Effects of Technology-assisted on the Level of Performance and Engagement of BSED Mathematics

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Abstract. This study investigates the effects of technology-assisted lessons on the performance and engagement of Bachelor of Science in Education (BSED) Mathematics students enrolled in Calculus II. A pre-experimental design with a one-group pretest-post-test approach was employed. The respondents of the study were the 3rd-year BSED Mathematics students of Central Bicol State University of Agriculture-Sipocot for the 2023-2024 school year. Technology was integrated into the lessons through educational PowerPoint and video presentations during two sessions. Pre-tests and post-tests were conducted to assess students' performance in Calculus II, while survey questionnaires were used to measure the level of their engagement. The results of the Paired t-test reveal a significant (N=40, t= - 30.691, p= 0.000) improvement in student performance following technology-assisted lessons. Findings also revealed that the level of engagement of the students towards Calculus II improved through the help of technology-assisted lessons. The study highlights the potential of technological integration in mathematics education and provides recommendations for further enhancing students' learning experiences in Calculus II.

1 Introduction

In the realm of mathematics education, technology-assisted lessons have emerged as a promising approach to enhance student engagement and elevate learning outcomes in calculus. By harnessing the power of technological tools, educators can unlock new avenues for enhancing the teaching and learning experiences in this pivotal branch of mathematics. Through technology-assisted lessons, students can delve into calculus concepts and enhance their comprehension of mathematical principles. This is particularly valuable as calculus is often perceived as challenging for many students.

In response to the challenges associated with abstract calculus concepts, educators integrate technology to enhance student engagement and foster a deeper understanding. Interactive apps and visualization tools enable active exploration of complex calculus concepts, resulting in heightened comprehension. Researchers have laid a strong foundation

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for this instructional approach, as their studies emphasized the positive influence of technology on student engagement, motivation, and academic performance in mathematics [1,2].

However, despite the potential benefits, there exists a research gap concerning the effects of technology-assisted lessons in calculus and how technology influences diverse learners [3]. Moreover, there is a need for further exploration into how technology can support higher-order thinking skills, such as critical thinking and problem-solving, among calculus students [4]. These research gaps underscore the need for comprehensive studies to assess the effect of technology integration on student outcomes in calculus education.

Acknowledging the digital divide in education, it is also crucial to recognize that not all students have equitable access to technology or possess the necessary skills to effectively utilize it [5]. While technology can complement traditional teaching methods, it cannot replace the indispensable role of teachers in guiding and supporting students' learning journeys [6]. Effective teaching encompasses building relationships, providing feedback, and adapting instruction to address the diverse needs of students [7].

To strike a balance between traditional teaching methods and technology-assisted lessons, educators can utilize interactive multimedia resources and learning management systems (LMS) [8,9]. These tools enrich the teaching process, increase student engagement, and provide opportunities for personalized instruction that cater to diverse learning styles and abilities.

This study aimed to investigate the optimal approach to enhance student engagement in calculus lessons through technology integration. Specifically, it focused on the effects of incorporating technology-assisted lessons into calculus instruction for students pursuing a Bachelor of Science in Education (BSED) in Mathematics. By examining the effect of technology on academic performance and engagement levels, this research contributed to the enriched existing knowledge and informed instructional practices in calculus education, fostering meaningful insights and practices.

Technology has revolutionized the way education is delivered, and its integration has been shown to enhance student learning outcomes. In mathematics education, technology-assisted lessons have been utilized to support student learning and engagement in various topics, including calculus. Therefore, this study aimed to examine the effects of technology integration on BSED Mathematics students' academic performance and engagement levels in Calculus II at Central Bicol State University of Agriculture-Sipocot during the 1st semester of the 2023-2024 academic year.

The study aimed to achieve the following objectives:

- To determine the performance level of respondents in Calculus II based on pre-test and post-test result
- To identify the level of engagement of the respondents in Calculus II before and after using technology-assisted lessons in terms of participation, quality of work, and feedback
- To evaluate if technology-assisted lessons significantly affect the level of performance and engagement of the respondents

2 Methodology

The research design, method, population and sampling, data gathering procedures, and statistical treatment were discussed in this section.

