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LEARNING LOSSES IN MATHEMATICS IN THE POST PANDEMIC ERA

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Abstract

This study seeks to add to the growing body of research that investigates the ways in which the COVID-19 pandemic has impacted the cognitive aspect of learning. This research aims to identify the learning losses of the fourth year Bachelor of Secondary Education (BSED) students majoring mathematics at the Isabela State University for the school year 2023-2024. This study utilized a diagnostic exam to quantitatively identify the specific competencies in algebra, geometry, statistics, and trigonometry that students are most struggling with. Results revealed evidential learning losses in the four learning areas. The insights gained from this study could help in designing teacher training programs, thereby equipping educators with the necessary skills to address the identified learning losses. Moreover, an in-depth and comprehensive review of the learning competencies where students have fallen behind provides baseline information for educators to develop strategies aimed at mitigating the learning losses and improving overall mathematical competence among students. It is recommended that targeted remediation and periodic teacher training be implemented to strengthen content knowledge and teaching strategies, ensuring students' recovery and improved mathematical competence.

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INTRODUCTION

The COVID-19 pandemic made an evidential impact on the educational system globally and made no exception in the field of mathematics. As schools were forced to close and students were required to remotely learn, mathematics education faced many challenges. The absence of in-person instruction and social interaction through online learning caused some problems for students learning mathematics. One of the problems encountered by the students in online courses amidst pandemic was internet connectivity and technology accessibility. UNESCO (2020) estimated that 1.5 billion children globally were affected by school closures, with most of them missing the tools and internet access needed to engage in online learning effectively. With a disproportionately negative effect on marginalized and underprivileged students, the digital divide has expanded educational inequality. Online learning demands a certain amount of technological and digital literacy proficiency for participation to be effective. The internet platforms, resources, and software utilized for remote learning may be unfamiliar to many students, especially older persons and those from low-income backgrounds. To successfully traverse virtual learning environments, learners must be supported in gaining certain skills (Schleicher, 2020).

Traditional classrooms give face-to-face social connection and engagement, which online learning frequently lacks. Students may experience a sense of isolation, which might affect their motivation, peer participation, and possibilities for discussion and feedback. The value of social presence in online learning and its beneficial effects on student engagement and outcomes were highlighted in a review by Means et al. (2013). Learners who take advantage of online courses must manage their time and learning more effectively. Without the support of a physical classroom, students could find it difficult to retain motivation, control outside distractions, and keep a regular study routine.

For students to flourish in online learning environments, Broadbent and Poon's (2015) research highlighted the necessity for them to build self-regulation strategies such as metacognition, time management, effort regulation, peer learning elaboration and help seeking. Education professionals must modify their pedagogies when moving from traditional education to online learning. However, not all educators have received the necessary training to give quality online instruction. According to a study by Prestoza (2024) and Hodges et al. (2020), it is crucial for educators to receive comprehensive support and specialized training to maintain elevated instructional standards within online learning environments. Such professional development is essential not only for enhancing teachers' pedagogical effectiveness but also for ensuring that students achieve quality educational outcomes, irrespective of the mode of instruction.

Students' online learning performance is greatly influenced by their motivation and involvement. The motivational elements affecting students' success in online learning were examined by Jang and Lee (2020). They discovered that student engagement and performance were positively influenced by their intrinsic motivation, self-efficacy, and perceived instructor support. Goal-setting, receiving feedback, and establishing a sense of autonomy were found to be important factors in motivating students in online settings. The disruption in education caused by school closures, the transition to remote learning, and the varied levels of access to educational resources have likely resulted in significant learning gaps for many students. These could have long-term effects on students' academic future. Thus, this study is conducted to address this issue comprehensively. Specifically, this study sought to investigate the learning losses in mathematics by college students after the pandemic.

METHODOLOGY

This study employed a descriptive quantitative research design to assess the learning losses experienced by fourth-year Bachelor of Secondary Education (BSED) students majoring in mathematics following the COVID-19 pandemic. The participants included 115 students from the five campuses of Isabela State University offering the program, allowing for a comprehensive assessment across various educational contexts.

