



The Impact of Case Study-Based Learning with SPSS on Student Outcomes at Medan State Polytechnic

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ABSTRACT

Statistics is a challenging subject for students in the Department of Computer Engineering and Informatics, Medan State Polytechnic, as many struggle with data analysis and interpretation, resulting in low academic performance and limited engagement. This study examines the effectiveness of a case study-based learning approach (STDCase) integrated with SPSS software in improving students' learning outcomes. Using a quasi-experimental research design, 70 purposively sampled students were divided into experimental and control groups. Data were collected through pre-tests, post-tests, and questionnaires, and analyzed using descriptive and inferential statistics, including an F-test and linear regression. The results showed that the STDCase approach led to higher average learning outcomes (78.89) compared to the NONCase method (74.26), with similar standard deviations (1.62 for NONCase and 1.85 for STDCase). Additionally, a significant linear relationship was observed between students' mastery of the STDCase method and their ability to apply SPSS, as indicated by the F count (0.982) being smaller than the F table (1.507). This finding suggests that integrating case study-based learning with practical tools like SPSS enhances students' engagement, problem-solving skills, and academic performance. Overall, this study highlights the potential of the STDCase approach to foster a deeper understanding of statistical concepts and improve learning outcomes in technical and vocational education programs.

Keywords: Statistical Learning Model, SPSS Software, Case Studies, Student Performance, Problem-Solving Approach.

Introduction

Statistics plays a crucial role in the field of Computer Engineering and Informatics, where data analysis skills are fundamental for decision-making and problem-solving. However, despite its importance, many students perceive statistics as one of the most challenging subjects. Observations in the Statistics class at Medan State Polytechnic revealed that students struggle with data analysis and interpretation tasks, as evidenced by low average scores on assignments and final exams. Approximately 60% of students scored below the minimum passing grade on midterm assignments involving data analysis, and many expressed a lack of confidence in applying statistical concepts independently. These challenges highlight the need for innovative teaching strategies to improve learning outcomes and engagement in statistics education.



To address these issues, this study implemented case study-based learning, which was chosen for its ability to connect theoretical knowledge with practical applications. Unlike traditional methods that focus on abstract theories, case study-based learning encourages active engagement through real-world problem-solving, making statistical concepts more relatable for students. This approach is particularly relevant for students in technical and vocational education, as it mirrors the analytical challenges they are likely to face in their professional careers. Research by (Setiawan et al., 2020) supports the use of case-based learning, showing that students engaged in this approach demonstrated higher motivation and participation compared to those taught using conventional methods.

The novelty of this research lies in its integration of Thinking Aloud Pair Problem Solving (TAPPS) and Mind Mapping techniques within a case study-based framework. Previous studies have highlighted the benefits of these methods in improving student outcomes. For instance, (Rahayu et al., 2020) found that combining TAPPS and Mind Mapping techniques enhanced creative mathematical thinking skills. Similarly, (Artika, 2019) reported that students using the TAPPS method achieved better mathematical problem-solving abilities compared to conventional approaches. Moreover, research by (Sari & Susiloningsih, 2015) demonstrated that integrating the ASSURE model with a problem-solving approach improved critical thinking skills in chemistry education. The findings align with those of (Andita & Taufina, 2020), who emphasized the role of problem-solving in enhancing students' mathematical understanding. (Aisyah et al., 2024) also argued that problem-solving techniques are crucial for overcoming barriers to learning and achieving educational objectives.

The theoretical foundation of this study is grounded in constructivist learning theories, which emphasize active engagement and contextualized problem-solving. According to (Juna Irawana, 2020), problem-solving techniques can make lessons more engaging and less monotonous for students, fostering better learning outcomes. Research by (Setiawan et al., 2020) further supports the notion that such approaches promote active participation and higher levels of engagement, particularly for prospective elementary education instructors. Additionally, findings by (Harizahayu et al., 2022) suggest that the design of mathematics exam questions, including material, construction, and language, significantly impacts student performance. This underscores the importance of well-structured learning strategies in achieving educational goals.

In summary, this research aims to explore the effectiveness of integrating case study-based learning with problem-solving techniques in improving students' learning outcomes and engagement in statistics. The findings are expected to provide valuable insights into the development of innovative pedagogical practices for technical and vocational education, particularly in addressing the challenges of teaching statistics.

