Enhancing Data Analysis Skills of STEM Students through Targeted Seminar Workshop

Rudeno B. Pequero[1], Marven B. Laude[2]

[1]Teacher II, Department of Education

[2]MS Student, Central Mindanao University

DOI: https://doi.org/10.47772/IJRISS.2026.100500253

Received: 28 April 2026; Accepted: 05 May 2026; Published: 28 May 2026

ABSTRACT

Given the limited proficiency in data analysis among senior high school students, this study explored the effectiveness of a targeted seminar-workshop in enhancing data analysis skills among 72 Grade 12 STEM students at Dangcagan National High School. Using a one-group quasi-experimental design conducted over a six-week period, participants received intensive instruction on core statistical concepts and hands-on training in using SPSS for data processing and interpretation. Pre-intervention scores indicated moderate proficiency (M = 12.04, SD = 2.18), which significantly improved after the intervention (M = 16.10, SD = 1.95), with a mean gain of 4.06 points (SD = 2.28, p = .001). The computed Cohen's d = 1.78 indicated a large effect size. Further analysis showed no statistically significant difference in performance between male and female students (p = .20), suggesting equitable learning outcomes. Comparison of immediate (M = 16.10, SD = 1.95) and delayed (M = 16.91, SD = 2.11) post-test scores after six weeks demonstrated strong retention, with a small effect size (Cohen's d = 0.34). These findings highlight the value of short, focused interventions in strengthening data analysis competencies. To sustain proficiency, the study recommends integrating similar workshops before Capstone Projects, alongside structured instruction, supplementary modules, retrieval-based assessments, and ongoing evaluation.

Keywords: Data Analysis Skills, Targeted Seminar-Workshop, STEM Education, Retention, Quasi-Experimental Design

INTRODUCTION

In the current data-driven world, analysis skills are increasingly recognized as essential across industries, scientific research, and governance. As education adapts to meet the demands of the 21st century, there is growing emphasis on cultivating students' critical thinking, problem-solving, and analytical reasoning, particularly among those in the STEM strand. Data analysis is acknowledged as a skill of global importance. The Department of Education's Curriculum Guide for Capstone Research (STEM_RP12-IIa-e-9) highlights the need to equip students with the ability to extract meaningful insights and make evidence-based decisions through data analysis.

Despite this curricular emphasis, many Filipino students continue to struggle with data analysis. It is common knowledge that the Philippines performed below the global average in Science and Mathematics, according to the Programme for International Student Assessment (OECD, 2023). At Dangcagan National High School, CMSS data for the Second Quarter SY 2023-2024, showed that STEM students obtained an average grade of 83 percent in Statistics and Probability. This fell short of the 86 percent benchmark in Mathematics set by DepEd Order No. 55, s. 2016.A persistent challenge is STEM students' difficulty in applying statistical methods and interpreting data in meaningful ways. The researcher identifies this discrepancy as a gray area, highlighting the need for potential growth and reflection to support continued improvement in the subject.

Moreover, students tend to depend on statisticians or external help for analysis tasks, indicating a lack of confidence and competence in independently analyzing data which is an essential skill for research and future

academic or career success. Students themselves have reported feeling overwhelmed when tasked with applying statistics to their own research projects.

The targeted seminar-workshop is grounded in Kolb's Experiential Learning Theory (ELT), which emphasizes learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation. ELT has been widely recognized for its effectiveness in fostering applied skills development (Lucas et al., 2025). In the local context, its implementation among Filipino Microbiology students has demonstrated promising outcomes in enhancing practical competencies (Allauigan et al., 2023).

This study aimed to address the performance gap by providing guided, practical training in data analysis to STEM students at Dangcagan National High School, with the goal of improving outcomes, building confidence, and preparing these students for evidence-based inquiry in their Capstone Research.

