Enhancing Student's Achievement in Statistics through Technology Integration

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ABSTRACT

This study aimed to evaluate the effectiveness of technology-integrated instructional method compared to conventional instructional method in enhancing students' academic performance in statistics. The research involved pre-test and post-test assessments of students in both experimental and control groups, categorized according to their mathematical proficiency levels. Findings revealed that the experimental group, which employed technology-based instructional methods, showed a greater improvement in scores, with an increase of 15.71 points compared to 10.09 points in the control group. The absence of a significant difference in pre-test scores confirmed that both groups started with comparable levels of knowledge. The significant improvement in post-test scores for the experimental group highlighted the effectiveness of the innovative instructional method. Additionally, the results indicated that the experimental method was more effective across different mathematical levels, with high-achieving students showing greater improvement. However, low-achieving students also benefited, albeit to a lesser extent. Conclusions drawn from the study emphasized that the experimental instructional method had a more significant positive impact on students' performance compared to the conventional method. The findings underscore the importance of adopting innovative teaching strategies to enhance educational outcomes. Future research should explore the specific elements of the experimental method that contributed to its success and investigate its applicability across different subjects and educational contexts. The study also highlighted the need for additional tailored support to maximize the effectiveness of these strategies for students with varying levels of mathematical proficiency. Recommendations based on the conclusions include the use of more exploratory and participatory methods to make math lessons enjoyable and engaging. Teachers should develop motivational strategies to engage students of all skill levels in math lessons. Encouraging students to conduct research and propose ideas for improving their enjoyment of statistics is also recommended. A range of strategies should be employed to suit the diverse needs of the class, as there is no one-size-fits-all approach to teaching. To determine the significant difference in students', mean scores when taught using two instructional methods, the mean standard deviation and one-way analysis of covariance (ANOVA) was used. To determine the significant difference in students', mean scores when taught using two instructional methods and grouped by their mathematical ability, the mean standard deviation, and two-way analysis of covariance (ANOVA) were used. To examine the significant interaction effect on students' achievement when exposed to two instructional methods and grouped by their mathematical ability, two-way analysis of covariance was employed.

INTRODUCTION

The teaching of statistics and probability is becoming increasingly important in academic institutions due to the growing need for professionals who can quickly analyze large amounts of information. Mastering data analysis techniques is essential for informed decision-making. In the digital age, integrating technology is crucial for engaging students. Studying statistics is vital for everyday mathematical experiences, and educators recognize technology as a key tool for effective teaching across all levels. According to Higase (2020), technology significantly influences college-level statistics instruction, distinguishing between introductory courses, applied statistics across disciplines, and specialized scientific disciplines. Concrete materials aid in making abstract mathematical concepts more engaging, as noted by McNeil and Jarvin (2019), who emphasize that manipulatives help in understanding these ideas. Different teaching objectives across these categories require varied methods, focusing either on computational skills or conceptual understanding. While Cruz (2012) points out that many

educators see the benefits of technology in preparing students for a tech-driven world and enhancing management, there is a misconception that technology alone can resolve educational challenges.

In Anibongan Integrated School, Grade 11 students struggle with mathematics, particularly in statistics and probability, as reflected in their low mean percentage scores. The mean percentage score (MPS) of 56.4 in their third-quarter exam highlights the urgent need for technical assistance to help teachers improve student performance. Enhanced training, localized learning materials, and research-based instruction are essential. Engaging teaching strategies that promote active participation are crucial for learning statistics, as students often struggle when taught abstract concepts without practical engagement. The researcher emphasized the importance of integrating technology to support education in this area.

The researcher observed that learners are naturally playful and engage better in lessons when technology is integrated rather than when taught through conventional methods. Therefore, technology will be utilized in lesson delivery to enhance learning. This study is significant for teachers as it promotes innovative teaching strategies and interactive activities, benefiting students by making fundamental statistical concepts easier to understand. It also aims to develop critical thinking skills applicable to everyday life. Utilizing a quasi-experimental design, this research examined the effectiveness of integrating technology in statistics lessons among Grade 11 students at Anibonngan Integrated School during the 2023-2024 school year. Ultimately, it strove to improve the curriculum and classroom experience while helping students achieve an acceptable mean percentage score.