Methods

This research employed a quasi-experimental design to evaluate the effectiveness of statistical teaching using a case-based approach. The study involved 70 students from the Department of Computer Engineering and Informatics, Medan State Polytechnic, as the research population. Using purposive sampling, participants were selected based on their varying levels of statistical competency to ensure diverse representation.

Data collection utilized multiple instruments, including pre-tests and post-tests to measure learning outcomes, questionnaires to assess student perceptions of the learning model, and observational checklists to monitor classroom activities. The statistical competency test was developed based on core competencies outlined in the curriculum, ensuring validity and reliability through expert reviews and pilot testing.

The following outlines the research method workflow that was carried out accordingly:

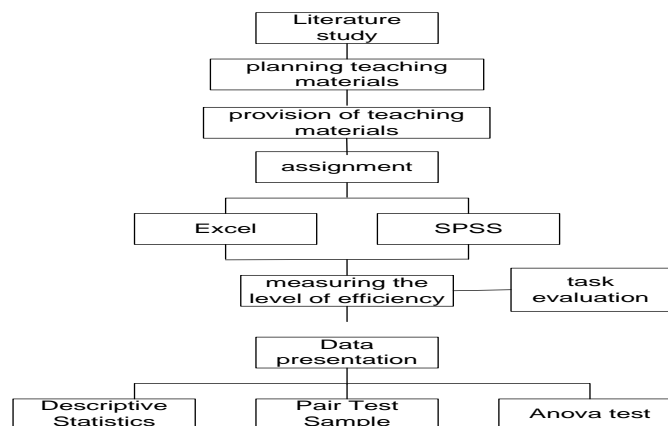


Figure 1. Research Flow Diagram

The research workflow began with a literature review to establish a theoretical foundation. A structured lesson plan was then developed, integrating statistical concepts with case-based learning activities. Teaching materials included real-world datasets, statistical exercises, and SPSS tutorials. During implementation, students were divided into two groups: one group analyzed data using Excel, while the other used SPSS. Students conducted data testing and analysis, presented their findings, and completed descriptive data analyses.

Lecturers evaluated student performance based on their analytical accuracy, presentation quality, and participation in discussions. Descriptive statistics were used to process data, and inferential tests such as paired t-tests and linearity tests were conducted to validate the findings. These analyses included paired sample statistics and ANOVA to compare learning outcomes between groups.

Overall, this methodological approach ensures active student involvement, fosters problem-solving skills, and produces reliable results by systematically integrating case studies and statistical tools into the learning process.

Results and Discussion

The data processed in this research includes only complete data (Harizahayu, 2020). Data was obtained from 70 respondents or samples from all students who completed and successfully uploaded Assignment 7 using SIPADI (Digital Learning System). SIPADI is a web-based online learning application. This web-based program for online learning is called SIPADI. This application offers a way for instructors and students to conduct teaching and learning activities without being constrained by space and time. SIPADI can be accessed at <https://sipadi.polmed.ac.id>, along with other learning resources designated by each instructor for supplementary use. The following are the results of the assignments uploaded via SIPADI:

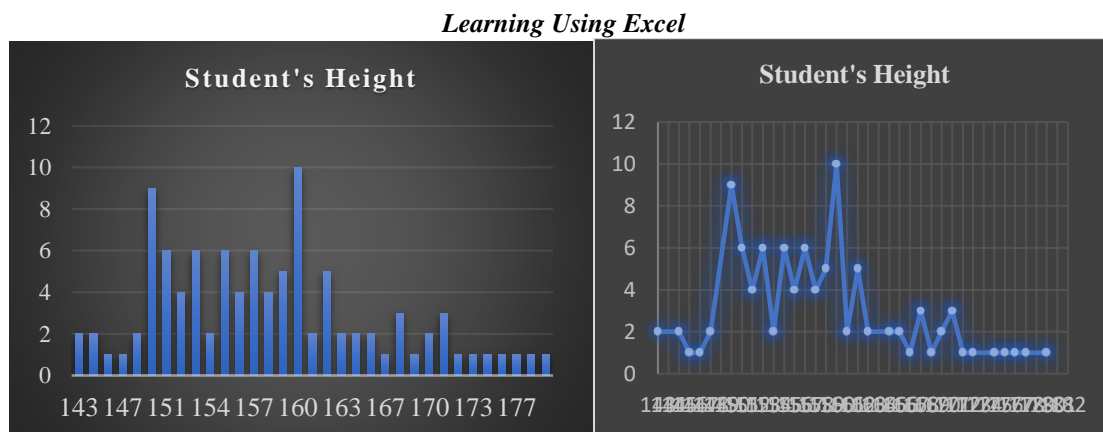


Figure 2. Data Interpretation Results Using Bar and Line Charts

Table 1. Interpretation of Student Data in Table Form

| Data | Lots of Data | Data | Lots of Data |
|------|--------------|------|--------------|
| 143 | 2 | 162 | 5 |
| 145 | 2 | 163 | 2 |
| 146 | 1 | 165 | 2 |
| 147 | 1 | 166 | 1 |
| 148 | 2 | 167 | 3 |
| 150 | 9 | 168 | 1 |
| 151 | 6 | 169 | 2 |
| 152 | 4 | 170 | 3 |
| 153 | 6 | 171 | 1 |
| 154 | 2 | 172 | 1 |
| 155 | 6 | 173 | 1 |
| 156 | 4 | 175 | 1 |

| | | | |
|-----|----|--------------|-----|
| 157 | 6 | 176 | 1 |
| 158 | 4 | 177 | 1 |
| 159 | 5 | 178 | 1 |
| 160 | 10 | 180 | 1 |
| 161 | 2 | Total | 100 |

The data interpretation results in Figure 2 tend to be stable and monotonous, only presenting charts in the form of bar and line diagrams, thus lacking additional information beyond the diagrams above. According to Table 1, students should be able to find the best way to present data such as highest and lowest values, class averages, values with the highest quantity in the class, and standard deviation. This prompted the researchers to initiate Statistics education based on case studies chosen by students in class or the most up-to-date case studies at the time of the study.

Assignment on Validity and Reliability Testing Using SPSS

The use of case studies facilitates students in understanding the validity measures of questionnaires that assess the impact of social media and product reviews on the Shopee marketplace among the general public. Validity testing is conducted to determine whether the instrument or questions in the questionnaire accurately measure what is intended to be measured. Reliability testing involves assessing the index to determine the extent to which the questionnaire can be considered trustworthy and dependable.

