

INTEGER OPERATIONS ASSESSMENT; BASIS FOR TARGETED INTERVENTION

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ABSTRACT: *Mastery of integer operations is a vital foundation for advanced mathematics and effective mathematics teaching. This study assessed the performance of first-year Bachelor of Secondary Education (BSEd) Mathematics students across academic strands using a teacher-made 10-item test. A total of 139 students participated, with comparative data from 2023 ($n = 58$) and 2024 ($n = 81$). Results revealed a decline in performance, with mean scores dropping from 5.78 ($SD = 2.37$) in 2023 to 3.65 ($SD = 2.22$) in 2024. ANOVA indicated no significant differences among strands in 2023, but in 2024 significant disparities emerged ($p = .029$), particularly between STEM and TVL strands. The findings highlight widespread deficiencies in integer proficiency, with some strands more affected than others. These results emphasize the need for targeted remediation and consistent instructional strategies to strengthen foundational skills. By addressing these gaps early, the study provides insights for improving mathematics readiness among future educators and informs curriculum and pedagogical development in mathematics education.*

Keywords: Integer Operations, High School Strand, Targeted Intervention, Mathematics Education, Philippines

1.0 INTRODUCTION

An alarming trend has been observed among incoming first-year BSEd Mathematics students, with nearly 10 percent passing preliminary tests on integer operations, where a passing score was set at 75 percent or higher. This strikingly low proficiency rate signals a serious deficiency in mathematical preparation and underscores a potential crisis in mathematics education.

Such findings are consistent with broader evidence of persistent learning gaps in mathematics. Filipino students have consistently ranked among the lowest in international assessments, including PISA 2018, where they scored an average of 353 compared to the OECD mean of 489, and TIMSS 2019, where the Philippines placed at the bottom in mathematics achievement [1, 2]. Likewise, the National Achievement Test (DepEd, 2019) has repeatedly shown that students' mathematics scores fall below national standards, a finding echoed in more recent analyses of NAT performance [3]. Recent local research further confirms that these gaps are most visible in fundamental areas such as integers, particularly after the disruptions caused by the COVID-19 pandemic [4].

The implications of such weak performance are far-reaching. Research shows that students' success in higher education mathematics is closely tied to the strength of their foundational skills. [5] found that inadequate prerequisite knowledge and weak basics hinder students' ability to cope with university-level mathematics, while those with strong prior knowledge, clear concepts, and consistent practice are more likely to succeed. This underscores that early mastery of basic mathematical skills serves as a critical determinant of achievement and persistence in higher education. Furthermore, teachers' mathematical mindsets and mastery of foundational concepts strongly influence student performance. [6] found that when teachers hold fixed beliefs or lack strong conceptual understanding, their students often struggle with motivation, confidence, and comprehension of basic mathematics. Applied to the context of BSEd Mathematics students, this finding is particularly critical: as future teachers, insufficient mastery of basic operations may not only hinder their own academic progression but also limit

their capacity to effectively teach these essential skills to their future learners.

These deficiencies point to systemic challenges, such as inadequate preparatory instruction, curricular misalignment between senior high school and college, and insufficient interventions to remediate basic skills [7]. Similar concerns were highlighted by [8], who found that integer operations consistently emerged as among the least-learned competencies in secondary school due to weak foundational understanding. Addressing these issues requires rigorous inquiry and targeted interventions designed to strengthen mathematical readiness. Against this backdrop, the present study employed a descriptive-comparative design to assess first-year BSEd Mathematics students' proficiency in integer operations, compare performance across strands, and provide empirical bases for designing interventions.

2.0 Methods

Design

This study employed a **descriptive-comparative research design**, a non-experimental approach commonly used in educational research to describe current conditions and compare differences between groups without manipulating variables [9]. Specifically, the design was utilized to assess the proficiency of first-year Bachelor of Secondary Education (BSEd) Mathematics students in basic integer operations. As freshmen, these students constitute a crucial cohort since their entry-level performance provides valuable insights into their preparedness for more advanced mathematical learning [10, 11]. The **descriptive component** of the design established a baseline profile of students' computational skills, identifying their levels of mastery and common errors in integer operations. On the other hand, the **comparative component** examined variations in performance across different senior high school academic strands (ABM, GAS, STEM, TVL, and HUMSS) and between two academic year batches (2023 and 2024), thereby highlighting both strand-related and year-on-year differences in mathematical readiness.

