PERFORMANCE ANALYSIS OF ENGINEERING STUDENTS IN STATISTICS ASSESSMENTS

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ABSTRACT

This study examines the performance of civil engineering students in probability and inferential statistics topics through two distinct assessment types: Assessment 1 (Quiz Individual) and Assessment 2 (Group Assignment). The Assessment 1 (Quiz Individual) focuses on probability topics such as binomial, Poisson, normal distributions, and sampling distributions, while the Assessment 2 (Group Assignment) evaluates their understanding of estimation, confidence intervals and hypothesis testing, including analyses of one mean, two means, one variance, and two variances. Additionally, a t-test for two means is conducted to determine if there is a significant difference between the mean scores of quizzes and assignments. The data includes scores from 26 civil engineering students, representing a subset of the total 346 engineering students across civil, chemical, mechanical, and electrical disciplines. The findings highlight key differences in individual and group performance, shedding light on common challenges faced by students in understanding statistical concepts and implications for improving teaching strategies.

Keywords: probability, statistics, quizzes, assignment, engineering

Introduction

Statistics is a critical component in engineering education, equipping students with the analytical tools necessary for data-driven decision-making in professional practice. Among the various statistical topics, probability and inferential statistics are particularly vital, providing a foundation for understanding uncertainty and variability in engineering processes. However, mastering these concepts poses significant challenges for students, as evidenced by varying performance levels in assessments. This study focuses on civil engineering students' performance in Assessment 1 (Quiz Individual) and Assessment 2 (Group Assignment), aiming to uncover patterns that can inform teaching strategies. By analyzing assessment data, this research contributes to a broader understanding of how students engage with statistical topics and identifies areas requiring pedagogical intervention. Additionally, the study employs hypothesis testing to evaluate whether there is a statistically significant difference between the mean scores of quizzes and assignments, further enriching the analysis.

Statistical literacy is crucial for university students across disciplines, particularly in engineering and data-driven fields. Studies have shown that many first-year university students struggle with basic statistical concepts, such as selecting appropriate descriptive statistics and creating meaningful data visualizations (Setiawan & Sukoco, 2021). This lack of proficiency extends to Pakistan, where research has revealed low statistical literacy among undergraduate students (Hassan et al., 2020). To address these challenges, experts advocate for curriculum reforms that emphasize real-world data analysis, decision-making under uncertainty, and the integration of data science concepts (Burrill, 2020). Additionally, introducing data literacy frameworks that encompass technical, legal, and ethical perspectives can help equip engineering students with essential skills for the digital age (Giese et al., 2020). Improving statistical education at both secondary and university levels is necessary to enhance students' ability to interpret and utilize data effectively in their academic and professional lives.

Collaborative learning environments can enhance student engagement and performance in various academic settings, including statistics and computer science courses (Mesghina et al., 2024; Wu et al., 2024). Group dynamics play a crucial role in these environments, with factors such as equal participation, peer interaction, and social presence influencing learning outcomes (Strauss & Rummel, 2021; Qureshi et al., 2021). While the presence of expert peers can benefit struggling students, this effect is not consistent across all groups (Wu et al., 2024). Interestingly, group composition (heterogeneous or homogeneous) does not significantly impact individual learning or discussion engagement (Mesghina et al., 2024; Wu et al., 2024). Social factors, including interactions with peers and teachers, positively influence collaborative learning and student involvement, ultimately affecting learning performance (Qureshi et al., 2021). Despite challenges in group dynamics, students generally perceive collaborative learning as valuable, promoting opportunities for positive interactions and revealing misunderstandings (Mesghina et al., 2024; Strauss & Rummel, 2021).

Recent research advocates for active learning strategies in teaching probability and statistics, with a focus on flipped classrooms (FC) and technology-enhanced teaching. Studies have shown that FC approaches can improve student performance, engagement, and critical thinking skills in introductory statistics courses (Farmus et al., 2020). A meta-analysis revealed that students in FC settings achieved 6.9% higher final performance outcomes compared to traditional lecture-based classrooms (Farmus et al., 2020). The FC model has been successfully implemented in various contexts, including mathematics for computer science courses, where it enhanced collaboration and problem-solving skills (Dori et al., 2020). Additionally, incorporating project-based learning components can further improve student performance and attitudes towards FC (Dori et al., 2020). Even in online settings, FC strategies have shown promise in addressing passivity issues and motivating engineering students in statistics courses (Andersson & Kroisandt, 2021).

Methodology

This study employs a quantitative approach to analyze the performance of 26 civil engineering students in two types of assessments: individual quizzes and group assignments. The Assessment 1 (Quiz Individual) assesses topics in probability, including Binomial, Poisson, Normal distributions, and sampling distributions, while the Assessment 2 (Group Assignment) covers estimation, confidence intervals and hypothesis testing involving one mean, two means, one variance, and two variances. Descriptive statistics, including mean is used to summarize performance. Based on the descriptive statistics show that the mean score for the quiz is 72, while the mean score for the group assignment is 85, based on a sample of 26 students.