2.1 Research Design

The study used a pre-experimental with a one-group pretest-post-test design. The research design aimed to investigate the effects of technology-assisted lessons on the level of performance and engagement of BSED Mathematics students in Calculus II.

2.2 Research Method

The study was conducted at the Central Bicol State University of Agriculture - Sipocot. The respondents, representing the target sample for the research question, were BSED Mathematics students enrolled in Calculus II during the 1st semester of the 2023-2024 school year. They were purposively selected by the researcher due to the exclusive offering of Calculus II, available solely to 3rd-year students in the BSED Mathematics program.

2.3 Data Gathering Procedure

This study followed a protocol to ensure the reliability and validity of the collected data. The protocol involved obtaining approval from the research adviser, research instructor, and panelists to conduct the study. A letter requesting permission and approval was submitted, and after the self-made survey and test questionnaire were approved, the intervention phase began with two sessions of technology-assisted lessons provided to the participants. The study used a one-group pre-test-post-test design to collect data from BSED Mathematics students. The pre-test was administered before the intervention, while the post-test was administered after the intervention. In orer to measure the performance of BSED Mathematics students in Calculus II, the study used the pre-test and post-test results. Furthermore, the survey questionnaire was used to measure the engagement levels of BSED Mathematics students before and after the technology-assisted lesson in Calculus II. The survey questionnaire was administered in person, and participants were given two weeks to complete the pre-test and post-test. The topics are integration concepts and formulas for week 4, as well as techniques of integration for week 5. The intervention phase involved technology-assisted lesson delivery designed to engage students in active learning. The technology-assisted lesson in Calculus II was delivered in a classroom setting, and participants attended these lessons in person. By following this protocol, the study aimed to collect reliable and valid data that could be analyzed to determine the effects of technology-assisted lessons on the performance of BSED Mathematics students in Calculus II. The data gathered were subjected to statistical treatment to analyze and interpret the results accurately.

2.4 Statistical Treatment Data

This study employed appropriate statistical treatments to analyze the data collected from BSED Mathematics students in Calculus II.

2.4.1 Frequency Count and Percentage Technique.

This statistical method was used to determine the performance of the students based on pre-test and post-test results. It provided a quantifiable measure of the difference in performance of the students before and after the intervention.

2.4.2 Weighted Mean and Ranking Technique.

The level of engagement of BSED Mathematics students before and after technology-assisted lessons in Calculus II was analyzed using weighted mean and ranking. This statistical treatment provided a numerical representation of the average level of engagement of the students, as well as the ranking order of their engagement level before and after the technology-assisted lesson.

2.4.3 Paired t-test.

The paired t-test was employed to assess the significance of the difference in BSED Mathematics students' performance in Calculus II based on pre-test and post-test results. This statistical tool compared the mean scores of pre-test and post-test results to determine any significant improvement or decline in performance within the same group. It is suitable for analyzing the same group at two different times, controlling for individual differences. Additionally, the paired t-test was utilized to evaluate the level of engagement by comparing pre-participation, pre-quality of work, and pre-feedback mean scores before and after the intervention. The survey questionnaire's reliability was confirmed through a Cronbach's Alpha test (n=30, α=0.87), indicating a high level of internal consistency and enhancing the questionnaire's reliability and study validity.

3 Results and Discussion

This section systematically presents the outcomes of the study, aligning them with the research questions posed. It is divided into five distinct sections, each addressing specific facets of the research. Firstly, the effect of technology-assisted lessons on academic performance is gauged by scrutinizing pre-test and post-test results in Calculus II. Subsequently, the levels of engagement observed among BSED Mathematics students before and after their exposure to technology-assisted lessons are delved into, encompassing dimensions like participation, work quality, and feedback. Additionally, significant disparities in the performance of respondents in Calculus II are explored by comparing their pre-test and post-test results. Lastly, an overarching assessment of the overall effect of technology-assisted lessons on both the performance and engagement of the respondents is provided.