The primary data collection tool was a diagnostic test, comprising 20 items covering key mathematical areas such as algebra, geometry, statistics, and trigonometry. To ensure validity, the instrument was subjected to expert review by six mathematics educators. Subsequently, a test-retest procedure was conducted with a subset of 45 students at Cagayan State University, Andrews Campus, establishing the test's reliability with a strong positive correlation ($r = 0.877$) between test and retest scores, as indicated in the Spearman correlation analysis. Following this validation, the diagnostic test was administered to the full sample of 115 students, and item analysis was performed to identify specific areas of learning losses. This analysis involved evaluating student responses to determine which competencies were most affected, thus informing future educational interventions aimed at addressing these learning losses.

RESULTS AND DISCUSSION

The analysis of the results of the diagnostic examination generally identified the learning competencies with which students struggled most. The overall result showed significant learning losses among students in four areas of mathematics, namely algebra, trigonometry, geometry, and statistics. These learning competencies were determined by at least 70% of the students who got the corresponding items incorrectly.

The findings presented in Table 1 reveal significant learning losses among students in the area of trigonometry, underscoring the challenges they face in mastering essential mathematical concepts. Trigonometry encompasses a wide array of topics, including the ratios of a triangle and functions, necessitating a comprehensive and in-depth understanding for effective application in real-world scenarios (Maknun et al., 2019). The data indicates that 71.30% of participants struggled to find the values of trigonometric functions, while an alarming 79.13% encountered difficulties using the law of sines and cosines to solve problems involving non-right triangles. These results suggest a limited conceptual grasp of fundamental trigonometric concepts among the majority of students, as supported by Nabie et al. (2018). The perception of trigonometry as an abstract and challenging subject may contribute to these learning gaps, particularly when applying the law of sines and cosines.

Furthermore, the analysis highlights a concerning performance rate, with 72.17% of students failing to solve problems related to angles of elevation and depression. The difficulties encountered by students in illustrating angles of depression, as discussed by Kusmayadi and Sujadi (2017), may play a crucial role in their inability to accurately represent these concepts through figures, as suggested by Anwar et al. (2016). Collectively, these findings emphasize the necessity for targeted instructional strategies and practice sessions aimed at enhancing students' understanding and application of trigonometric principles. This aligns with the work of Hamzah et al. (2021), who found similar challenges faced by students in solving trigonometric problems involving right triangles and related formulas.

Therefore, the need for effective interventions is paramount to mitigate these learning losses and improve overall mathematical competence among students.

Table 1. Learning Losses of the Students in Trigonometry

Subject Area	Item No.	% of students got the item incorrectly	Learning competencies
Trigonometry	7	71.30%	Find the value of some trigonometric functions.
	14 & 15	79.13%	Use the law of sines and cosines to solve triangles and problems involving non-right triangles.
	18 & 20	72.17%	Solve word problems involving angles of elevation and depression.

The findings presented in Table 2 highlight significant learning losses among students in the area of algebra, particularly concerning their ability to solve systems of equations. The examination results reveal that an alarming 84.78% of students struggled with this competency, indicating a substantial gap in their conceptual understanding of algebra. According to Anwarudin et al. (2021), interviews with students suggest that foundational skills, such as using the least common multiple, elimination, and substitution methods, are perceived as crucial yet inadequately understood for effectively solving algebraic problems involving equations. A strong understanding of algebraic concepts is essential for students, as it forms the basis for more complex mathematical reasoning. However, challenges arise when students encounter difficulties in distinguishing between variables and constants, a fundamental aspect of algebra (Sugiarti & Retnawati, 2019). This inability to grasp basic algebraic principles can hinder their progress in learning advanced concepts, particularly in solving systems of equations, as indicated by Subanji and Nusantra (2016).

Table 2. Learning Losses of the Students in Algebra

Subject Area	Item No.	% of students got the item incorrectly	Learning competency
Algebra	5 & 7	84.78%	Solve systems of equations.

The results shown in Table 3 indicate significant learning deficiencies among students in geometry, especially regarding fundamental skills such as determining angles using their supplements and complements. A significant 70.43% of participants failed to meet this competency, indicating widespread misconceptions related to complementary, supplementary, adjacent, and opposite angles, as noted by Unal (2021). Many students encountered difficulties in visually illustrating these angles, which is crucial for effective problem-solving. Anwar et al. (2016) emphasize the importance of constructing visual representations, as these aids facilitate the problem-solving process.

Furthermore, the data indicate that 75.65% of participants struggled with utilizing congruence criteria, such as Side-Side-Side (SSS), Side-Angle-Side (SAS), and Angle-Side-Angle (ASA), in proving triangle congruence. These congruence theorems are foundational topics in geometry; however, students frequently experience challenges in

comprehending them. Research conducted by Wang et al. (2023) highlights that eighth-grade students often commit errors in their reasoning and proofs related to congruent triangles, which can be attributed to a lack of understanding of these essential theorems.