To further analyze the data, a hypothesis testing procedure is conducted to determine if there is a statistically significant difference between the mean scores of quizzes and assignments. The hypotheses are formulated as follows:

H_0: There is no significant difference between the mean scores of quizzes and assignments ($\mu_1 = \mu_2$).
H_1: There is a significant difference between the mean scores of quizzes and assignments ($\mu_1 \neq \mu_2$).

A paired t-test is applied, as the data represents matched scores for the same group of students across two assessment types. The p-value is calculated to determine the significance of the results. Statistical analysis is conducted using a 95% confidence level ($\alpha = 0.05$). The results of the hypothesis test, p-value is presented in the findings and discussion section.

Findings and Discussion

Based on Figure 1, the bar chart compares quiz and group assignment marks for 26 civil engineering students. The data clearly shows that students perform better in group assignments than in quizzes, with average scores of 85 and 72, respectively. Most students achieve higher marks in group assignments, indicating that collaborative work enhances their performance. In contrast, quiz scores vary significantly, with some students particularly students 3, 13, 17, 23, and 26 scoring noticeably lower. This suggests that quizzes, which require individual effort and quick problem-solving, pose greater challenges for certain students.

Several factors may contribute to this difference in performance. Quizzes assess independent understanding and the ability to apply concepts immediately, whereas group assignments allow discussion, research, and peer support. Additionally, weaker students may benefit from working with stronger peers in group tasks, leading to overall higher scores. To address this gap, providing targeted revision and additional practice questions could help improve quiz performance. Incorporating quiz-style questions into group assignments may also strengthen individual comprehension while preserving the advantages of teamwork.

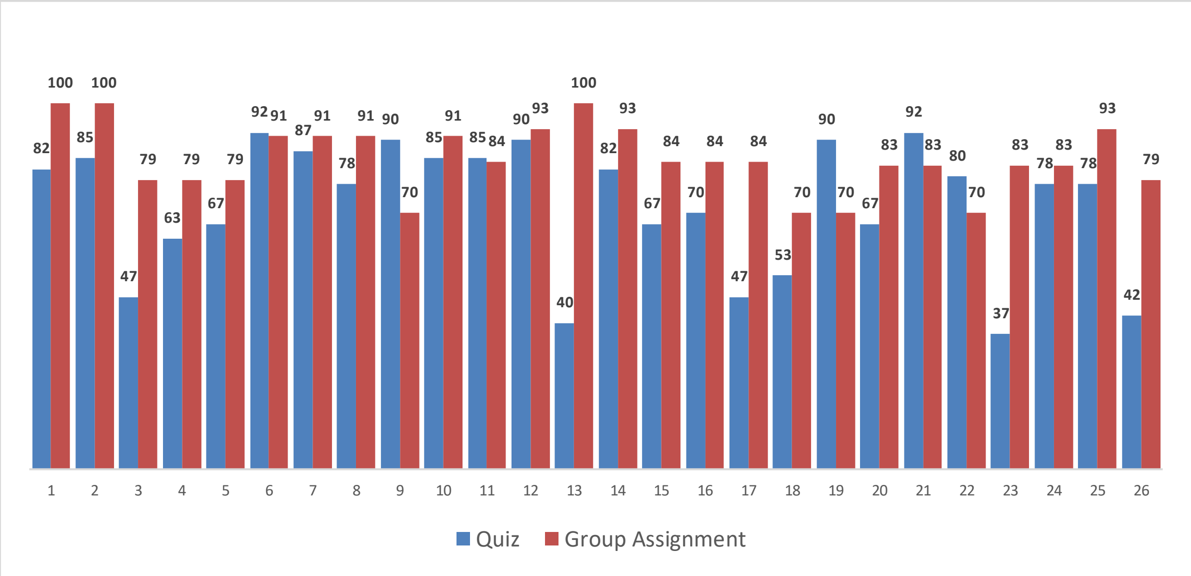

Figure 1: Comparison of Quiz and Group Assignment Scores

The paired t-test results indicate a significant difference between the mean scores of quizzes and assignments (p-value < 0.05), leading to the rejection of the null hypothesis. This finding supports the hypothesis that students exhibit better performance in group assignments compared to individual quizzes, likely due to the collaborative nature of group work and the relatively higher level of guidance provided during assignments. The data also show a wide range of performance among students, indicating variability in statistical aptitude within the cohort. This underscores the need for differentiated instructional strategies to address diverse learning needs. Comparisons with other engineering disciplines could provide further insights into the impact of curriculum design on statistical performance.

Conclusion

This study highlights significant differences in civil engineering students' performance on individual and group assessments in statistics, emphasizing the challenges of mastering probability concepts and the benefits of collaborative learning in inferential statistics. The hypothesis testing confirms a statistically significant difference between the mean scores of quizzes and assignments, suggesting that students perform better in collaborative settings. The findings suggest the need for targeted interventions, such as active learning strategies and differentiated instruction, to address students' learning gaps. Future research could explore longitudinal data across all engineering disciplines to provide a more comprehensive understanding of statistical education in engineering. This study contributes to the ongoing discourse on enhancing statistical literacy in engineering education, with implications for curriculum design and instructional practices.

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