The study commenced with a pre-test administered to 40 respondents in Calculus II to determine their baseline proficiency in the subject. This initial assessment laid the groundwork for exploring the effect of instructional interventions on subsequent academic performance. Subsequently, a post-test evaluated the effects of these interventions on the ongoing performance of the same 40 respondents, serving as a crucial benchmark to assess the effectiveness of interventions and gain insights into respondents' academic development within the course.

Table 1. Performance level of respondents in Calculus II based on pre-test and post-test results.

Performance	Pre-test(n=40)	Post-test(n=40)
Highly Outstanding	0(0%)	1(2.5%)
Outstanding	0(0%)	2(5%)
Very Satisfactory	0(0%)	19(47.5%)
Very Good	0(0%)	17(42.5%)
Satisfactory	0(0%)	1(2.5%)
Failed	40(100%)	0(0%)
Mean	5.0 (Failed)	1.9 (Very Satisfactory)

Legend:

Numerical Grade	**Equivalent Performance**
1.0 - 1.20	Excellent
1.25– 1.40	Highly Outstanding
1.50– 1.70	Outstanding
1.75 – 1.90	Very Satisfactory
2.00 – 2.20	Very Good
2.25 – 2.40	Satisfactory
2.50 – 2.60	Good
2.70 – 2.90	Fair
3.0	Passing
4.0	Conditional
5.0	Failed

Table 1 presents the pre-test and post-test results of 40 respondents in Calculus II. The pre-test revealed a uniform distribution of numerical grades, with all respondents receiving a failing grade of 5.0. This numerical score signifies a complete absence of proficiency in Calculus II for the entire sample, as indicated by the interpretation column, where every respondent is classified as having failed the pre-test, constituting 100% of the respondents. Meanwhile, the post-test resulted in an overall mean of 1.9, corresponding to "Very Satisfactory." These results show a substantial improvement compared to the pre-test scores discussed. Specifically, 19 (47.5%) respondents achieved grades categorized as "Very Satisfactory" (1.8 - 1.9), indicating a commendable level of proficiency. Additionally, 17 (42.5%) respondents obtained a "Very Good" grade (2.1 - 2.2), reflecting significant progress in their understanding of Calculus II concepts. A smaller percentage of students received grades labeled as "Outstanding" (1.5 - 1.7) with 2 (5%) respondents and "Highly Outstanding" (1.3 - 1.4) with 1 (2.5%) respondent. Also, 1 (2.5%) respondent earned a "Satisfactory" grade (2.25 - 2.4). In summary, the overall performance improvement is supported by the mean grade of 1.9, corresponding to the "Very Satisfactory" category.

The findings in this study align with Khashi'ie et al.'s (2017) examination of Mathematics Competency Tests, reinforcing the observations made here [10]. The authors identified deficiencies in Algebra, Trigonometry, and Functions, which parallel overarching inadequacies in respondents' understanding of Calculus II. Collectively, these results emphasize the urgent need for targeted educational interventions and enhanced support to address knowledge gaps and enhance performance in advanced mathematics courses [10]. The uniformly low pre-test scores underscore the collective necessity for interventions, highlighting the importance of identifying and addressing foundational knowledge gaps in mathematics—critical for success in intricate domains like Calculus II.

On the other hand, the post-test results demonstrate a significant improvement in the academic performance of respondents in Calculus II, attributed to technology-assisted lessons. The shift from pre-test failures to the majority achieving "Very Satisfactory" or "Very Good" grades underscores the positive effect of technology integration in mathematics education. These findings find support in Rizada et al.'s (2023) study, which investigated the influence of technology on the academic performance of college millennial learners in mathematics [11]. Their experimental approach revealed a significant improvement in post-test results, with the experimental group outperforming the control group by 2.58 percentage points. This alignment with contemporary research reinforces the notion that technology serves as a potent educational tool, enhancing the understanding of mathematical concepts and boosting academic achievement among college millennial learners in mathematics [12]. It emphasizes the relevance of technology integration as an effective pedagogical strategy in modern mathematics education, benefiting both educators and students.