Research Respondents and Sampling

The respondents of this study were first-year Bachelor of Secondary Education (BSEd) major in Mathematics students enrolled at Agusan del Sur State College of Agriculture and

Technology (ASSCAT) during the academic years 2023 and 2024. As freshmen, these students were purposively chosen because their performance in basic integer operations reflects their initial preparedness for advanced college-level mathematics. Assessing this group is crucial, as it provides baseline data on the mathematical readiness of future mathematics educators.

A total of 139 students participated in the study, with 58 respondents from the 2023 batch and 81 respondents from the 2024 batch. The distribution also reflected the students' academic strands in senior high school (ABM, GAS, STEM, TVL, and HUMSS), allowing for strand-based comparative analysis.

The study employed purposive sampling, since all available first-year BSED Mathematics students in the two academic years were included. This method was deemed appropriate because the research specifically targeted a defined population—freshmen mathematics majors—whose performance in integer operations is directly relevant to the study's objectives. By focusing on the total accessible population, the results provide a comprehensive picture of the learning gaps that must be addressed through targeted interventions.

Research Instrument

The instrument used in this study was a teacher-made test composed of 10 items on basic integer operations, specifically addition, subtraction, multiplication, and division of integers. The items were crafted to reflect typical classroom assessment tasks that gauge students' fundamental computational skills, such as solving problems like $-4 - (-5)$ and $(-4) \div 20$. The test was designed to provide a straightforward measure of students' proficiency in integer operations upon entry into college. As a diagnostic tool, it captured not only correct or incorrect responses but also reflected common misconceptions and difficulties. This simple, classroom-based assessment was appropriate for establishing a baseline profile of the respondents' skills, as it directly aligned with the basic competencies expected of freshmen mathematics majors and allowed for the identification of areas needing targeted intervention. Table 1 presents scores interpretation using a **10-point scale**, classified into four categories: *Below Average* (1–4), *Average* (5–6), *Above Average* (7–8), and *Excellent* (9–10).

Table 1. Scores and Descriptive Interpretation

Below Average (Scores 1-4)	Students have major difficulties with integer operations, showing limited or no grasp of basic rules and concepts.
Average (Scores 5-6)	Students show basic understanding but struggle with complex problems, reflecting unstable comprehension.
Above Average (Scores 7-8)	Students demonstrate solid understanding and can apply integer rules effectively, though occasional errors may occur.
Excellent (Scores 9-10)	Students excel in integer operations, showing strong mastery and the ability to handle complex applications.

This method of interpretation not only helps in assessing individual student performance but also aids teachers in identifying specific areas of student needs across different levels of achievement. By understanding where students stand in their understanding of integer operations, targeted

teaching strategies can be implemented to improve overall mathematical skills and performance.

Data Gathering Procedure

The data gathering began with the administration of the teacher-made integer operations test to all first-year BSED Mathematics students during the opening weeks of the first semester in Academic Years 2023 and 2024. The test was conducted in a regular classroom setting under the supervision of the course instructor to ensure uniform conditions and minimize distractions. Students were given sufficient time to complete the 10-item test, which required them to solve problems involving integer addition, subtraction, multiplication, and division.

Completed test papers were collected immediately after the session and checked manually by the teacher using a predetermined answer key to ensure consistency in scoring. Each student received a raw score ranging from 0 to 10, which was then categorized according to established proficiency levels: *Below Average* (1–4), *Average* (5–6), *Above Average* (7–8), and *Excellent* (9–10).

After scoring, results were tabulated and organized by academic strand (ABM, GAS, STEM, TVL, and HUMSS) and by academic year batch (2023 and 2024). The compiled data were subjected to descriptive statistical analysis to determine measures of central tendency and variability, followed by inferential tests (ANOVA and Tukey HSD) to compare mean performance across strands. This systematic process ensured that the assessment provided not only an overview of students' baseline performance but also strand-specific insights that informed the study's recommendations for targeted instructional interventions.