Objectives

The general objective of this study is to determine the effectiveness of a targeted seminar-workshop in enhancing the data analysis skills of Grade 12 STEM students at Dangcagan National High School. Specifically, the study aims to assess the level of data analysis skills of STEM students before and after the implementation of the seminar-workshop and determine whether there is a significant difference in their skills following the intervention. It also seeks to examine whether a significant difference exists in the data analysis skills of male and female STEM students after the implementation of the seminar-workshop. Furthermore, the study evaluates the level of data analysis skills of students in both the immediate post-test and delayed post-test, and determines whether there is a significant difference between these two sets of results.

METHODOLOGY

Research Design

This study employed a quasi-experimental one-group pretest–posttest–delayed posttest design to determine the effectiveness of a targeted seminar-workshop in enhancing the data analysis skills of Grade 12 STEM students. This design is appropriate in educational settings where random assignment is not feasible, allowing for practical yet systematic evaluation of instructional interventions. It enabled the researcher to measure immediate learning gains and long-term retention by comparing students' performance across three time points: pretest, immediate posttest, and delayed posttest.

Participants of the Study

Purposive sampling was used to select the participants, consisting of seventy-two (72) Grade 12 STEM students enrolled at Dangcagan National High School for the Academic Year 2024–2025, including thirty-eight (38) males and thirty-four (34) females. All participants were engaged in Capstone Research projects, requiring the application of statistical analysis, making them suitable for the study.

Intervention and Implementation Process

The study implemented a targeted seminar-workshop to address gaps in students' statistical analysis skills, focusing on practical competencies required for Capstone and Practical Research. The workshop was conducted on January 6, 2025, at the Dangcagan National High School Multi-Purpose Building. Students worked in small groups with shared laptops to promote collaboration and hands-on practice. The session was facilitated by a statistics instructor from San Agustin Institute of Technology, with assistance from STEM teachers.

SPSS was used as the primary tool for data analysis. Since participants had no prior experience, the training covered guided navigation, data entry, descriptive statistics, and basic inferential procedures. Activities followed Kolb's Experiential Learning Cycle, progressing through guided instruction, practice, independent application, and reflection. To support continuity of learning, students were given access to computer laboratory sessions, workshop materials, and continued guidance from the Capstone Research teacher.

Research Instrument

A 20-item researcher-made multiple-choice test was used to measure students' data analysis skills. The instrument covered competencies in data organization, descriptive statistics, inferential analysis such as t-test and correlation, and basic SPSS operations.

Content validity was established through expert review using a structured rubric. A Table of Specifications and alignment matrix ensured adequate coverage of competencies. Pilot testing and item analysis were conducted, leading to the revision of three items. The final instrument demonstrated high reliability, with a Cronbach's alpha of $\alpha = 0.929$.

Data Collection Procedures

Prior to data collection, approval was secured from the school administration, and informed consent was obtained from participants and their parents or guardians. Confidentiality and voluntary participation were strictly observed.

Data collection followed three phases. First, a pretest was administered to establish baseline data analysis skills. This was followed by the implementation of the targeted seminar-workshop. Immediately after the intervention, a posttest was conducted to measure learning gains. A delayed posttest was administered six weeks later to assess retention of skills over time. The six-week interval aligns with principles of memory retention, providing a meaningful measure of sustained learning.

Data Analysis Procedures

Descriptive and inferential statistics were used to analyze the data. Mean and standard deviation were computed to describe students' performance across test administrations. A paired-samples t-test was used to determine significant differences between pretest and posttest scores, as well as between immediate and delayed posttest results. An independent samples t-test was employed to examine gender differences. Assumptions of normality and homogeneity of variance were tested prior to analysis. Cohen's d was computed to determine effect size and assess the practical significance of the intervention.

Ethical Considerations

This study adhered to the ethical standards set by the Department of Education, including DepEd Order No. 16, s. 2017 and DepEd Memorandum No. 28, s. 2022. Administrative approval was obtained prior to implementation. Informed consent was secured from all participants, and confidentiality of data was maintained. Participation was voluntary, and no academic disadvantage was imposed on non-participants.