Table 2. Perceived level of engagement of the respondents in Calculus II before and after using technology-assisted lessons in terms of participation

Statement Indicators		Weighted Mean	
Before	**After**	**Before**	**After**
1. I anticipated actively participating in upcoming lessons in Calculus II.	1. I actively participated in the technology-assisted lessons in Calculus II.	4.28(HE)	4.55(HE)
2. I expected to be able to express my ideas and questions clearly during lessons.	2. I can express my ideas and questions clearly during technology-assisted lessons.	3.75(E)	4.45(HE)
3. I foresaw myself as an active participant during lessons in Calculus II.	3. I feel that I am an active participant during technology-assisted lessons in Calculus II.	4.05(E)	4.78(HE)
4. I had a positive outlook on the level of participation required during lessons in Calculus II.	4. I am satisfied with the level of participation required during technology-assisted lessons in Calculus II.	4.18(E)	4.58(HE)
5. I expected to feel comfortable sharing my ideas and opinions during the lessons in Calculus II.	5. I feel comfortable sharing your ideas and opinions during the technology-assisted lessons in Calculus II.	4.03(E)	4.23(HE)
Overall Mean		4.06(E)	4.52(HE)

Legend:

Numerical Scale		Interpretation		Level of engagement
4.21 – 5.00	--	*Strongly Agree*	--	Highly Engaged (HE)
3.41 – 4.20	--	*Agree*	--	Engaged(E)
2.61 – 3.40	--	*Moderately Agree*	--	*Less Engaged (LE)*
1.81 – 2.60	--	*Disagree*	--	*Not Engaged (NE)*
1.00 – 1.80	--	*Strongly Disagree*	--	*Highly Not Engaged (HN)*

Before the implementation of technology-assisted lessons in Calculus II, as indicated in Table 2, students held positive but varying levels of anticipation and expectations. The weighted mean scores in Table 2 indicate a generally favorable outlook before the intervention, ranging from Moderately Agree (3.41–4.20) to Strongly Agree (4.21–5.00) on the numerical scale. Specifically, students anticipated actively participating (MW: 4.28, Engaged) and expressing their ideas clearly (MW: 3.75, Engaged). However, the anticipation of being an active participant (MW: 4.05, Engaged), satisfaction with the level of participation required (MW: 4.18, Engaged), and comfort in sharing ideas and opinions (MW: 4.03, Engaged) reflected slightly lower engagement levels.

After the introduction of technology-assisted lessons, as indicated in Table 2, there was a notable positive shift in students' perceptions across all indicators. The Weighted Mean scores for each statement increased, and the Overall Mean shifted from Engaged (4.06) to Highly Engaged (4.52). Specifically, students actively participated (MW: 4.55, Highly Engaged), expressed ideas clearly (MW: 4.45, Highly Engaged), felt they were active participants (MW: 4.78, Highly Engaged), were satisfied with the level of participation required (MW: 4.58, Highly Engaged), and felt comfortable sharing ideas and opinions (MW: 4.23, Highly Engaged). This demonstrates a consistent improvement in students' engagement levels after the incorporation of technology-assisted lessons in Calculus II.

The findings in Table 2 provide valuable insights into students' attitudes toward technology-assisted learning in Calculus II, both before and after the intervention. Initially, students had a positive outlook on their anticipated active participation, expressing ideas clearly and foreseeing themselves as active participants during traditional lessons. However,

after experiencing technology-assisted lessons, these expectations significantly increased, as reflected in higher weighted mean scores for each statement.

Before the intervention, students generally anticipated a high level of engagement, falling within the "Engaged" category (3.41 – 4.20). After the technology-assisted lessons, there was a notable shift to the "Highly Engaged" category (4.21 – 5.00), indicating a stronger agreement with statements related to active participation, clarity in expression, and comfort in sharing ideas.

