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The Effectiveness of the Simulation-Based Learning Method in Improving Statistical Inferential Testing Abilities Using SPSS for English Students

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ABSTRACT

This study investigates the effectiveness of Simulation-Based Learning (SBL) in improving students' ability to conduct inferential statistical analysis using SPSS. The research employed a quantitative approach with a sample of 31 students, utilizing observation and testing as data collection methods. Statistical analysis was conducted through normality tests, homogeneity tests, and hypothesis testing. The results of the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that both pre-test and post-test data were not normally distributed ($p < 0.05$). Furthermore, Levene's test revealed that the data did not meet the assumption of homogeneity of variances. Consequently, non-parametric analysis was applied using the Wilcoxon Signed Rank Test. The Wilcoxon test results showed a Z value of -4.794 with a significance level of 0.000 ($p < 0.05$), confirming a significant difference between pre-test and post-test scores. These findings demonstrate that SBL is effective in enhancing students' statistical analysis skills, particularly in applying inferential tests through SPSS. Overall, this research provides empirical evidence that SBL is a powerful pedagogical approach for bridging theoretical knowledge and practical application in statistical learning, thereby equipping students with essential competencies for academic and professional contexts.

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INTRODUCTION

Statistics for university students serves as a bridge between foundational theories previously studied and their practical application in research and professional contexts (Rahma.,2024; Dasari et al., 2025) . At this stage, students are not only introduced to basic concepts such as data distribution, measures of central tendency, and variability, but are also guided to master more advanced analytical techniques (Stevens., 2013; Mertler et al., 2025). The material usually provided includes regression analysis, correlation, hypothesis testing, analysis of variance (ANOVA), and non-parametric statistics (Field, 2018; Hogg et al., 2019; Ghosh & Mitra., 2020). With this knowledge, students are expected to independently process research data, interpret analytical results, and draw valid and accountable conclusions.

Beyond technical aspects, statistical learning emphasizes critical thinking and problem-solving skills (Pudjiastuti., 2022; Sa'idah et al 2026; Siregar et al., 2026). Students are trained to select appropriate analytical methods according to the characteristics of their data. For instance, when data do not meet normality assumptions, they must be able to apply alternative approaches (Howell., 2012; Field, 2018; Gravetter, & Wallnau 2021) This is particularly important in fields such as social sciences, education, and health, where data are often imperfect. Thus, statistics becomes a tool that enables students to generate meaningful findings despite data limitations. Furthermore, statistics at this level provides methodological preparation for thesis or final research projects, encouraging students to integrate theory with practice from research design and data collection to analysis and interpretation.

With technological advancements, statistics has become more accessible, as many universities now teach students to use statistical software such as SPSS (Statistical Package for the Social Sciences). The use of SPSS offers several advantages over manual calculation. First, SPSS can process large datasets quickly and accurately (Pallant, 2020). While manual computation is time-consuming and prone to error, SPSS can perform complex analyses such as regression, correlation, or ANOVA within seconds. This is particularly beneficial for students and researchers working with extensive and diverse datasets. Second, SPSS provides a user-friendly interface with menus and commands that are easy to understand, allowing students to focus on interpreting results rather than mastering complex formulas. Third, SPSS produces systematic outputs in the form of tables, charts, and statistical summaries, which are more professional and easier to interpret than raw manual calculations.

Moreover, SPSS supports both parametric and non-parametric statistical methods, enabling users to adapt techniques to their data characteristics—something difficult to achieve manually due to time and complexity constraints. Another advantage is SPSS's ability to automatically conduct assumption tests, such as normality and homogeneity, which are often prerequisites in statistical analysis. These features help students ensure the validity of their research findings. Overall, SPSS enhances efficiency, accuracy, and ease in statistical learning. Advanced-level students preparing for final research projects benefit greatly, as SPSS not only accelerates analysis but also improves the quality of interpretation. Thus, SPSS is a relevant and superior tool compared to manual calculation, especially in academic and modern research contexts.

