is a common practice in multilingual classrooms. In educational contexts, it is not viewed as a deficiency in language proficiency but as a strategic pedagogical tool that facilitates understanding (Macaro, 2001). In mathematics instruction, where abstract concepts and specialized vocabulary are prominent, code-switching enables teachers to bridge linguistic gaps and make content more accessible to learners (Setati & Adler, 2000).

Research indicates that code-switching serves multiple instructional functions. One of its primary purposes is clarification, particularly when learners struggle with technical terms or complex procedures. Ferguson (2003) noted that

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teachers often shift to the learners' first language to simplify explanations, especially in cognitively demanding topics. Similarly, Abad (2010) found that Filipino teachers use code-switching to rephrase mathematical concepts when learners show signs of confusion. This practice enhances comprehension by linking unfamiliar academic language to more familiar linguistic structures.

Code-switching also functions as a tool for emphasis and reinforcement. Cook (2001) explained that switching to the learners' first language highlights key rules and procedures, making them more memorable. In mathematics, this is particularly useful in teaching integer operations, where learners must recall rules involving positive and negative numbers. Martin (2005) further observed that teachers often repeat instructions in both languages to ensure accuracy and reduce procedural errors.

In addition, code-switching supports classroom interaction and learner engagement. Üstünel and Seedhouse (2005) found that teachers use the learners' first language to manage classroom behavior and encourage participation. In multilingual settings, this practice creates a more inclusive learning environment where learners feel comfortable expressing their ideas. Probyn (2009) emphasized that code-switching helps sustain learner attention, particularly during challenging mathematical tasks.

From a cognitive perspective, code-switching aligns with learners' natural language practices. García and Wei (2014) argued that bilingual individuals draw from their full linguistic repertoire when constructing meaning. In mathematics learning, this allows learners to process concepts in their first language before expressing them in English. Moschkovich (2002) similarly observed that learners often engage in internal code-switching during problem solving, suggesting that language alternation supports both comprehension and reasoning.

Overall, the literature positions code-switching as a purposeful and multifaceted instructional strategy that enhances clarity, reinforces key concepts, and promotes active participation in mathematics classrooms., information processing, and executive functioning, to improve learning outcomes.

### B. Benefits of Code-Switching in Mathematics Learning

A growing body of research highlights the cognitive and affective benefits of code-switching in mathematics education. One of its key advantages is the reduction of cognitive load. According to Sweller's (1994) Cognitive Load Theory, learning becomes more effective when unnecessary mental demands are minimized. In mathematics classrooms, the exclusive use of English may impose additional cognitive burden on learners who must simultaneously process language and mathematical concepts. Code-switching reduces this burden by allowing learners to focus on problem-solving rather than translation.

Empirical studies support this claim. Moussa-Inaty (2015) found that learners in bilingual classrooms demonstrated better understanding of mathematical tasks when instruction incorporated code-switching. By reducing language-related difficulties, learners were able to allocate more cognitive resources to reasoning and computation.

Code-switching also enhances conceptual understanding, particularly in abstract topics such as integers. Adler (2001) emphasized that language plays a critical role in making mathematical ideas accessible. When teachers explain concepts in the learners' first language, abstract ideas become more concrete and easier to grasp. Setati and Barwell (2008) further explained that multilingual learners use their languages complementarily to construct meaning, enabling them to connect prior knowledge with new concepts.

Beyond cognitive benefits, code-switching positively influences learners' affective development. Probyn (2010) reported that learners become more confident and participative when instruction incorporates their home language. Similarly, Lee (2016) found that learners in multilingual classrooms were more willing to ask questions and engage in discussions when code-switching was permitted. This increased participation contributes to deeper understanding and improved performance.

Taken together, these studies suggest that code-switching enhances both comprehension and engagement, making it a valuable instructional strategy in mathematics learning.learners.

### C. Code-Switching and Learners' Errors in Mathematics

Errors in mathematics are often attributed to misconceptions or procedural difficulties; however, research indicates that language barriers also play a significant role. Bernardo (2005) found that Filipino learners sometimes misinterpret mathematical terms when instruction is delivered solely in English, leading to incorrect responses. Similarly, Cummins (2000) argued that learners' difficulties may stem from limited language proficiency rather than lack of mathematical ability.