RESULT AND DISCUSSION

This section presents the analysis of the data collected to assess the effectiveness of the Data Analysis Seminar Workshop in improving the data analysis skills of STEM students at Dangcagan National High School. The results are examined in relation to the research questions using statistical tools such as mean, standard deviation, paired t-tests, and independent t-tests to determine skill improvements, gender differences, and retention levels.

Research Question 1.

What is the level of data analysis skills of STEM students in Dangcagan National High School before and after the implementation of data analysis seminar workshop?

Table 1. Level of Data Analysis Skills of STEM Students Before and After the Seminar Workshop.

Indicators	Mean	SD	Description	Interpretation
Pretest	12.04	2.18	Satisfactory	Students have a basic understanding of data analysis.

Posttest	16.10	1.95	Very Good	Students have a strong understanding of data analysis concepts.

Legend: Excellent (18-20); Very Good (16-17.9); Good (14-15.9); Satisfactory (12-13.9); Needs Improvement (10-11.9); Weak (below 10)

Table 1 presents the level of data analysis skills of Grade 12 STEM students from Dangcagan National High School before and after the seminar workshop. The pretest mean score of 12.04 (Satisfactory) with a standard deviation of 2.18 suggests that the G12 STEM students had a basic understanding of data analysis, though with varying proficiency levels. The pretest further shows that some students performed near the average, while others showed significantly higher or lower scores. After the seminar, the post-test mean increased to 16.10 (Very Good), and the standard deviation decreased to 1.95, indicating a substantial improvement in data analysis skills and a more consistent level of performance across the group.

This indicates that the Grade 12 STEM students showed a marked improvement in their data analysis skills following the seminar-workshop. The pretest results revealed a basic understanding of data analysis, but with a wide range of skill levels. After the intervention, the post-test results revealed a significant improvement, as evidenced by the increased mean score and reduced variability in student performance. The decreased standard deviation from 2.18 to 1.95 suggests that students who initially had weaker skills showed substantial improvement, while those with stronger skills maintained or slightly enhanced their proficiency.

The reduction in variability in the post-test scores suggests that the seminar-workshop not only improved the data analysis skills of Grade 12 STEM students but also aligned the proficiency levels across the entire group. The more consistent performance after the seminar reflects the success of the intervention in providing more uniform understanding and skill development. The increased mean score and decreased standard deviation indicate that the seminar-workshop effectively enhanced the overall proficiency of students while reducing skill gaps. This pattern demonstrates that the intervention not only benefited high-performing students but also supported those who initially struggled with data analysis concepts. Such results underscore the effectiveness of structured, targeted training programs in achieving equitable academic outcomes.

Studies by Schiepe-Tiska et al. (2023) and Yildirim & Selvi (2016) support the effectiveness of structured instructional approaches in enhancing STEM students' statistical reasoning and data analysis skills. Likewise, research by Ow-Yeong et al. (2023) emphasizes the positive effects of active learning strategies, which were likely employed during the seminar-workshop, on improving students' data analysis skills. These findings align with the observed improvement in students' performance between the pretest and posttest phases of the study.

Research question 2

Is there a significant difference on data analysis skills of STEM students in Dangcagan National High after the implementation of seminar workshop?

Table 2. Comparative Analysis on Pretest and Immediate Posttest

	Mean	**SD**	***p*-value**	**Cohen's *d***	**Remarks**
Pre-test Immediate Post-test	-4.06	2.28	.001*	1.78	Significant

**Significant at p<.05*

Cohen's d Interpretation Guidelines

0.0-.19-Negligible-No meaningful difference; .20-.40 (small)-Visible but minor effect; .50-.79 (medium)-Substantial practical importance; ≥.80 (large)- Educationally significant difference

Table 2 shows a statistically significant improvement in students' data analysis skills following the seminar-workshop. The mean difference of −4.06 indicates an average increase of 4.06 points from pretest to immediate posttest, reflecting improved performance after the intervention. The relatively low standard deviation (SD = 2.28) suggests that gains were consistent across participants.