Nevertheless, many students encounter difficulties when using SPSS as a statistical analysis tool. The main challenge lies in their limited understanding of available features and menus, leading to confusion in selecting appropriate statistical tests for their data. Additionally, the output of SPSS, which is often filled with tables and numerical results, can be difficult to interpret correctly. Other obstacles include limited prior experience with software, as some students are more accustomed to manual calculation or theoretical statistics. Consequently, they require more time to adapt to SPSS. Technical issues such as software installation, operating system compatibility, or restricted license access also pose challenges. These factors make learning statistics with SPSS demanding, requiring intensive guidance and repeated practice for students to master the application effectively. One method that can be applied to address these challenges is Simulation-Based Learning (SBL).

Simulation-Based Learning (SBL) is an instructional approach that places learners in simulated situations resembling real-world conditions, allowing them to practice skills, develop understanding, and make decisions without direct risk. The primary advantage of

this method is the creation of a safe learning environment. Learners can make mistakes without serious consequences, encouraging them to experiment and explore. In health education, for example, medical or nursing students can practice clinical procedures without endangering patients. Lateef (2010) emphasizes that simulation enables “realistic learning” while maintaining safety for all parties.

SBL also enhances practical skills through repeated practice. Learners can consistently refine motor and cognitive skills, making them better prepared for real situations. Cant and Cooper (2010), in their systematic review, demonstrated that simulation improves nurses’ clinical skills while reducing errors in patient care. Similar benefits are observed in fields such as engineering and aviation, where repeated simulation training enhances accuracy and response speed.

Another strength of SBL is its ability to foster decision-making and critical thinking. Simulations present complex scenarios that require learners to analyze, strategize, and make rapid decisions. Cook et al. (2011) found that simulation-based instructional design effectively develops critical thinking and problem-solving skills. Thus, learners acquire not only technical competencies but also analytical abilities essential in professional contexts.

SBL has also been shown to increase self-confidence. After practicing in simulations, learners feel more prepared to face real-world challenges. Cant and Cooper (2010) highlighted that simulation reduces anxiety among nursing students when interacting with patients, as they have already rehearsed procedures in a safe environment. This confidence is crucial for ensuring calm and accurate performance in actual practice.

Furthermore, simulation promotes collaboration and communication. Many simulations are conducted in teams, enabling learners to practice communication, coordination, and teamwork. Issenberg et al. (2005), in their systematic review, demonstrated that high-fidelity simulations support communication and teamwork skills, which are vital in healthcare and other professions requiring collective effort. Thus, SBL not only develops individual competencies but also strengthens group collaboration.

Finally, SBL facilitates knowledge transfer to real-world situations. Because simulations are designed to closely resemble actual conditions, learning experiences become more relevant and applicable. Learners can easily apply what they have practiced in simulations to real-life contexts. This makes SBL an effective method for preparing students to face professional challenges and everyday problem-solving.

RESEARCH METHOD

This study employed a quantitative approach, a method that emphasizes objective measurement of research variables using numerical data, statistical analysis, and systematic interpretation of results. The quantitative approach was chosen because the study aims to test predetermined hypotheses and to draw conclusions that can be generalized to the relevant population.

The population of this study consisted of all students who served as research subjects. From this population, a sample of 32 students was selected. The sampling process was carried out with consideration of the representativeness of population characteristics, ensuring that the findings reflect actual conditions. This sample size was deemed sufficient for conducting inferential statistical analysis.

Data collection was conducted through observation and testing. Observation was used to obtain direct insights into students' behavior, activities, and engagement within the research context. It was carried out systematically using structured instruments to ensure the validity and reliability of the data. In addition, tests were administered to measure students' abilities or learning outcomes in accordance with the variables under investigation. The tests were designed based on indicators relevant to the research objectives, thereby providing accurate quantitative data.