Local studies provide further support for this relationship. Tejero (2019) reported that students committed fewer errors in integer operations when teachers used code-switching during instruction. Likewise, Bautista and Bernardo (2021) found that bilingual presentation of word problems improved learners' comprehension and reduced misinterpretation.

International research aligns with these findings. Clarkson (2007) observed that bilingual learners who used both their first language and English demonstrated fewer logical errors in mathematical tasks. Code-switching allowed learners to verify their understanding and refine their reasoning before arriving at a final answer.

These findings suggest that code-switching helps reduce errors by eliminating language-related misunderstandings, enabling learners to focus on mathematical reasoning and accuracy.mathematics.

### D. Students' Errors and Performance in Integer Operations

Integer operations are widely recognized as a challenging topic in mathematics due to their abstract nature and reliance on sign rules. Research consistently shows that learners experience

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persistent difficulties in applying operations involving positive and negative numbers.

Foreign studies indicate that students frequently commit systematic errors, such as sign confusion and incorrect application of rules (Lin & Riccomini, 2025). For example, learners may incorrectly solve −5 + (−3) as +8 or misinterpret subtraction involving negative numbers. Bishop et al. (2014) explained that these errors often result from reliance on procedural knowledge without conceptual understanding.

In the Philippine context, similar patterns have been observed. Flores et al. (2024) reported that Grade 7 learners show lower performance in integer subtraction compared to other operations. Aquiler (2023) identified misconceptions and incorrect rule application as common sources of error. Ramos and Obispo (2021) further noted that learners frequently misinterpret problem instructions, indicating the influence of language on performance.

Mathematics performance is closely linked to both conceptual understanding and instructional practices (NCTM, 2017; OECD, 2019). Moschkovich (2002) emphasized that learners construct mathematical meaning through language and interaction, highlighting the importance of comprehensible instruction. When language barriers are reduced, learners are better able to engage in reasoning and problem solving.

These findings underscore the need for instructional strategies that address both conceptual and linguistic challenges, particularly in topics such as integer operations.

The reviewed literature highlights the critical role of language in mathematics learning. Code-switching emerges as an effective instructional strategy that enhances comprehension, reduces cognitive load, and promotes learner engagement. Both foreign and local studies consistently demonstrate that teacher-led code-switching improves understanding and may reduce errors in mathematical tasks.

At the same time, research on integer operations reveals persistent difficulties among learners, particularly in applying sign rules and interpreting problem statements. These errors are often linked not only to conceptual gaps but also to language-related challenges.

Despite these findings, limited empirical studies have examined the direct effect of code-switching on error reduction in integer operations, particularly in the Philippine context. This gap highlights the need for further investigation into how structured code-switching strategies can improve learners' performance.

## III. PURPOSE OF THE STUDY

This study aimed to determine the effect of code-switching instruction on error reduction in integer operations among Grade 7 learners in an island school in Concepcion, Iloilo.
Specifically, the study aimed to answer the following questions

1. What is the pretest mathematics performance of Grade 7 learners in integer
   operations in the experimental and control groups?
2. Is there a significant difference in the pretest mathematics performance of Grade 7 learners in integer operations in the experimental and control groups?
3. What is the posttest mathematics performance of Grade 7 learners in integer
   operations in the experimental and control groups?
4. Is there a significant difference in the posttest mathematics performance of the experimental and control groups after the use of code-switching in instruction?
5. What is the level of mathematics performance of Grade 7 learners in the pretest and posttest of both experimental and control groups?
6. Is there a significant difference in the mathematics performance of Grade 7
   learners in integer operations between the pretest and posttest of the experimental group exposed to code-switching instruction and the control group?
7. What is the extent of error reduction in integer operations among learners in the experimental group compared to the control group?

## IV. THEORETICAL FRAMEWORK

This study was primarily anchored in Vygotsky's Sociocultural Theory of Learning (1978), which emphasizes the fundamental role of social interaction and language in cognitive development. According to Vygotsky, learning first occurs at the social level through interaction with more knowledgeable others, such as teachers, before it is internalized by the learner.