Therefore, what serves as a positive reinforcement for one student may not necessarily promote positive learning behavior for another. This study focused on determining and analyzing the effectiveness of technology integration in teaching statistics and probability lessons. The subjects of this study were Grade 11 students at Anibongan Integrated School during the fourth quarter of the 2023-2024 school year. The learning areas covered selected topics in Grade 11 statistics and probability. This study employed an experimental design utilizing two methods of instruction in teaching statistics: conventional and technology-integrated instruction. The variables which were examined in this study included the teaching methods mentioned above, the students' mathematical ability levels, and pre-test and post-test scores.

Theoretical/Conceptual Framework

Students' performance is greatly influenced by their engagement level in the teaching-learning process. Specifically, integrating technology into instruction is believed to enhance students' understanding of fundamental statistical concepts, thereby enabling students to tackle more complex statistical problems. This study is anchored on Jerome Bruner's Theory of Constructivism, which posits that learning is an active process. Learners form new ideas based on their current and past knowledge. Thus, instructional resources should emphasize encouragement and support, allowing students to uncover key principles independently. Moreover, independent learning within Computer-Assisted Instruction (CAI) aligns Jean Piaget's Cognitive Learning Theory, wherein children actively construct knowledge through interaction with their environment. Additionally, this study is supported by Burrhus Frederic Skinner's theory of individual differences, which explains that students come from diverse environments where their learning behaviors are shaped and reinforced in various ways. Therefore, what serves as a positive reinforcement for one student may not necessarily promote positive learning behavior for another.

Robert Gagné's Conditions of Learning Theory stipulates that different types or levels of learning require distinct instructional approaches. Consequently, effective educational technology through technology integration employs multiple strategies to both support and challenge learners. Machine learning by Tom M. Mitchell, which is rooted in artificial intelligence, statistics, and computer science, has established itself as a scientific discipline. Unlike artificial intelligence, which aims to generate intelligent behavior, machine learning focuses on discovering mechanisms by which computers can learn specific tasks. Moreover, it addresses problems familiar from statistics or physics, such as regression, classification, and clustering, with a focus on inductive inference and generalization ability. The researcher adopted the TPACK framework introduced by Punya Mishra and Matthew J. Koehler in 2019. This framework identifies three primary forms of knowledge: Content Knowledge

(CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK) offering comprehensive approach to integrating technology into teaching.

In summary, this theoretical framework integrated various educational theories and technological advancements to explore the impact of different teaching methods on students' academic performance. Ultimately, the findings contribute to the ongoing discourse on effective teaching strategies and the role of technology in education. The conceptual paradigm of this study, depicts the interaction of the variables. These corresponds to the teaching methods, which include conventional instruction and technology-integrated instruction. These served as the independent variables of the study. These independent variables may influence the dependent variable which is the pre-test and post-test scores obtained by the respondents. This study focused on determining and analyzing the effectiveness of technology integration in teaching statistics and probability lessons. The subjects of this study were Grade 11 students at Anibongan Integrated School during the fourth quarter of the 2023-2024 school year. The learning areas covered selected topics in Grade 11 statistics and probability. This study employed an experimental design utilizing two methods of instruction in teaching statistics: conventional and technology-integrated instruction. The variables which were examined in this study included the teaching methods mentioned above, the students' mathematical ability levels, and pre-test and post-test scores.

RESEARCH METHODOLOGY

This study used the pretest-posttest quasi-experimental design method of research. Its primary objective was to compare the performance of the students who were exposed to technology-integrated instruction and those who were taught using conventional instruction. This quasi-experimental design was appropriate for the study because it consisted of two groups, with each randomly selected member. This design involved selecting groups upon which a variable is tested, without any random pre-selection processes (Shuttleworth, 2019). The researcher chose this design to meet the objectives of the study, namely, to determine the effect of technology integration on students' academic achievement. After this selection, the experiment proceeded similarly to any other experiment, with a variable being compared between different groups over a period. The experimental group was exposed to technology-integrated instruction, while the control group was taught using conventional instruction. At the end of the topic, a post test was administered to compare the performance of the two groups.

This study was conducted at Anibongan Integrated School during the fourth quarter of the 2023-2024 school year. The school was in Anibongan, Lingig, Surigao del Sur. It was a a public integrated school with a total student population of 227 and a faculty of 18 teachers. The research setting for this study was the Anibongan Integrated School-Senior High, specifically focusing on Grade 11 students enrolled in statistics. The respondents of this study were the Grade 11 students of Anibongan Integrated School, who were enrolled in statistics. Two sections were created for the experiment. Twenty-seven students were assigned to the conventional group, while the other remaining twenty-seven students placed in the technology-integrated instruction group resulting in a total of fifty-four respondents.