These findings align with Demir's (2023) study on students' attitudes toward technology-integrated learning in Mathematics education, supporting the positive effect of technology-assisted instruction on engagement, problem-solving skills, and metacognitive abilities [13]. The increased agreement levels after the intervention not only reinforce the effectiveness of technology integration but also emphasize the transformative potential of such approaches in optimizing the learning experience in Mathematics education. Additionally, the positive correlation observed aligns with Li et al.'s (2021) research, supporting the broader understanding that technology plays a pivotal role in enhancing student engagement in mathematics education, contributing to improved learning outcomes [14]. The shifts in student attitudes, as evidenced in Table 2, underscore the positive effect of technology-assisted lessons in creating a more engaging and effective learning environment in Calculus II.

Before the implementation of technology-assisted lessons in Calculus II, the Weighted Mean scores for each statement in Table 3 indicate positive but varied levels of engagement, falling within the "Agree" (3.41–4.20) and "Moderately Agree" (2.61–3.40) categories on the numerical scale. Specifically, students believed they would be motivated to actively engage and perform well (MW: 4.25, Engaged), expected well-organized lessons (MW: 4.08, Engaged), had confidence in their ability to excel (MW: 4.03, Engaged), believed the lessons would motivate and inspire high-quality work (MW: 4.05, Engaged), and anticipated timely task completion (MW: 4.30, Engaged). The Overall Mean reflected an "Agree" level (4.14).

After the introduction of technology-assisted lessons, there was a consistent positive shift in students' perceptions across all indicators, as seen in the increased Weighted Mean scores. The Overall Mean shifted from an "Agree" level (4.14) to a "Highly Engaged" level (4.48). Specifically, students reported being highly motivated to actively engage and perform well (MW: 4.53, Highly Engaged), found lessons well-organized and easy to follow (MW: 4.38, Highly Engaged), were confident in their ability to excel (MW: 4.48, Highly Engaged), felt motivated and inspired to produce high-quality work (MW: 4.45, Highly Engaged), and could complete tasks in a timely manner (MW: 4.60, Highly Engaged). The differences between the Before and After Weighted Mean scores indicate a notable positive change in each statement, contributing to the overall improvement in engagement levels. The positive shifts demonstrate the significant effect of technology-assisted lessons in enhancing students' motivation, confidence, and overall learning experience in Calculus II.

Table 3. Perceived level of engagement of the respondents in Calculus II before and after using technology-assisted lessons in terms of quality of work

Statement Indicators		**Weighted Mean**	
Before	**After**	**Before**	**After**
1. I believe I would be motivated to actively engage and perform well in the quizzes and activities in Calculus II.	1. During the technology-assisted lessons, I was highly motivated to actively engage and perform well in the quizzes and activities in Calculus II.	4.25(HE)	4.53(HE)
2. I expected the lessons in Calculus II, including quizzes and activities, to be well-	2. The technology-assisted lessons in Calculus II, including quizzes and	4.08(E)	4.38(HE)

Statement Indicators		Weighted Mean	
Before	**After**	**Before**	**After**
organized and easy to follow, enhancing my learning experience.	activities, were well-organized and easy to follow, enhancing my learning experience.		
3. I had confidence in my ability to excel in the quizzes and activities during the lessons in Calculus II.	3. I was confident in my ability to excel in the quizzes and activities during the technology-assisted lessons in Calculus II.	4.03(E)	4.48(HE)
4. I believed that the lessons in Calculus II would motivate and inspire me to consistently produce high-quality work.	4. The technology-assisted lessons in Calculus II motivated and inspired me to consistently produce high-quality work.	4.05(E)	4.45(HE)
5. I anticipated being able to complete tasks during lessons in a timely manner.	5. I can complete tasks during technology-assisted lessons in a timely manner	4.30(HE)	4.60(HE)
Overall Mean		4.14(E)	4.48(HE)