In multilingual classroom settings, the use of learners' home language becomes a powerful form of instructional support. Vygotsky's concept of the Zone of Proximal Development (ZPD) explains that learners are able to perform tasks more effectively when provided with appropriate scaffolding. In mathematics instruction, code-switching functions as a form of linguistic scaffolding that enables teachers to explain abstract ideas, clarify procedures, and guide learners through difficult problem-solving processes. By temporarily shifting to a familiar language, teachers help learners bridge the gap between prior knowledge and new mathematical concepts.

This theoretical perspective is particularly relevant to teaching integer operations, a topic that many Grade 7 learners find challenging due to abstract rules and symbolic representations. When instruction is delivered exclusively in English, learners with limited language proficiency may struggle to follow explanations, leading to misunderstandings and repeated computational errors. Through code-switching, teachers can reduce linguistic barriers and support learners in constructing meaning within their ZPD, thereby improving understanding and accuracy in solving integer problems.

The study was further supported by Cognitive Load Theory (Sweller, 1994), which posits that learners have limited working memory capacity. In English-only mathematics instruction, learners are required to process both mathematical procedures and

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a second language simultaneously, which may increase cognitive load and contribute to errors. The strategic use of code-switching during instruction may help reduce this cognitive burden by allowing learners to focus more on the mathematical task rather than on language comprehension.

The study is further supported by Translanguaging Theory, as proposed by García (2009), which views bilingualism as an integrated system in which learners use their full linguistic repertoire to construct meaning. Unlike traditional views that separate languages, translanguaging emphasizes the flexible and purposeful use of multiple languages in the learning process. In the context of mathematics instruction, this suggests that code-switching between English and Hiligaynon is not merely a communication strategy but a cognitive tool that enables learners to better understand complex concepts. By allowing learners to process information using both languages, translanguaging supports deeper comprehension, facilitates meaning-making, and enhances problem-solving skills.

Grounded in these theoretical perspectives—Sociocultural Theory, Cognitive Load Theory, and Translanguaging Theory—the present study assumes that teacher-led code-switching, when used intentionally during mathematics instruction, can support learners' understanding and lead to a reduction in errors in integer operations.

## V. CONCEPTUAL FRAMEWORK

This study is guided by the conceptual model as shown in the paradigm.

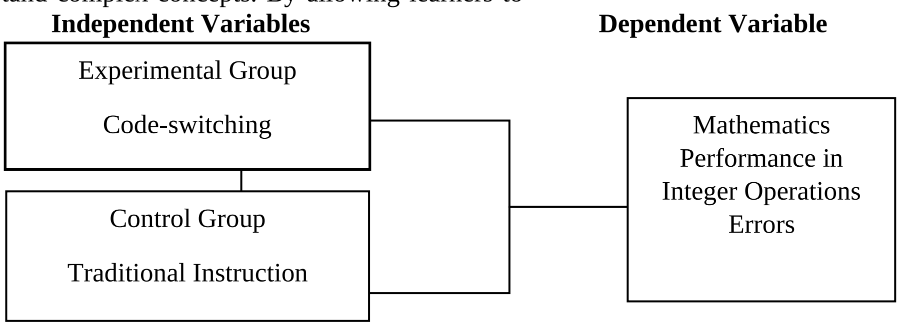


Figure 1. The Effect of Code-Switching Instruction on Error Reduction in Integer Operations Among Grade 7 Learners

The figure shows the effect of code-switching instruction on error reduction in integer operations among Grade 7 learners. The independent variable is the instructional approach, which includes code-switching for the experimental group and traditional instruction for the control group. The dependent variable is the learners' mathematics performance in terms of errors in integer operations.

## VI. METHODOLOGY

### A. Research Design

This study employed a quasi-experimental non-equivalent control group pretest–posttest design to determine the effect of code-switching on errors in integer operations among Grade 7 learners. Two intact classes were used: the experimental group received instruction through code-switching (English–Hiligaynon), while the control group was taught using English-only instruction. Both groups took the same pretest and posttest.

### B. Subjects of the Study

The participants were sixty (60) Grade 7 learners from Crisanto M. Ciriaco Integrated School during the School Year 2025–2026. Each group consisted of thirty (30) learners. The classes were selected based on availability, and random assignment was not possible. Pretest results were used to establish baseline equivalence between groups.