Moreover, the ability to solve problems involving proportions and ratios in similar figures is another critical learning competency, yet 70.43% of students encountered difficulties in this area. Common issues arise from students' tendencies to overlook essential information or misinterpret relevant and irrelevant data while solving problems involving ratios and proportions, as observed by Tiflis et al. (2019). To address these challenges, some scholars advocate for a more focused instructional approach when teaching ratios and proportions. For instance, Postier (2021) recommends that educators guide students to consider the visual aspects of problems carefully. By encouraging students to illustrate proportional triangles, they can better understand the relationships involved. This strategy serves as an effective first step toward incorporating real-world geometry problems, thereby enhancing students' comprehension of geometric concepts and their applications.

To summarize, a thorough comprehension of foundational concepts, including angles, triangle congruence, and the principles of ratios and proportions, is crucial for students to effectively engage with more advanced geometric problems. The recurring errors noted in these domains can substantially hinder students' future grasp of mathematical concepts (Subanji & Nusantra, 2016). It is vital to address these learning deficiencies to enhance students' mathematical proficiency and confidence in geometry.

Table 3. Learning Losses of the Students in Geometry

Subject Area	Item No.	% of students got the item incorrectly	Learning competencies
Geometry	1	70.43%	Solve for an angle using its supplement and complement.
	14	75.65%	Use congruence criteria like SSS, SAS and ASA in finding unknown sides of a triangle and prove that two triangles are congruent.
	20	70.43%	Solve problems involving proportions and ratios in similar figures.

Table 4 illustrates the learning losses experienced by students in the area of statistics. A significant majority of participants (76.09%) appear to require additional practice in calculating and interpreting measures of variability, highlighting a need to revisit the foundational concepts of statistics to enhance their ability to analyze and interpret data accurately. Zamora et al. (2018) identified a lack of confidence among students in solving problems related to statistics and probability, which aligns with this study's findings that 71.30% of students struggled with questions involving probability. Additionally, students exhibit a reluctance to engage with statistical and probability concepts, which contributes to negative attitudes toward the subject matter. These findings indicate a pressing need for strategies that can bolster students' confidence and foster more positive attitudes toward solving statistical and probabilistic problems, thereby improving their engagement and satisfaction with the subject.

Moreover, Table 4 reveals that 70.43% of participants face considerable difficulties in selecting the appropriate statistical tools for data analysis. According to Ali and Bhaskar (2016), it is essential for researchers to grasp the statistical methods necessary for effective data analysis. For mathematics students, mastering these fundamental concepts is critical, as it not only establishes a solid mathematical foundation but also equips them with the skills needed for proficient statistical analysis.

Table 4. Learning Losses of the Students in Statistics

Subject Area	Item No.	% of students got the item incorrectly	Learning competencies
Statistics	5 & 6	76.09%	Calculate and interpret the measures of variability including z-score, variance and standard deviation.
	9	71.30%	Solve word problems involving probability.
	19	70.43%	Select the appropriate statistical tool for analyzing data.

CONCLUSION

The findings of this study have significant implications for educational practices and policies, particularly in addressing the learning losses in mathematics observed among students following the pandemic. The evident gaps in students' knowledge across key areas such as algebra, geometry, statistics, and trigonometry suggest a need for targeted interventions aimed at reinforcing foundational mathematical skills. These gaps underline the importance of revisiting the learning competencies where students have shown the most difficulty, providing a critical basis for designing effective remediation programs.

Implementing such programs would help bridge the identified learning gaps and support students in regaining essential mathematical knowledge. Furthermore, the study highlights the necessity of ongoing professional development for teachers. Intensive and periodic training sessions can empower educators with a deeper understanding of mathematical concepts and the skills to implement effective instructional strategies. By strengthening teachers' content knowledge and pedagogical skills, the educational system can create a more supportive and adaptive learning environment. Such initiatives would not only address the immediate learning losses caused by the pandemic but also contribute to building a more resilient educational framework. This, in turn, can ensure that students are better equipped for future academic challenges and improve their overall mathematical competence, ultimately fostering long-term academic success and growth. The emphasis on equipping both students and teachers reflects a holistic approach to overcoming the setbacks in mathematics education and ensuring sustained progress in the post-pandemic period.

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