Legend:

Numerical Scale		Interpretation		Level of engagement
4.21 – 5.00	--	*Strongly Agree*	--	Highly Engaged (HE)
3.41 – 4.20	--	*Agree*	--	Engaged(E)
2.61 – 3.40	--	*Moderately Agree*	--	*Less Engaged (LE)*
1.81 – 2.60	--	*Disagree*	--	*Not Engaged (NE)*
1.00 – 1.80	--	*Strongly Disagree*	--	*Highly Not Engaged (HN)*

Students' positive outlook aligns with another study on the use of digital manipulatives in primary school mathematics education [15]. The study reveals a positive effect on students' mathematics achievement, reflecting a correlation with students' positive anticipation and motivation for quizzes and activities in Calculus II, as presented in Table 3. This alignment suggests that effective technology integration, akin to the use of digital manipulatives, can enhance engagement and academic outcomes. Meanwhile, the positive and confident expectations of students correlate with a study on student engagement with technology-enhanced resources in higher education mathematics [16].

This alignment underscores the enduring effect of technology-assisted lessons on motivation, confidence, and efficiency in producing high-quality work, as demonstrated in the improved engagement levels presented in Table 3. The empirical evidence from both studies supports the interpretation that technology integration positively influences students' engagement and performance in mathematical tasks, reinforcing the transformative potential of technology-assisted instruction in Calculus II.

Table 4. Perceived level of engagement of the respondents in Calculus II before and after using technology-assisted lessons in terms of feedback

Statement Indicators		Weighted Mean	
Before	**After**	**Before**	**After**
1. I looked forward to being interested in the topics covered during the lessons in Calculus II.	1. I was interested in the topics covered during the technology-assisted lessons in Calculus II.	4.18(E)	4.58(HE)
2. I anticipated feeling challenged during the lessons in Calculus II.	2. I felt challenged during the technology-assisted lessons in Calculus II.	4.40(HE)	4.53(HE)
3. I expected to learn something new during the lessons in Calculus II.	3. I learned something new during the technology-assisted lessons in Calculus II.	4.40(HE)	4.55(HE)

Statement Indicators		Weighted Mean	
Before	**After**	**Before**	**After**
4. I anticipated finding the lessons in Calculus II helpful in my learning.	4. I found the technology-assisted lessons in Calculus II to be helpful in my learning.	4.40(HE)	4.48(HE)
5. I expected to be able to apply the concepts I would learn in the lessons in Calculus II to real-life situations.	5. I was able to apply the concepts I learned in the technology-assisted lessons in Calculus II to real-life situations.	4.30(HE)	4.53(HE)
Overall Mean		**4.06(E)**	**4.34(HE)**

Legend:

Numerical Scale		Interpretation		Level of engagement
4.21 – 5.00	--	*Strongly Agree*	--	Highly Engaged (HE)
3.41 – 4.20	--	*Agree*	--	Engaged(E)
2.61 – 3.40	--	*Moderately Agree*	--	*Less Engaged (LE)*
1.81 – 2.60	--	*Disagree*	--	*Not Engaged (NE)*
1.00 – 1.80	--	*Strongly Disagree*	--	*Highly Not Engaged (HN)*

Before the implementation of technology-assisted lessons in Calculus II, students expressed positive yet varied expectations. The weighted mean scores indicated an overall agreement (Agree) with statements such as looking forward to being interested in the topics (MW: 4.18, E) and anticipating feeling challenged (MW: 4.40, HE). Expectations also leaned towards anticipating new learning (MW: 4.40, HE), finding the lessons helpful (MW: 4.40, HE), and applying learned concepts to real-life situations (MW: 4.30, HE). The overall mean was in the Engaged category (4.06, E), reflecting a positive but moderate level of engagement.