### C. Research Instrument

A researcher-made 40-item test was used to measure learners' performance in integer operations. The test covered addition, subtraction, multiplication, division, mixed operations, and word problems involving integers, aligned with the Grade 7 Mathematics MATATAG Curriculum Guide. Each correct answer was scored as one point, with a total possible score of 40.

The instrument was validated by experts to ensure content accuracy and clarity, and revisions were made based on their recommendations. It was also pilot-tested among Grade 7 learners from a different school who were not part of the actual study to assess item clarity, difficulty, and suitability. The results of the pilot testing indicated that the items were generally clear and appropriate; thus, no major revisions were necessary.
Reliability analysis using Cronbach's alpha yielded a coefficient of 0.895, indicating a high level of internal consistency of the test.

### D. Data Analysis

After The data collected from the pretest and posttest were analyzed using descriptive and inferential statistics. Mean and standard deviation were computed to describe the mathematics performance of learners in both the experimental and control groups.

The test consisted of 40 items. To determine learners' errors, error rates were computed using the formula:

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$$Error\ Rate\ (\%) = \left(\frac{40 - \text{mean score}}{40}\right) \times 100$$

This formula was applied to both pretest and posttest results to measure the percentage of incorrect responses.
To determine improvement, the extent of error reduction was computed using the formula:

$$Error\ Reduction\ (\%) = \left(\frac{\text{Pretest Error Rate} - \text{Posttest Error Rate}}{\text{Pretest Error Rate}}\right) \times 100$$

This measure represents the proportional decrease in errors from pretest to posttest and was used to compare the effectiveness of the intervention between groups.

To interpret learners' performance, mean scores were classified using the following scale: 0–9 (Not Proficient), 10–19 (Low Proficiency), 20–29 (Nearly Proficient), 30–35 (Proficient), and 36–40 (Highly Proficient).

Inferential statistics were used to determine significant differences. A paired-samples t-test was applied to compare pretest and posttest scores within each group, while an independent-samples t-test was used to compare posttest performance and error reduction between the experimental and control groups. All tests were conducted at a 0.05 level of significance.1976).

## VII. RESULTS AND DISCUSSIONS

The findings of the study are presented in this section.

**Table 1**

*Pre-Test Mathematics Performance of Grade 7 Learners in Integer Operations in the Experimental and Control Groups*

| Group | Mean Score | Description | SD |
|---|---|---|---|
| Experimental | 14.07 | Low Proficiency | 6.08 |
| Control | 15.17 | Low Proficiency | 8.80 |

Note: (0-9) Not Proficient, (10-19) Low Proficiency, (20-29) Nearly Proficient, (30-35) Proficient, (36-40) Highly Proficient

The pre-test results showed that both the experimental group (M = 14.07, SD = 6.08) and control group (M = 15.17, SD = 8.80) had a "Low Proficiency" level in integer operations. The close mean scores indicate that both groups had comparable prior knowledge before the intervention.

This suggests that learners had limited mastery of integer operations and commonly committed errors such as sign confusion and incorrect application of rules. The similarity in results confirms that both groups were at the same baseline, making them suitable for testing the intervention's effectiveness.

These findings align with Saligumba and Dagoc (2023) and Ramos and Obispo (2021), who reported low mastery and frequent errors in integer operations among Grade 7 learners. Bernardo (2005) and Cummins (2000) further explain that language-related difficulties may contribute to learners' low performance in mathematics.

**Table 2**

*Difference in the Pretest Mathematics Performance of Grade 7 learners in Integer Operations in the Experimental and Control Groups*

| Group | Mean | SD | t-value | df | p | Remarks |
|---|---|---|---|---|---|---|
| Experimental | 14.07 | 6.08 | .56 | 58 | .105 | Not Sig. |
| Control | 15.17 | 8.80 | | | | |

*p>0.05 not significant*

The pre-test results showed no significant difference between the experimental group (M = 14.07, SD = 6.08) and control group (M = 15.17, SD = 8.80), as the p-value (p = 0.105) is greater than 0.05. Both groups were described as having "Low Proficiency" in integer operations.

This indicates that learners in both groups had similar baseline performance and a high extent of errors, reflecting limited mastery of integer concepts such as signed numbers and basic operations. The similarity confirms that both groups were comparable prior to the intervention.