The collected data were analyzed using inferential statistics. This analysis aimed to test the research hypotheses and to draw conclusions applicable to the population based on the sample data. The stages of analysis included:

1. **Normality Test** – conducted to determine whether the data were normally distributed. This test is essential because most inferential statistical techniques require normally distributed data.
2. **Homogeneity Test** – performed to ensure that the variances across groups were equal. Homogeneity of variance is a prerequisite for certain hypothesis tests, thereby enhancing the validity of the analysis.
3. **Hypothesis Testing** – the final stage of analysis, aimed at verifying the research hypotheses. Hypothesis testing was conducted using appropriate statistical techniques, such as the *t-test* or *ANOVA*, depending on the research design and the number of variables analyzed.

RESULTS AND DISCUSSION

A. Results

1. Normality Test Results

The normality test is an essential stage in statistical analysis, aimed at determining whether the research data are normally distributed. A normal distribution serves as a fundamental assumption in many parametric statistical methods, such as regression, ANOVA, and the *t*-test; therefore, this test is crucial in assessing the appropriateness of applying such methods.

Statistical approaches employ formal tests such as Kolmogorov-Smirnov, Shapiro-Wilk, Anderson-Darling, or Lilliefors, which generate significance values (*p*-values) to evaluate the conformity of the data to a normal distribution. If the *p*-value is greater than 0.05, the data are considered normally distributed; conversely, if the *p*-value is less than 0.05, the data are deemed not normally distributed.

The following table presents the results of the normality test for students' **pre-test** and **post-test** scores.

Tests Of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
PRE TEST RESULT	.204	31	.002	.866	31	.001
POST TEST RESULT	.190	31	.006	.924	31	.031

A. Lilliefors Significance Correction

Based on the results of the normality tests conducted using both the Kolmogorov-Smirnov and Shapiro-Wilk methods, the pre-test and post-test data yielded significance values (Sig.) less than 0.05. Specifically, the pre-test results showed a Kolmogorov-Smirnov significance value of 0.002 and a Shapiro-Wilk value of 0.001, while the post-test results indicated a Kolmogorov-Smirnov value of 0.006 and a Shapiro-Wilk value of 0.031.

These findings indicate that the distribution of both pre-test and post-test data does not meet the assumption of normality, as the p-values are below the threshold of 0.05. Consequently, the research data are considered non-normally distributed. Therefore, subsequent analyses should employ non-parametric statistical tests or apply data transformation techniques to align with the assumptions of normality.

2. Homogeneity Test Results

The homogeneity test is a statistical procedure used to determine whether the variances of several data groups are equal. Homogeneity of variance is one of the key assumptions in parametric analyses, such as ANOVA, which require that each group exhibit relatively similar levels of variability. The primary purpose of the homogeneity test is to ensure that differences identified in the analysis are not due to unequal variances across groups, but rather to genuine differences in means or the factors under investigation.

Decision-making in homogeneity testing commonly employs Levene's test or Bartlett's test. The results are evaluated based on the significance value (p-value). If the p-value is greater than 0.05, the variances across groups are considered homogeneous (not significantly different). Conversely, if the p-value is less than 0.05, the variances are considered non-homogeneous. Thus, the decision is made by comparing the p-value with the predetermined significance level, enabling researchers to determine whether parametric analysis can be applied or whether non-parametric methods are required.

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
GROUP	Based on Mean	5.417	11	48	.000
	Based on Median	.854	11	48	.589
	Based on Median and with adjusted df	.854	11	19.364	.595
	Based on trimmed mean	4.099	11	48	.000

Based on the results of Levene's test, the significance values varied depending on the basis of calculation. For tests based on the mean and trimmed mean, the significance values were 0.000, which are less than 0.05, indicating that the variances among learning groups were not homogeneous. In contrast, for tests based on the median and the median with adjusted degrees of freedom, the significance values were 0.589 and 0.595, respectively, which are greater than 0.05, suggesting that the variances among groups were relatively homogeneous. However, since Levene's test

is most commonly interpreted based on the mean, it can be concluded that the learning group data do not meet the assumption of homogeneity of variances.

3. **Hypothesis Test Results**

Based on the results of the normality test, the data were found not to be normally distributed, and the homogeneity of variance assumption was also not met. Consequently, the fundamental assumptions required for parametric statistical tests could not be satisfied. Therefore, it was decided that the data analysis would be conducted using **non-parametric tests**. This decision was made to ensure that the research findings remain valid and reliable, given that non-parametric tests do not require normal distribution or homogeneity of variance, making them more suitable for the characteristics of the data obtained. In this study, the **Wilcoxon test** was employed.