3.0 RESULT AND DISCUSSION

Comparative Assessment Result

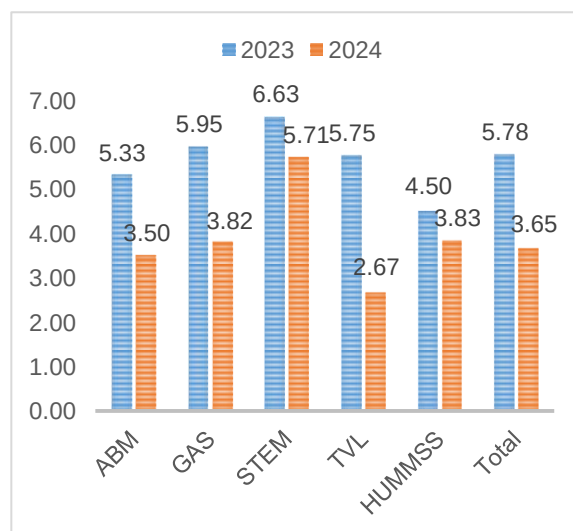


Figure 1. Basic Integer Assessment Scores (2023 VS 2024)

Table 2 and Figure 1 present the descriptive results of students' Basic Integer Assessment scores across strands for 2023 and 2024. In 2023, the overall mean score was **5.78 (SD = 2.37)**, which falls within the **Average range (Scores 5–6)**. This suggests that most students had a basic but somewhat

shaky grasp of integer operations, capable of handling straightforward problems but struggling with more complex applications. Strand-wise, STEM students performed the highest ($M = 6.63$, $SD = 3.16$), placing them at the **upper bound of the Average scale and approaching Above Average**, consistent with their curriculum's focus on mathematical reasoning and problem-solving. GAS ($M = 5.95$), TVL ($M = 5.75$), and ABM ($M = 5.33$) also fell within the **Average range**, while HUMSS ($M = 4.50$) was classified as **Below Average**, indicating foundational gaps in integer operations.

Table 2. Scores of Basic Integer Assessment

Strand	2023			2024		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
ABM	6	5.33	1.75	8	3.50	2.20
GAS	22	5.95	2.28	33	3.82	2.21
STEM	8	6.62	3.16	7	5.71	2.98
TVL	16	5.75	2.29	21	2.67	1.65
HUMSS	6	4.50	2.43	12	3.83	1.99
Total	58	5.77	2.37	81	3.65	2.22

By contrast, in 2024, the total mean score dropped markedly to **3.65 ($SD = 2.22$)**, placing the cohort within the **Below Average range (Scores 1–4)**. This decline reflects significant difficulties in mastering basic integer rules and operations, pointing to persistent misconceptions and a failure to consolidate foundational skills. Strand-level results confirm this trend: ABM ($M = 3.50$), GAS ($M = 3.82$), HUMSS ($M = 3.83$), and TVL ($M = 2.67$) all scored within the **Below Average range**, indicating widespread challenges in handling integer concepts. Only STEM ($M = 5.71$, $SD = 2.98$) remained within the **Average range**, suggesting greater resilience, though still showing a decline compared to the previous year.

Figure 1 graphically illustrates this decline, highlighting the significant downward trend across strands, particularly in TVL and ABM. The shift from **Average in 2023 to Below Average in 2024** signals a worrying learning regression. This trend is consistent with evidence from international studies showing that the COVID-19 pandemic caused widespread learning losses in mathematics due to prolonged school closures, reduced instructional engagement, and inequitable access to resources [12, 13]. Even after the resumption of face-to-face classes, many learners struggled to recover foundational knowledge, leading to observable performance declines [14].

Overall, the results suggest that while STEM strand students demonstrated relative resilience, the majority of learners regressed from **Average to Below Average** performance levels. This underscores the need for remedial programs, targeted interventions, and adaptive instructional strategies to rebuild fundamental mathematical competencies [15].