The p-value of 0.001, which is below the 0.05 level of significance, confirms that the observed improvement is not due to chance. Moreover, the computed Cohen's d of 1.78 indicates a large effect size, signifying that the intervention had a substantial and educationally meaningful impact on students' data analysis skills. The results demonstrate a clear improvement in students' performance, with a shift from "Satisfactory" to "Very Good," indicating that the seminar-workshop effectively enhanced their competencies in data analysis.

These findings are consistent with previous studies showing that structured, hands-on interventions improve learning outcomes. Similar gains were reported by Maala et al. (2025) in AI-supported learning environments and by Mokkapati and Mada (2018) in seminar-based training contexts. Likewise, studies by Molina (2021) and Becker and Park (2011) support the effectiveness of integrative and problem-based approaches in strengthening analytical skills.

Research Question 3

Is there a significant difference in data analysis skills between male and female STEM students in Dangcagan National High after the implementation of seminar workshop?

Table 3. Comparative Analysis on Immediate Posttest by Sex

	Group	**Mean**	**SD**	**Mean Difference**	***p*-value**	**Remark**
Immediate Posttest	Male	15.63	2.45	-.723	.20	Not Significant
	Female	16.35	1.61			

*Significant at p<.05

The immediate post-test results show that male students had an average score of 15.63 (SD = 2.45), while female students had a slightly higher mean of 16.35 (SD = 1.61). The mean difference of -0.723 suggests that males scored lower on average. However, with a p-value of 0.20, this difference is not statistically significant, indicating that biological categories did not meaningfully impact post-test performance.

These results suggest that both male and female students benefited equally from the seminar-workshop, demonstrating its effectiveness between male and female students. This finding aligns with research on gender equity in STEM education. Studies by Wang & Degol (2017) show that when provided with equal opportunities, male and female students perform similarly in STEM-related tasks, including data analysis. Schiepe-Tiska et al. (2023) and Wrigley-Asante et al. (2023) emphasized that structured instructional strategies help reduce gender disparities and improve data literacy across diverse student populations.

Research Question 4

What is the level of student data analysis skills in the immediate post-test and delayed post-test?

Table 4. Level of Data Analysis Skills of STEM Students during Immediate Posttest and Delayed Posttest

Indicators	Mean	SD	Description	Interpretation
Immediate Post-test	16.10	1.95	Very Good	Students have a strong understanding of data analysis concepts.
Delayed Post-test	16.91	2.11	Very Good	Students have a strong understanding of data analysis concepts.
Legend: Excellent (18-20); Very Good (16-17.9-); Good (14-15.9); Satisfactory (12-13.9); Needs Improvement (10-11.9); Weak (below 10)				

Table 4 shows that STEM students demonstrated a consistently strong level of data analysis skills in both the immediate post-test (M = 16.10, SD = 1.95) and delayed post-test (M = 16.91, SD = 2.11), both interpreted as "Very Good." This indicates that students maintained a solid understanding of data analysis concepts after the intervention.

The slight increase in the delayed post-test mean suggests not only retention but modest improvement over time. This may be attributed to students' continued engagement in their Capstone research projects, where they applied and reinforced their data analysis skills in authentic contexts. However, the slightly higher variability in delayed post-test scores indicates differences in individual retention and application, likely influenced by varying levels of engagement, motivation, and research complexity.

These findings align with prior studies emphasizing the role of active application and retrieval practice in strengthening long-term learning. Santhosh et al. (2023) similarly reported improvements in STEM skills through project-based engagement, while studies on the "testing effect" (Roediger & Butler, 2011; Rowland, 2014) highlight how repeated assessment enhances retention.

Research Question 5.

Is there a significant difference between the immediate post-test and the delayed post-test?