These findings align with Saligumba and Dagoc (2023) and Ramos and Obispo (2021), who reported low mastery and frequent errors in integer operations among Grade 7 learners. Bishop et al. (2014) further noted that such errors often stem from reliance on procedural rather than conceptual understanding, while Bernardo (2005) and Cummins (2000) highlighted language-related difficulties as a contributing factor to poor mathematics performance.

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**Table 3**

*Posttest Mathematics Performance of Grade 7 Learners in Integer Operations in The Experimental and Control Groups*

| Group | Mean Score | Description | SD |
|---|---|---|---|
| Experimental | 21.07 | Nearly Proficient | 7.06 |
| Control | 16.73 | Low Proficiency | 8.76 |

Note: (0-9) Not Proficient, (10-19) Low Proficiency, (20-29) Nearly Proficient, (30-35) Proficient, (36-40) Highly Proficient

The The posttest results showed that the experimental group (M = 21.07, SD = 7.06), which used code-switching, achieved a higher performance described as “Nearly Proficient,” while the control group (M = 16.73, SD = 8.76) remained at “Low Proficiency.” This indicates that learners exposed to code-switching performed better than those taught using traditional instruction.

The higher performance of the experimental group suggests fewer errors in integer operations, reflecting improved understanding and application of rules. In contrast, the control group’s continued low proficiency indicates that errors, particularly in operations involving signed numbers, still persisted.

These findings are consistent with Segura (2022), Moussa-Inaty (2015), Alcantara (2020), and Clarkson (2007), who reported that code-switching or bilingual instruction improves learners’ comprehension and mathematical performance. Bernardo (2005) and Cummins (2000) further explain that language barriers contribute to difficulties in mathematics, while Probyn (2010) and Lee (2016) noted that using learners’ familiar language enhances engagement and understanding, leading to fewer errors.

**Table 4**

*T-test Result of the Difference in the Posttest Performance of the Experimental and Control Groups After the Use of Code-Switching in Instruction*

| Group | Mean | SD | t-value | df | p | Remarks |
|---|---|---|---|---|---|---|
| Experimental | 21.07 | 7.06 | | | | |
| | | | -2.11 | 58 | 0.039 | Sig. |
| Control | 16.73 | 8.76 | | | | |

*p*<0.05 significant

The posttest results showed a significant difference between the control group (M = 16.73, SD = 8.76) and the experimental group (M = 21.07, SD = 7.06), t(approx.) = -2.11, p = 0.039. This indicates that learners exposed to code-switching performed significantly better in integer operations than those under traditional instruction.

The significant difference suggests that code-switching contributed to a reduction in errors, as learners in the experimental group demonstrated better understanding and more accurate application of integer rules. In contrast, the control group showed persistent errors, indicating that difficulties in understanding instructions may have continued under English-only teaching.

These findings align with Alcantara (2020), Clarkson (2007), and Moussa-Inaty (2015), who reported that bilingual or code-switching instruction improves learners’ mathematical performance. Bernardo (2005) and Cummins (2000) further explain that language barriers hinder mathematical understanding, while Probyn (2010) and Lee (2016) emphasize that using learners’ familiar language increases engagement and comprehension, leading to better learning outcomes.

Overall, the results suggest that code-switching is an effective instructional strategy in improving performance and reducing errors in integer operations.

**Table 5**

*Level of Mathematics Performance of Grade 7 Learners in the Pretest and Posttest of Both Experimental and Control Groups*

| Group | Pretest Mean Score | Posttest Mean Score | Mean Score Difference |
|---|---|---|---|
| Experimental | 14.07 | 21.07 | 7.00 |
| Control | 15.17 | 16.73 | 1.56 |

The findings showed that both groups improved from pretest to posttest in integer operations, with a greater increase in the experimental group. The experimental group’s mean score rose from 14.07 to 21.07 (MD = 7.00), while the control group increased from 15.17 to 16.73 (MD = 1.56), indicating a substantially higher improvement in the experimental group.

This suggests that code-switching facilitated better understanding and application of integer operations, while the smaller gain in the control group indicates that learning difficulties may have persisted under traditional instruction. The results also imply a greater reduction of errors in the experimental group, as reflected in the larger mean gain.