The study utilized a pretest-posttest quasi-experimental research design. The instrument used was adopted from the division office. This study utilized a fifty (50) item multiple choice nit test for both the controlled and experimental group. The same questionnaire was used for the pre-test, which was based on the participants' prior knowledge of the unit, and for the post-test, which assessed the concepts learned after the lessons had been conducted. The topics covered in the questionnaires include random variables and probability distributions, normal probability distribution, sampling and sampling distributions of the sample mean, estimation of population mean and population proportion and correlation and regression analyses. Additionally, a specification table had been provided to guide the researcher in constructing test items. Using these methods, the researcher assessed students' learning by administering a pre-test, followed by the lesson, and then a post-test using same questionnaire. The researcher collected and analyzed the pre-test and post-test scores of the respondents. The responses were processed and subjected to statistical treatment. Findings were extracted and analyzed based on the processed data. Afterward, inferences were drawn, followed by the recommendations from the researcher to improve students' performance in solving problems in statistics.

To determine the significant difference in students' mean scores when taught using two instructional methods, the mean standard deviation and one-way analysis of covariance (ANOVA) was used. To determine the

significant difference in students' mean scores when taught using two instructional methods and grouped by their mathematical ability, the mean standard deviation, and two-way analysis of covariance (ANOVA) were used. To examine the significant interaction effect on students' achievement when exposed to two instructional methods and and grouped by their mathematical ability, two-way analysis of covariance was employed.

RESULTS AND DISCUSSIONS

The Mean Scores of Students in the Pre-test and Post-test Results using Conventional and Experimental Methods

Table 1. Students' Mean scores in the Pre-test and Post-test

	Experimental		Control	
	Pre-Test	Post Test	Pre-Test	Post Test
Mean Score	18.42	34.13	17.23	27.32

The table illustrates the mean scores of students in the pre-test and post-test for both the experimental and control groups. The experimental group, which received technology-integrated instruction, showed a significant improvement in their mean scores, increasing from 18.42 in the pre-test to 34.13 in the post-test. This indicates an increase of 15.71 points. On the other hand, the control group, which received conventional instruction, also inhibited an improvement in their mean scores. Their pre-test mean score of 17.23 increased to 27.32 in the post-test, reflecting a gain of 10.09 points. Initially, the pre-test mean scores for both groups were relatively close, with the experimental group scoring 18.42 and the control group scoring 17.23. This suggests that the baseline knowledge of students in both groups was similar before the intervention. After the instructional intervention, the post-test means scores revealed a more pronounced difference between the two groups. The experimental group achieved a higher mean score of 34.13 compared to the control group's mean score of 27.32. This indicates that the experimental instructional method was more effective in enhancing students' understanding and performance in the subject matter. The delivery of learning experiences or scenarios enhanced understanding. A rich learning environment, along with educational technology integration, materials, and equipment, is essential for effective education. To make learning more meaningful, these materials and devices help capture students' attention, imitate thinking, and encourage understanding. According to Booker (2020), one advantage of integrating technology into discussions is that it provided structured procedures allowing learners to receive immediate feedback and engage in discussions as issues arise. He also mentioned that students could build on their prior knowledge and establish connections between problem solving process and real-life applications.

The Significance Difference between the Mean Scores of the Research Subjects

Table 2. Significant difference between the mean scores of the respondents

	GROUP	Mean	p-value	Decision	Conclusion
Pre-Test	Control Group Experimental Group	17.23 18.42	0.121	Failed to Reject Null Hypothesis	There is no significant difference
Post-Test	Control Group Experimental Group	27.32 34.13	0.000	Reject Null Hypothesis	There is a significant difference

The table presents the mean scores and statistical analysis of the pre-test and post-test results for both the control and experimental groups. The analysis includes the mean scores, p-values, decisions, and conclusions regarding the significance of the differences between the groups. For the pre-test, the mean scores were 17.23 for the control group and 18.42 for the experimental group. The pre-test comparison was 0.121, which is greater than

the typical significance level of 0.05. Consequently, the null hypothesis was not rejected, indicating that there was no significant difference between the pre-test scores of the control and experimental groups. This suggests that both groups had similar baseline knowledge before the intervention. In contrast, the post-test results showed a mean score of 27.32 for the control group and 34.13 for the experimental group. The p-value for the post-test comparison is 0.000, which is below the 0.05 significance level. As a result, the null hypothesis was rejected, confirming a significant difference between the post-test scores of the two groups. This suggests that the instructional method utilized in the experimental group was more effective in improving student performance compared to the conventional method taught in the control group.