Normality Test

Table 3 summarizes the results of the Shapiro–Wilk test of normality for both Scores of 2023 and 2024 across strands. For Score-2023, all strands—ABM ($p = .918$), GAS ($p = .493$), STEM ($p = .182$), TVL ($p = .316$), and HUMSS ($p = .221$)—met the assumption of normality. Similarly, in Score-2024, most strands also demonstrated normal distributions,

including ABM ($p = .295$), GAS ($p = .123$), STEM ($p = .126$), and TVL ($p = .299$). However, HUMSS in Score2024 showed a significant deviation from normality ($p = .037$).

Despite this single violation, parametric tests such as ANOVA are generally robust to minor departures from normality, particularly when group sizes are relatively balanced [16]. Therefore, the data were considered acceptable for further parametric analyses.

Table 3. Normality Test Results by Strand

Strand	Score-2023 p-value	Normality (2023)	Score-2024 p-value	Normality (2024)
ABM	0.918	Normal	0.295	Normal
GAS	0.493	Normal	0.123	Normal
STEM	0.182	Normal	0.126	Normal
TVL	0.316	Normal	0.299	Normal
HUMSS	0.221	Normal	0.037	Not Normal

Test of Difference

The ANOVA results highlighted two contrasting dynamics between the 2023 and 2024 cohorts. In 2023, no significant strand-level differences were observed, suggesting a relative uniformity of performance across groups. This could indicate that instructional practices and preparatory experiences had a balanced effect across strands, whether through broadly effective instruction or through the absence of strand-specific interventions. In contrast, the 2024 data revealed significant disparities, with STEM students outperforming their counterparts, particularly those from the TVL strand. This shift suggests that strand-specific factors—including differences in preparatory instruction, curricular exposure, or external interventions—played a stronger role in shaping readiness in 2024.

Such findings resonate with earlier observation by [17], who noted that strand-based differences may not always manifest strongly at the entry level, but can emerge depending on the depth of prior mathematical exposure. They also align with studies emphasizing the stronger mathematical readiness of STEM students compared to TVL and HUMSS students, where mathematics exposure is less intensive [18, 7]. Importantly, the emerging disparities underscore systemic challenges in aligning senior high school preparation with college demands, consistent with concerns raised by [19] about inconsistencies in student readiness across cohorts.

Furthermore, these insights point to the need for targeted educational attention. As [20] argue, differentiated interventions and effective resource allocation are essential for improving learning outcomes. Applying this perspective, the disparities observed in 2024 may reflect uneven access to effective instruction or support systems, reinforcing the necessity for remedial programs and strand-sensitive interventions. These findings also reinforce the argument of [21], and as well as [22], that early mastery of foundational subjects strongly predicts persistence and long-term success. For teacher education programs in particular, ensuring competence in core mathematical concepts is paramount, since these students will later serve as mathematics educators themselves.

Table 4. One-Way ANOVA Results for Integer Operations Test Scores, 2023 and 2024

Year	Source	df	F	p
2023	Between Groups	4	0.763	0.554
	Within Groups	53		
	Total	57		
2024	Between Groups	4	2.864	.029*
	Within Groups	76		
	Total	80		

Pairwise Comparisons Across Strands

The Tukey HSD post hoc analysis revealed that among the multiple pairwise comparisons of strand performance, only the comparison between STEM and TVL yielded a statistically significant difference (Mean Difference = 3.05, $p = .013$). This indicates that STEM students significantly outperformed their counterparts in the TVL strand. All other pairwise comparisons (ABM vs. GAS, ABM vs. HUMSS, GAS vs. HUMSS, etc.) did not reach statistical significance ($p > .05$), suggesting relatively comparable performance across those groups.

The significant advantage observed for STEM students over TVL students aligns with prior research showing that the STEM curriculum, with its strong emphasis on analytical and problem-solving skills, tends to equip learners with competencies that translate into stronger performance in mathematics and related disciplines [23]. In contrast, TVL programs, which are geared toward technical and vocational preparation, may not provide the same depth of exposure to abstract and theoretical problem-solving, which could explain their lower performance in this comparison.