These findings align with Hiebert and Carpenter (1992), Moschkovich (2002), and Setati and Adler (2000), who emphasize that conceptual understanding and language support are essential for meaningful mathematics learning, especially in multilingual contexts. Overall, the results suggest that code-

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switching enhances performance and reduces errors in integer operations more effectively than traditional instruction.

**Table 6**

*T-test Result in the Difference in the Mathematics Performance of Grade 7 Learners between the Pretest and Posttest of the Experimental Groups Exposed to Code-Switching Instruction and Control Groups*

| Comparison | Mean Score | | MD | t-value | df | P | Remarks |
|---|---|---|---|---|---|---|---|
| | Pretest | Posttest | | | | | |
| Experimental | 14.07 | 21.07 | 7.00 | -8.33 | 29 | 0.000 | Sig. |
| Control | 15.17 | 16.73 | 1.57 | -1.81 | 29 | 0.081 | Not Sig. |
| Experimental vs Control (Posttest) | __ | __ | 4.34 | -2.11 | 58 | 0.039 | Sig. |

*$p<0.05$ significant*

The table shows that both the experimental and control groups improved from pretest to posttest in integer operations, but the degree of improvement differs significantly. The experimental group increased from a mean score of 14.07 to 21.07 (MD = 7.00), with a statistically significant difference, $t(29) = -8.33$, $p = 0.000$. This indicates a highly significant improvement in mathematics performance after the intervention.

In contrast, the control group showed only a slight increase from 15.17 to 16.73 (MD = 1.57), and this change was not statistically significant, $t(29) = -1.81$, $p = 0.081$. This suggests that traditional instruction alone did not lead to a meaningful improvement in learners' performance.

Furthermore, the posttest comparison between groups shows a significant difference in favor of the experimental group, $t(58) = -2.11$, $p = 0.039$. The mean difference of 4.34 indicates that learners exposed to code-switching performed significantly better than those in the control group.

Overall, the results imply that code-switching had a significant positive effect on learners' mathematics performance in integer operations, both in terms of achievement gain and posttest outcomes, compared to traditional instruction.

**Table 7**

*Extent of Error Reduction in Integer Operations Among Learners in the Experimental Group and Control Group*

| Group | Pretest Mean | Pretest Error Rate (%) | Posttest Mean | Posttest Error Rate (%) | Error Reduction (%) |
|---|---|---|---|---|---|
| Experimental | 14.07 | 64.83 | 21.07 | 47.33 | 27.00 |
| Control | 15.17 | 62.07 | 16.73 | 58.17 | 6.28 |

The findings showed a clear difference in the extent of error reduction between the experimental and control groups. The experimental group decreased from 64.83% (pretest) to 47.33% (posttest), resulting in a 27.00% error reduction. In contrast, the control group showed only a slight decrease from 62.07% to 58.17%, with a 6.28% error reduction.

These results indicate that the experimental group, which was exposed to code-switching, experienced a substantially greater reduction in errors in integer operations. This suggests improved understanding of concepts and more accurate application of mathematical rules compared to the control group.

These findings are consistent with Tejero (2019) and Bautista and Bernardo (2021), who reported that code-switching helps reduce learners' mathematical errors by improving comprehension. Similarly, Clarkson (2007) and Moschkovich (2002) emphasized that learners use their home language as cognitive support in solving mathematical problems, which leads to more accurate reasoning and fewer mistakes. Lavadia et al. (2025) further noted that teacher-led code-switching clarifies key mathematical concepts, supporting better understanding and accuracy.

Overall, the results suggest that code-switching is an effective instructional strategy for reducing errors in integer operations by improving learners' comprehension and procedural accuracy in mathematics.

## VIII. CONCLUSIONS AND RECOMMENDATIONS

The following were the findings of the study:

1. The pretest mathematics performance of Grade 7 learners in integer operations in both the experimental and control groups showed that the learners had relatively similar levels of prior knowledge before the implementation of the intervention. Both groups were found to have low proficiency, indicating limited understanding and mastery of basic integer concepts.
2. No significant difference was observed in the pretest mathematics performance of Grade 7 learners in integer operations between the experimental and control groups, indicating that both groups were statistically comparable at baseline in terms of their knowledge, skills, and error patterns.