The Post-test Mean Scores When Group According to their Mathematical Level

Table 3. Students' Mean Gain scores in the Post-test According to Mathematical Level

Mathematical Level	Experimental	Control
High	33.09	28.14
Low	27.11	26.97

The table presents the mean gain scores in the post-test according to the mathematical level of students in both the experimental and control groups. The analysis includes the mean scores for students with high and low mathematical levels. For students with a high mathematical level, the mean gain score in the experimental group was 33.09, while in the control group, it was 28.14. This indicates that students with higher mathematical proficiency benefited more from the experimental instructional method compared to the conventional method. The difference in mean scores suggests that the innovative teaching strategies employed in the experimental group were more effective in enhancing the performance of high-achieving students. For students with a low mathematical level, the mean gain score in the experimental group was 27.11, while in the control group, it was 26.97. Although the difference between the two groups was smaller compared to the high mathematical level group, the experimental group still showed a slight advantage. This suggests that the experimental instructional method also had a positive impact on students with lower mathematical proficiency, albeit to a lesser extent. The slight improvement indicates that while innovative methods are beneficial, additional support may be needed to maximize their effectiveness for low-achieving students.

As students' Mathematical confidence increased through the integration of technology in the classroom, so did their engagement, which led to students' success. Most of the children enjoyed solving problems using technology-based instruction, particularly through software applications. Research has shown that solving problems using trial-and-error strategy in the classroom has numerous advantages. On the other hand, claimed that students in each classroom had varied capacities, which resulted in displayed diverse academic accomplishments. Unfortunately, traditional instruction required all students to learn from the teacher in the same way and at the same time.

Significant Interaction Effect on the Academic Achievement of the Students Using the Two Teaching Strategies When Grouped According to their Mathematical Level

Table 4. Significant Interaction Effect on the Academic Achievement of the Students Using the Two Methods of Teaching and When Grouped According to their Mathematical Level

	F Value	p-value	Decision
Level	5.85	0.069	Failed to Reject
Method	0.42	0.000	Reject
Level*Method	3.216	0.103	Failed to Reject

The table presents the significant interaction effect on the academic achievement of students using two methods of teaching and when grouped according to their mathematical level. The analysis includes the F values, p-values, and decisions for the main effects of level and method, as well as their interaction. The F value for the main effect of mathematical level is 5.85, with a p-value of 0.019. Since the p-value is less than the significance level of 0.05, we reject the null hypothesis. This indicates that there is a significant difference in academic achievement based on the students' mathematical level. In other words, students' mathematical proficiency significantly impacts their academic performance, regardless of the teaching method used. The F value for the main effect of the teaching method is 0.42, with a p-value of 0.000. Since the p-value is less than the significance level of 0.05, we reject the null hypothesis. This indicates that there is a significant difference in academic achievement based on the teaching method used. The results suggest that the innovative instructional method employed in the experimental group was more effective in enhancing students' academic performance compared to the conventional method used in the control group. The F value for the interaction effect of mathematical level and teaching method is 3.216, with a p-value of 0.103. Since the p-value is greater than the significance level of 0.05, we fail to reject the null hypothesis. This indicates that there is no significant interaction effect between students' mathematical level and the teaching method on their academic achievement. In other words, the effectiveness of the teaching method does not significantly vary based on the students' mathematical proficiency.

CONCLUSION

The greater improvement in the experimental group's scores suggests that the innovative instructional method employed was more effective than the conventional method. The increase of 15.71 points in the experimental group compared to 10.09 points in the control group highlights the potential benefits of adopting new teaching strategies to improve student learning outcomes. The lack of a significant difference in the pre-test scores confirms that both groups started with comparable levels of knowledge. The significant improvement in the post-test scores of the experimental group highlights the effectiveness of the innovative instructional method employed. The results indicate that the experimental instructional method was more effective in improving the performance of students across different mathematical levels. The greater improvement observed in high-achieving students suggests that these students were able to leverage innovative teaching strategies to enhance their understanding and performance. For low-achieving students, the experimental method provided a slight improvement over the conventional method, indicating that it can also support students who may struggle with mathematical concepts. The significant main effects of both mathematical level and teaching method highlight the importance of considering these factors independently when aiming to improve academic achievement. The lack of a significant interaction effect suggests that while both factors independently influence academic performance, their combined effect does not produce additional significant differences. This implies that innovative teaching methods can be beneficial across different levels of mathematical proficiency, but additional tailored support may be needed to maximize their effectiveness for all students.