The Wilcoxon test is a non-parametric method used to test hypotheses, particularly when data do not meet the assumptions of normality or homogeneity of variance. This test is commonly applied to compare two paired samples, such as pre-test and post-test results from the same group, in order to determine whether there are significant differences following an intervention. The basic principle of the Wilcoxon test involves comparing differences between two conditions, ranking the differences, and assigning positive or negative signs according to the direction of change.

In decision-making, the results of the Wilcoxon test are evaluated based on the significance value (p-value). If the p-value is less than 0.05, the null hypothesis (H_0), which states that there is no difference, is rejected, indicating that a significant difference exists between the two conditions tested. Conversely, if the p-value is greater than 0.05, H_0 is accepted, meaning that no significant difference is present. Thus, the Wilcoxon test serves as an appropriate alternative when the assumptions of parametric tests are not fulfilled, as it is more flexible with respect to data distribution while still providing valid results for research analysis. The following section presents the Wilcoxon test results generated using SPSS.

Test Statistics[a]

	POST-TEST RESULTS - PRE-TEST RESULTS
Z	-4.794[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

B. Discussion

The results of the normality test indicated that both pre-test and post-test data were not normally distributed (*p*-value < 0.05 for Kolmogorov-Smirnov and Shapiro-Wilk). In addition, the homogeneity of variance test using Levene's test, based on mean and trimmed mean, also produced significance values below 0.05, suggesting that the variances across groups were not homogeneous. These conditions confirm that the assumptions required for

parametric testing were not met; therefore, the analysis was continued using a non-parametric test, namely the Wilcoxon Signed Rank Test.

The Wilcoxon test results showed a Z value of -4.794 with a significance level of 0.000 ($p < 0.05$). This indicates a significant difference between the pre-test and post-test results. In other words, the Simulation-Based Learning (SBL) method proved effective in enhancing students' ability to perform inferential statistical tests using SPSS. This improvement can be interpreted as a positive impact of simulation-based learning, whereby students not only understand concepts theoretically but are also able to apply statistical analysis procedures practically through real-case simulations.

These findings are consistent with previous studies. Lateef (2010) emphasized that SBL provides a "realistic" yet safe learning experience that effectively enhances analytical skills. Cant and Cooper (2010), in their systematic review, demonstrated that simulation improves confidence and reduces errors in practice, which is highly relevant to students working with statistical software. Cook et al. (2011) further highlighted that simulation-based instructional design effectively develops critical thinking and problem-solving skills. Moreover, Issenberg et al. (2005) asserted that high-fidelity simulations foster collaboration and communication skills, which are essential in group discussions when interpreting statistical analysis results.

Thus, the findings of this study strengthen empirical evidence that Simulation-Based Learning is an effective method for improving inferential statistical analysis skills. Students not only gain conceptual understanding but also acquire practical competencies that are highly relevant to academic and professional demands.

CONCLUSION

The findings of this study demonstrate that the Simulation-Based Learning (SBL) method is effective in enhancing students' ability to conduct inferential statistical analysis using SPSS. The results of the normality and homogeneity tests indicated that the data did not meet parametric assumptions; therefore, the analysis was carried out using the non-parametric Wilcoxon Signed Rank Test. The Wilcoxon test produced a Z value of -4.794 with a significance level of 0.000 ($p < 0.05$), indicating a significant difference between the pre-test and post-test results. This outcome confirms that the implementation of SBL successfully improved students' skills in both understanding statistical concepts and applying analytical techniques. These findings are consistent with previous studies, which emphasize that SBL supports the development of critical thinking, problem-solving, self-confidence, and collaboration skills. Accordingly, this research provides empirical evidence that SBL is a relevant and effective pedagogical approach for bridging theory and practice in statistical learning, while also preparing students to meet academic and professional demands more optimally.

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