3. The posttest mathematics performance of Grade 7 learners in integer operations improved from Low Proficiency to Nearly Proficient in the experimental group, while the control group remained at the Low Proficiency level. This indicates that learners exposed to code-switching demonstrated greater improvement in understanding integer operations compared to those who received traditional instruction.
4. A significant difference existed in the posttest mathematics performance between the experimental and control groups after the implementation of code-switching instruction. The experimental group performed better, indicating that code-switching enhanced learners' understanding and contributed to more accurate application of integer concepts.
5. The level of mathematics performance improved from pretest to posttest in both groups; however, the improvement was substantially greater in the experimental group. The experimental group progressed to a higher level of proficiency, while the control group showed only minimal improvement, indicating that code-switching supported better learning outcomes.
6. A significant improvement was observed in the mathematics performance of the experimental group from pretest to posttest, while the control group showed no significant improvement. Moreover, a significant difference in posttest performance between the two groups further confirms that code-switching led to greater learning gains.
7. There was a clear difference in the extent of error reduction between the experimental and control groups. Although both groups improved, the experimental group demonstrated a substantially greater reduction in errors, indicating that code-switching effectively minimized misconceptions and improved accuracy in integer operations.

## CONCLUSION

Based on the findings gathered and observations made by the researcher, the following conclusions were drawn:

1. Grade 7 learners demonstrated insufficient understanding of integer operations at the beginning of the study, as reflected in their low proficiency during the pretest. The similar performance of the experimental and control groups indicates that both groups were comparable before the implementation of the instructional intervention, providing a fair basis for evaluating its effectiveness.
2. The absence of a significant difference in the pretest mathematics performance confirms that the experimental and control groups had similar levels of prior knowledge and error patterns. This comparability ensures that any changes observed in the posttest can be attributed to the instructional strategy rather than pre-existing differences.
3. Learners exposed to code-switching instruction demonstrated notable improvement in mathematics performance, progressing from Low Proficiency in the pretest to Nearly Proficient in the posttest. This suggests that code-switching facilitated better understanding of mathematical concepts by allowing clearer and more accessible explanations.
4. The significant difference in posttest mathematics performance between the experimental and control groups indicates that code-switching is more effective than traditional instruction in enhancing learners' understanding and mastery of integer operations.
5. Although both groups showed improvement, the greater increase in performance observed in the experimental group indicates that code-switching supports deeper conceptual understanding and more effective application of mathematical rules compared to traditional instruction.
6. The significant improvement in the experimental group, compared to the non-significant improvement in the control group, confirms that code-switching leads to meaningful learning gains, whereas traditional instruction alone may not be sufficient to significantly improve learners' mathematics performance.
7. The greater extent of error reduction observed in the experimental group, compared to the control group, indicates that learners exposed to code-switching instruction were able to significantly reduce their errors in integer operations. This suggests that the use of learners' home language alongside English contributed to clearer understanding of mathematical concepts, which helped minimize misconceptions and improve accuracy in solving problems. In contrast, the smaller error reduction in the control group implies that traditional instruction alone was less effective in addressing learners' difficulties in integer operations.

## RECOMMENDATIONS

The researcher formulated the following recommendations as drawn from the findings and conclusions made in the study:

1. Mathematics teachers are encouraged to strengthen learners' understanding of integer operations by using instructional strategies that promote clarity and comprehension, such as code-switching and contextualized explanations. Schools may support the adoption of language-responsive teaching approaches, while future researchers may explore additional strategies that further improve learners' performance in mathematics.
2. Students are encouraged to actively participate in classroom discussions and make use of code-switching explanations to better understand integer operations, improve problem-solving skills, and reduce errors in mathematical computation.
3. Teachers are encouraged to adopt code-switching as a strategic instructional approach, especially when teaching complex topics such as integer operations, to enhance learners' understanding and improve learning outcomes. Schools may also support bilingual instructional practices to address learners' difficulties in mathematics.

4. Future researchers are encouraged to ensure proper group matching or random assignment and conduct diagnostic pre-assessments to establish baseline equivalence and accurately measure learners' prior knowledge and error patterns before implementing interventions.
5. Future studies may further investigate the use of code-switching in other areas of mathematics and across different grade levels to determine its broader effectiveness in improving learners' mathematical performance and conceptual understanding.

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