Table 5. Comparisons Result Across Strands

Significant Comparison	Mean Difference	p-value	Interpretation
STEM – TVL	3.05	0.013	STEM performed significantly higher than TVL

Nevertheless, the absence of significant differences among most strands indicates that strand classification alone may not be the primary determinant of student achievement. Other factors, such as instructional strategies, prior academic preparation, and the availability of learning resources, may play more decisive roles in shaping outcomes [24]. This finding underscores the importance of contextualized support, particularly for TVL learners, to bridge performance gaps and enhance mathematics competencies across strands [25].

4.0 CONCLUSION

This study examined the proficiency of first-year BSED Mathematics students in basic integer operations using a teacher-made diagnostic test. Findings revealed a marked decline in performance from 2023, where students performed at an *Average* level, to 2024, where performance regressed to *Below Average*. While 2023 results showed no significant strand-level differences, the 2024 data indicated disparities, with STEM students significantly outperforming their TVL

counterparts. These results highlight both a general weakening in foundational mathematics skills and persistent strand-based gaps in preparedness.

The overall trend underscores systemic issues in the transition from senior high school to college, particularly in bridging foundational competencies needed for advanced mathematics. Since these students are future mathematics educators, their lack of mastery in basic operations poses risks not only to their academic success but also to the quality of mathematics teaching they will eventually provide. Strengthening proficiency in integer operations at the entry level is therefore critical for building a more competent and confident pool of future teachers.

5.0 Educational Implications

The results of this study carry meaningful implications for mathematics education and teacher preparation programs. The evident decline in freshmen proficiency from 2023 to 2024 highlights not just a statistical concern but a real learning gap that affects students' confidence and readiness for higher-level mathematics. This finding calls for early and sustained interventions to rebuild mathematical foundations at the entry level. It also echoes international evidence showing that prolonged disruptions, such as those caused by the pandemic, leave lasting scars on learners' academic performance and self-efficacy in mathematics.

The differences observed across strands further remind us that a one-size-fits-all approach to teaching is no longer sufficient. While STEM students showed relative strength, many TVL and HUMSS students struggled to keep pace. This suggests the need for strand-responsive instruction and support mechanisms that acknowledge the varied academic experiences students bring with them. Without such differentiated support, inequities in mathematics achievement may persist, ultimately affecting the competence of future teachers.

For teacher education institutions, these findings serve as a clear call to action. BSED Mathematics students, who will soon become the nation's math teachers, must not only pass through their courses but also achieve genuine mastery of basic operations like integer skills. Embedding regular diagnostic assessments, targeted tutorials, and remediation activities within the curriculum can help ensure that no student falls behind. At ASSCAT, efforts have already begun through tutorial programs that serve as a concrete step toward addressing these gaps—an initiative that can be further expanded and institutionalized.

Taken together, these implications highlight a dual responsibility for higher education institutions: first, to strengthen incoming students' mathematical readiness so that they can thrive in their coursework, and second, to cultivate the competence and confidence future teachers need to foster mathematical literacy in their own classrooms. Policymakers, teacher educators, and school leaders must therefore work hand in hand to design sustainable intervention programs, allocate adequate resources, and champion instructional practices that give every future teacher an equitable chance to succeed.

6.0 Recommendation

1. **Targeted Remediation Programs:** Develop strand-sensitive intervention modules, audio-visual SIM, particularly for TVL and HUMSS students, focusing on mastery of integer rules through scaffolded practice, manipulatives, and real-life applications.
2. **Diagnostic Assessment at Entry Level:** Institutionalize baseline testing for all incoming freshmen to identify learning gaps early and implement support strategies before students' progress to higher mathematics.
3. **Curricular Alignment:** Strengthen collaboration between senior high school and college curriculum developers to ensure consistency in mathematical competencies across strands.
4. **Strand-Responsive Teaching Strategies:** Incorporate differentiated instructional strategies that acknowledge the varied mathematical backgrounds of students from ABM, GAS, STEM, TVL, and HUMSS.
5. **Sustained Academic Support:** Provide tutorial services, peer mentoring, and enrichment activities for freshmen to help consolidate foundational skills and promote mathematical confidence.
6. **Faculty Development:** Equip mathematics instructors with training in diagnostic pedagogy and intervention design to address learning gaps effectively within the classroom setting.

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