Table 5. Comparative Analysis on Immediate Posttest and Delayed Posttest

	Mean	SD	*p*-value	Remarks	Cohen's *d*
Immediate Post-test Delayed Post-test	-.81	2.40	.006*	Significant	.34

**Significant at p<.05*

Cohen's d Interpretation Guidelines

0.0-.19-Negligible-No meaningful difference; .20-.40 (small)-Visible but minor effect; .50-.79 (medium)-Substantial practical importance; $\geq .80$ *(large)- Educationally significant difference*

Table 5 indicates a statistically significant difference between the immediate and delayed post-test scores (p = .006). The mean difference of −0.81 reflects a slight increase in performance after six weeks, with the delayed post-test mean (16.91) higher than the immediate post-test mean (16.10). This suggests that students were able to retain their data analysis skills while showing modest improvement over time.

The computed Cohen's d of 0.34 indicates a small effect size, suggesting that although the difference is statistically significant, the magnitude of improvement is limited. This pattern implies that the majority of learning gains occurred immediately after the intervention, with only incremental development observed in the weeks that followed.

The improvement may be associated with students' continued engagement in their Capstone research projects, where they applied data analysis concepts in authentic contexts. This aligns with studies on retrieval practice and the "testing effect" (Roediger & Butler, 2011; Rowland, 2014), as well as findings by Khalafi et al. (2024), which report modest gains between immediate and delayed assessments.

The variability in scores (SD = 2.40) indicates differences in individual learning trajectories, likely influenced by levels of engagement, prior knowledge, and the complexity of research tasks undertaken by students. Some students may have had more opportunities to apply statistical techniques in their Capstone projects, allowing for deeper reinforcement of concepts, while others may have had limited practice due to varying research demands. Differences in motivation and consistency of practice may have also contributed to the observed spread in scores. These factors highlight how individual learning conditions can shape the extent to which skills are retained and further developed over time.

CONCLUSION

The findings show that the one-day seminar-workshop significantly improved STEM students' data analysis skills, as evidenced by the increase from pretest to immediate post-test scores (MD = -4.06, p = .001). This indicates that the intervention effectively enhanced students' statistical reasoning and SPSS-based data processing skills. In terms of gender differences, there was no significant difference between male and female students' post-test scores (p = .20), indicating comparable performance after the intervention. For knowledge retention, delayed post-test scores (M = 16.91) were significantly higher than immediate post-test scores (M = 16.10) (p = .006), showing a measurable change in performance over time.

RECOMMENDATION

The seminar-workshop may be expanded to include learners from other strands to strengthen data analysis skills across the school. Active learning strategies such as inquiry-based activities, problem-solving workshops, and hands-on data interpretation should be integrated into research-related subjects.

Supplementary learning modules with guided exercises, real-world datasets, and SPSS-based tasks are recommended to further support Quantitative Research, Practical Research, and Capstone Projects. Regular formative assessments, low-stakes quizzes, and peer discussions should also be implemented to reinforce retention and deepen understanding through practice and collaboration.

Future studies may include qualitative approaches or longitudinal and experimental designs to better examine long-term effects and compare instructional strategies. A student research mentorship program is also recommended to strengthen guidance and application of skills.

Finally, teachers are encouraged to promote cross-strand collaboration, reinforcing data analysis as a core competency essential for both academic success and real-world problem-solving.

ACKNOWLEDGMENT

First and foremost, I thank Almighty God for His guidance and blessings throughout this research journey.

Sincere gratitude is extended to our School Principal, Mrs. Mercedes R. Abarquez, for her support, encouragement, and approval of this study. Appreciation is also given to our resource person, Mr. Marven B. Laude, for his expertise and valuable insights during the seminar-workshop, and to Ms. Lesly Alingay for her assistance and input in Statistics and Probability.

Special thanks to RH Tan Enterprises, Mr. Edwin Paelmao, and Mr. Ferdinand Flauta for their generous support. Deep appreciation is also given to the Grade 12 STEM students and their parents for their active participation.

The researcher also acknowledges the Senior High School and Junior High School faculty of Dangcagan National High School for their encouragement and support. Finally, heartfelt thanks to my family for their unwavering love and support throughout this academic endeavor.