The experimental instructional method demonstrated a greater positive impact on students' performance compared to the conventional method. The significant improvement in the experimental group's mean scores underscores the importance of exploring and implementing innovative teaching strategies to enhance educational outcomes. The results indicate that while both groups had similar baseline knowledge, the experimental instructional method led to significantly better learning outcomes compared to the conventional method. These findings underscore the importance of adopting innovative teaching strategies to improve educational outcomes The experimental instructional method demonstrated a greater positive impact on students' performance across different mathematical levels compared to the conventional method. The significant improvement observed among high-achieving students highlights the potential of innovative teaching strategies to enhance educational outcomes.

The results indicate that both students' mathematical level and the teaching method used had significant independent effects on academic achievement. The innovative instructional method proved to be greater effective in improving student performance compared to the conventional method. However, the absence of a significant interaction effect suggests that the benefits of the teaching method are consistent across different levels of mathematical proficiency.

REFERENCES

1. Antipolo, A. M. R., & Rogayan, D. V. Jr. (2021). Filipino Prospective Teachers' Experiences in Teaching in K12 Science Curriculum: A Cross-Sectional Research. Jurnal Pendidikan Biologi Indonesia, 7(1), 1-10.
2. Bhat, R. (2023). The Impact of Technology Integration on Student Learning Outcomes: A Comparative Study.
3. Booker, R. (2020). Advancements in AI and Their Educational Implications. Journal of Educational Technology, 15(3), 68-85
4. Bruce, A., & Smith, J. (2019). The Role of AI in Modern Education. As cited in James, T. (2020). Exploring the Impact of Artificial Intelligence on Teaching Practices. Journal of Educational Innovations, 22(4), 123-145.
5. David, I. P., & Maligalig, D. S. (2023). Are We Teaching Statistics Correctly to Our Youth? The Philippine Statistician, 55(3-4), 1-28.
6. Deslauriers, L., McCarty, L., Miller, K., Kestin, G., & Callaghan, K. (2019). Study shows that students learn more when taking part in classrooms that employ active-learning strategies. Harvard University.
7. Harris, J. L., Al-Bataineh, M. T., & Al-Bataineh, A. (2023). 1:1 Technology and its Effect on Student Academic Achievement and Motivation.
8. Harvard Graduate School of Education. (2023). New Data Show How the Pandemic Affected Learning Across Whole Communities. Center for Education Policy Research.
9. Lee, J., & Kim, S. (2023). An empirical study on integrating technology into statistics classroom practice. Journal of Pedagogical Research, 6(3), 112-136.
10. Luke, M. (2017). Utilizing a Metaphoric Approach to Teach the Neuroscience of Play Therapy: A Pilot Study. Journal of Counselor Leadership and Advocacy, 4(1), 1-15.
11. Lumando, P. (2021). Challenges and Opportunities in Integrating Technology in Education. Philippine Journal of Educational Technology, 18(2), 45-60.
12. Luna, S. (2021). Integrating Technology in Education: Challenges and Opportunities. Journal of Philippine Educational Research, 19(1), 34-50.
13. Meliton, J. (2020). Enhancing Student Understanding Through Learning Experiences: A Citation of Turing (2019).
14. Msafiri, M., Kangwa, D., & Cai, L. (2023). A Systematic Literature Review of ICT Integration in Secondary Education.
15. National Center for Education Statistics. (2024). Report on the Condition of Education 2024. U.S. Department of Education.
16. Olayinka, A., Waghid, Z., & Wambua, A. (2024). Technology Integration in Teacher Education: Challenges and Adaptations in the Post-Pandemic Era.
17. Prodromou, T. (2023). Teaching statistics with technology. Journal of Educational Research.
18. Researchers (2023). Teaching and Learning with Technology: Effectiveness of ICT Integration
19. Rodrigues, J., & da Ponte, J. P. (2022). Didactic Knowledge in Teaching Statistics: Enhancing Teachers' Competencies. Journal of Educational Research.