After the introduction of technology-assisted lessons, a notable positive shift occurred in students' perceptions across all indicators. The weighted mean scores for each statement increased, with all statements reaching the Highly Engaged level. Specifically, students expressed being highly interested (MW: 4.58, HE), feeling challenged (MW: 4.53, HE), learning something new (MW: 4.55, HE), finding the lessons helpful (MW: 4.48, HE), and being able to apply concepts to real-life situations (MW: 4.53, HE). The overall mean shifted to Highly Engaged (4.34, HE), demonstrating a consistent improvement in students' engagement levels after the incorporation of technology-assisted lessons in Calculus II. This positive transformation underscores the efficacy of technology integration in fostering a highly engaged learning environment in the context of feedback and perceived effect on learning outcomes.

These findings aligned with Simelane-Mnisi and co-workers' study of enhancing engagement and fostering a growth-oriented mindset [17]. Their positive perception of technology's helpfulness and foresight regarding practical applications of course content suggested the potential positive effect of technology-engagement teaching strategies on student engagement and academic performance in mathematics. Recognizing and nurturing these positive expectations is crucial for successful strategy implementation. This aligns with the proactive approach advocated by Ma et al. (2020), supporting the notion that cultivating positive anticipation of technology's role in learning is essential for optimizing the effectiveness of technology-engagement teaching strategies in mathematics education [18]. After the introduction of technology-assisted lessons, students' positive anticipation was validated by a continued alignment with the goals of enriching engagement and improving learning outcomes. This study further supports the positive effect of technology-assisted instruction on students' interest, academic progress, and responsiveness to feedback mechanisms in Calculus II [18]. The personalized learning and practice opportunities afforded by online platforms contributed to increased engagement and improved

understanding and application of mathematical concepts. These findings reinforce the enduring positive influence of technology-assisted lessons on students' learning experiences and outcomes in the realm of mathematics education. The convergence of positive expectations and actualized benefits emphasizes the pivotal role of technology in fostering a progressive and student-centered educational experience in the context of Calculus II.

Table 5. Effect of technology-assisted Lessons on the Level of Performance and Engagement of the Respondents

Source of Difference		Mean	SD	df	t-Computed	p-value
Level of performance	Pre-test	6.43	3.27	39	- 30.69***	0.000
	Post-test	20.64	0.53			
	Difference	-14.21				
Level of engagement - Participation	Before	4.06	0.39	39	-5.140***	0.000
	After	4.52	0.29			
	Difference	-0.46				
Level of engagement - Quality of work	Before	4.14	0.36	39	-6.220***	0.000
	After	4.49	0.30			
	Difference	-0.35				
Level of engagement - Feedback	Before	4.34	0.42	39	-3.221**	0.003
	After	4.53	0.34			
	Difference	-0.20				

*Note: ***p < 0.001, ** p < 0.01*

Table 5 illustrates the transformative effect of technology-assisted lessons on the academic performance and engagement levels of respondents in Calculus II. The pre-test and post-test results reveal a substantial improvement in the level of performance, with a significant negative difference of -14.21 (t-computed = -30.69, $p < 0.000$). This finding underscores the effectiveness of technology integration in enhancing academic performance. Moreover, the analysis of engagement levels indicates significant positive changes across various dimensions. The participants demonstrated heightened levels of participation, as reflected in a mean increase from 4.06 to 4.52 (difference of -0.46, t-computed = -5.140, $p < 0.000$). Quality of work also exhibited a notable enhancement, with a mean increase from 4.14 to 4.49 (difference of -0.35, t-computed = -6.220, $p < 0.000$). Additionally, feedback mechanisms improved, as seen in the mean scores rising from 4.34 to 4.53 (difference of -0.20, t-computed = -3.221, $p < 0.003$). These statistically significant results provide compelling evidence of the positive influence of technology-assisted lessons on both academic performance and engagement in the context of advanced mathematics education.