REFERENCES

1. Allauigan, M. A., Melad, K., Beltran, O., Jamoral, L., & Bete, A. (2023). Kolb's experiential learning theory application in home-based laboratory activities of science major students in microbiology. Jurnal Pendidikan Progresif, 13(2), 580–596. https://doi.org/10.23960/jpp.v13.i2.202333
2. Becker, K., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. Journal of STEM Education: Innovations and Research, 12(5–6), 23–37.
3. Khalafi, A., Fallah, Z., & Sharif-Nia, H. (2024). The effect of spaced learning on the learning outcome and retention of nurse anesthesia students: A randomized-controlled study. BMC Medical Education, 24, 322. https://doi.org/10.1186/s12909-024-05290-9
4. Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Prentice-Hall.

5. Lucas, M., Bem-haja, P., Zhang, Y., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2025). A comparative analysis of pre-service teachers' readiness for AI integration. Computers and Education: Artificial Intelligence, 8, 100396. https://doi.org/10.1016/j.caeai.2025.100396
6. Maala, G. L. I. P., Montoya, L. M. D., Pampan, F. N. L., Cahapin, E. L., Anciro, E. C., & Malabag, B. A. (2025). Exploring the impact of AI tools on student learning through text mining. Journal of Educational Technology Systems. Advance online publication. https://doi.org/10.1177/00472395241234567
7. Mokkapati, A., & Mada, P. (2018). Effectiveness of a teacher training workshop: An interventional study. Journal of Clinical and Diagnostic Research, 12(2), 10–13. https://doi.org/10.7860/JCDR/2018/30165.11219
8. Molina, R. (2021). Research competencies of Science, Technology, Engineering, and Mathematics (STEM) students in a state college in Zamboanga City, Philippines. Eurasian Journal of Educational Research, 94, 359–378. https://doi.org/10.14689/ejer.2021.94.16
9. OECD. (2023). PISA 2022 Results (Volume I): The State of Learning and Equity in Education. OECD Publishing. https://doi.org/10.1787/53f2383c-en
10. Ow-Yeong, Y. K., Yeter, I. H., & Ali, F. (2023). Learning data science in elementary school mathematics: A comparative curriculum analysis. International Journal of STEM Education, 10(1), 1–22. https://doi.org/10.1186/s40594-023-00397-9
11. Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. Trends in Cognitive Sciences, 15(1), 20–27. https://doi.org/10.1016/j.tics.2010.09.003
12. Rowland, C. A. (2014). The effect of testing versus restudy on retention: A meta-analytic review of the testing effect. Psychological Bulletin, 140(6), 1432–1463. https://doi.org/10.1037/a0037559
13. Santhosh, M., Farooqi, H., Ammar, M., Siby, N., Bhadra, J., Al-Thani, N. J., Sellami, A., Fatima, N., & Ahmad, Z. (2023). A meta-analysis to gauge the effectiveness of STEM informal project-based learning: Investigating the potential moderator variables. Journal of Science Education and Technology, 32(5), 671–685. https://doi.org/10.1007/s10956-023-10063-y
14. Schiepe-Tiska, A., & Schmidtner, S. (2023). Integrating statistical and data literacy into K-12 STEM curricula: A systematic review. ZDM – Mathematics Education, 55, 1025–1039. https://doi.org/10.1007/s11858-023-01531-1
15. Wang, M.-T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. Educational Psychology Review, 29(1), 119–140. https://doi.org/10.1007/s10648-015-9355-x
16. Wrigley-Asante, C., Owusu, A. B., & Oteng-Ababio, M. (2023). Gender disparities in STEM education: Evidence from senior high schools in Ghana. Asia Pacific Education Review. Advance online publication. https://doi.org/10.1007/s43545-023-00608-8
17. Yildirim, I., & Selvi, K. (2016). The effect of STEM education practices on students' attitudes and achievements: A meta-analysis study. Journal of Technology and Science Education, 13(1), 73–86. https://doi.org/10.3926/jotse.1790