Llorente-Odicta's (2017) exploration of the effects of differentiated instruction on mathematics achievement and critical thinking skills [19] provides a crucial backdrop for interpreting the results presented in Table 5. Much like the technology-assisted lessons analyzed in the table, the study employed tailored teaching strategies with the shared goal of enhancing student performance and learning outcomes. This research showed a substantial enhancement in mathematics achievement and critical thinking skills, closely aligning with and reinforcing the outcomes highlighted in Table 5. This alignment underscores the consistent positive effect of technology-assisted lessons on academic performance and engagement, emphasizing the broader applicability of personalized teaching methods across diverse educational settings. Together, these findings emphasize the potential of such

approaches in fostering robust academic achievement and enriching students' overall learning experiences, contributing to the broader discourse on effective instructional strategies in mathematics education.

These results are in line with a recent study that demonstrates that students engaged in a technology-enhanced mathematics intervention program exhibited significantly greater gains in mathematics achievement compared to those without participation [20]. This additional study provides further support for the efficacy of technology-assisted lessons in enhancing both student performance and engagement in mathematics. These collective findings extend beyond individual studies to illuminate the broader educational landscape, emphasizing the transformative potential of technology integration for improved learning outcomes. The positive influence of technology-assisted lessons, as evidenced in Table 5, not only offers empirical support but also provides valuable insights for educators and researchers navigating the evolving landscape of mathematics education.

In conclusion, these comprehensive findings underscore the substantial effect of technology integration on academic performance and student engagement in mathematics education. They not only offer empirical support for the positive influence of technology-assisted lessons but also lay the groundwork for ongoing research and advancements in refining methodologies for mathematics education in the digital age.

4 Conclusion and Recommendation

4.1 Conclusion

The pre-test results for 40 respondents in Calculus II indicated a uniform distribution of numerical grades, with all participants (100%) receiving a failing grade of 5.0. However, the post-test revealed a significant improvement, with an average weighted mean of 1.9, corresponding to a "Very Satisfactory" performance level. A positive shift in students' perceptions and engagement levels in terms of participation after the implementation of technology-assisted lessons in Calculus II was also evident. Before the intervention, students displayed favorable outlooks, with varying levels of anticipation, indicating engagement falling within the "Engaged" category. Notably, they anticipated active participation, clear expression of ideas, and satisfaction with the participation level. However, their comfort in sharing ideas and opinions showed slightly lower engagement. After experiencing technology-assisted lessons, there was a consistent improvement in all indicators, reflected in higher Weighted Mean scores. The Overall Mean shifted from "Engaged" to "Highly Engaged," demonstrating a substantial enhancement in students' engagement levels. The transformative effect of technology-assisted lessons on the academic performance and engagement levels of respondents in Calculus II. The pre-test and post-test results demonstrated a substantial improvement in the level of performance, evident from a significant negative difference of -14.21 (t-computed = -30.69, $p < 0.000$). This finding underscores the effectiveness of technology integration in enhancing academic performance. Additionally, the analysis of engagement levels revealed significant positive changes across various dimensions.

4.2 Recommendation

Building on the findings and results, it is advisable for educational institutions to refine the instructional approach, creating a more supportive, engaging, and effective learning environment to boost student performance in the course. Based on the positive outcomes, it is recommended that technology-assisted lessons in Calculus II and similar educational

settings be further explored and integrated. Educators should leverage technology to enhance engagement, foster active participation, and improve overall learning experiences. Professional development opportunities for educators to adapt and incorporate technology effectively can contribute to sustained positive outcomes. Educational institutions are recommended to integrate technology-assisted lessons persistently and expansively, considering their demonstrated statistically significant positive effect on both academic performance and engagement. A substantial investment in professional development for educators is considered imperative to enhance their proficiency in effectively incorporating technology into teaching practices. Furthermore, the implementation of tailored support mechanisms, such as targeted tutoring and supplementary resources, is advised to be considered for addressing specific knowledge gaps and augmenting overall student comprehension. Additionally, institutions are encouraged to establish a structured platform for ongoing collaboration and research in technology-assisted instruction in mathematics, with the aim of cultivating a culture of continuous improvement.

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