| | D | E | F | G | H | I | J | K | L | M | N |
|----|---------------|----------------------|------------------------|----------------------|-------------------------|-----------------------|-----------------------|-------------------|-----------------------|----------------------|----------------------------|
| 1 | jenis kelamin | 1.seberapa sering ar | 2. apa yang membua | 3.apakah anda tertar | 4.riview atau iklan prc | 5.bagaimana cara an | 6.jenis produk apa ya | 7.sebelum membeli | 8.apakah iklan social | 9.apakah riview atau | 10.menurut anda, ter |
| 2 | perempuan | 2-3kali/minggu | harga relatif murah | tertarik | Instagram | melihat iklan produk | alat rumah tangga | iya | iya | sangat membantu | tertarik tapi tidak lang s |
| 3 | laki-laki | 5-6kali/minggu | aman dan terpercaya | sangat tertarik | Instagram | melihat iklan produk | pakaian | iya | tidak sama sekali | tidak sama sekali | tertarik tapi tidak lang s |
| 4 | perempuan | 2-3kali/minggu | aman dan terpercaya | tertarik | Instagram | melihat riview produk | skincare dan kosmet | iya | iya | sangat membantu | tertarik tapi tidak lang c |
| 5 | perempuan | 2-3kali/minggu | harga relatif murah | tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | iya | cukup membantu | tertarik tapi tidak lang c |
| 6 | perempuan | 5-6kali/minggu | harga relatif murah | tertarik | tidok | melihat riview produk | pakaian | kadang-kadang | iya | cukup membantu | tertarik tapi tidak lang c |
| 7 | perempuan | 5-6kali/minggu | aman dan terpercaya | sangat tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | tergantung idannya | sangat membantu | tertarik dan langsung c |
| 8 | laki-laki | 9-10kali/minggu | aman dan terpercaya | tidak sama sekali | Instagram | melihat riview produk | pakaian | kadang-kadang | tergantung idannya | cukup membantu | tidak sama sekali ti |
| 9 | laki-laki | 2-3kali/minggu | produk tidak membos | tertarik | Instagram | melihat iklan produk | pakaian | kadang-kadang | tergantung idannya | sangat membantu | tertarik tapi tidak lang c |
| 10 | laki-laki | 2-3kali/minggu | produk tidak membos | tertarik | facebook | melihat riview produk | pakaian | iya | iya | kurang membantu | tertarik tapi tidak lang c |
| 11 | perempuan | 9-10kali/minggu | aman dan terpercaya | tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | iya | sangat membantu | tertarik tapi tidak lang s |
| 12 | perempuan | 2-3kali/minggu | aman dan terpercaya | tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | tergantung idannya | kurang membantu | tertarik tapi tidak lang c |
| 13 | laki-laki | 2-3kali/minggu | harga relatif murah | tertarik | Instagram | melihat riview produk | kebutuhan sekolah | iya | tergantung idannya | cukup membantu | tertarik tapi tidak lang c |
| 14 | laki-laki | 2-3kali/minggu | aman dan terpercaya | tertarik | tidok | melihat riview produk | pakaian | iya | tergantung idannya | cukup membantu | tertarik tapi tidak lang c |
| 15 | laki-laki | 2-3kali/minggu | aman dan terpercaya | tertarik | tidok | melihat riview produk | pakaian | iya | iya | cukup membantu | tidak sama sekali c |
| 16 | perempuan | 9-10kali/minggu | harga relatif murah | tertarik | tidok | melihat riview produk | skincare dan kosmet | kadang-kadang | tergantung idannya | cukup membantu | tertarik tapi tidak lang c |
| 17 | perempuan | 9-10kali/minggu | aman dan terpercaya | sangat tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | tergantung idannya | sangat membantu | tertarik dan langsung c |
| 18 | perempuan | 2-3kali/minggu | riwiew dan iklan sosia | tertarik | Instagram | melihat riview produk | skincare dan kosmet | iya | iya | sangat membantu | tertarik tapi tidak lang c |
| 19 | laki-laki | 2-3kali/minggu | harga relatif murah | tertarik | Instagram | melihat riview produk | skincare dan kosmet | kadang-kadang | iya | sangat membantu | tertarik tapi tidak lang s |
| 20 | perempuan | 2-3kali/minggu | harga relatif murah | tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | iya | sangat membantu | tertarik tapi tidak lang c |
| 21 | perempuan | 2-3kali/minggu | harga relatif murah | tertarik | tidok | melihat riview produk | pakaian | kadang-kadang | tergantung idannya | kurang membantu | tertarik tapi tidak lang c |
| 22 | perempuan | 9-10kali/minggu | produk tidak membos | tertarik | Instagram | melihat riview produk | pakaian | iya | tergantung idannya | cukup membantu | tertarik tapi tidak lang c |
| 23 | perempuan | 2-3kali/minggu | harga relatif murah | tertarik | Instagram | melihat riview produk | skincare dan kosmet | iya | iya | sangat membantu | tertarik tapi tidak lang s |
| 24 | laki-laki | 2-3kali/minggu | harga relatif murah | tertarik | facebook | melihat riview produk | skincare dan kosmet | tidak pernah | iya | sangat membantu | tertarik tapi tidak lang s |
| 25 | perempuan | 5-6kali/minggu | riwiew dan iklan sosia | tertarik | tidok | melihat riview produk | skincare dan kosmet | iya | iya | cukup membantu | tertarik tapi tidak lang c |
| 26 | laki-laki | 2-3kali/minggu | aman dan terpercaya | tertarik | Instagram | melihat riview produk | pakaian | kadang-kadang | tergantung idannya | cukup membantu | tertarik tapi tidak lang c |
| 27 | laki-laki | 2-3kali/minggu | aman dan terpercaya | tertarik | tidok | melihat riview produk | pakaian | iya | iya | cukup membantu | tertarik tapi tidak lang c |

Figure 2. Results of Questionnaire Collection from 500 Respondents

Based on Figure 2, Students are trained to create questionnaires for specific cases they find worth studying. This training helps them design effective research instruments to collect relevant and

valid data. Questionnaires are efficient for collecting data when the variables and respondents' expectations are clear. After data collection, students learn to analyse and present data, such as using pie charts to show proportions and percentages of each category, making it easier for readers to understand the distribution and comparison between categories. The following are the results of data interpretation presented by students using pie charts.

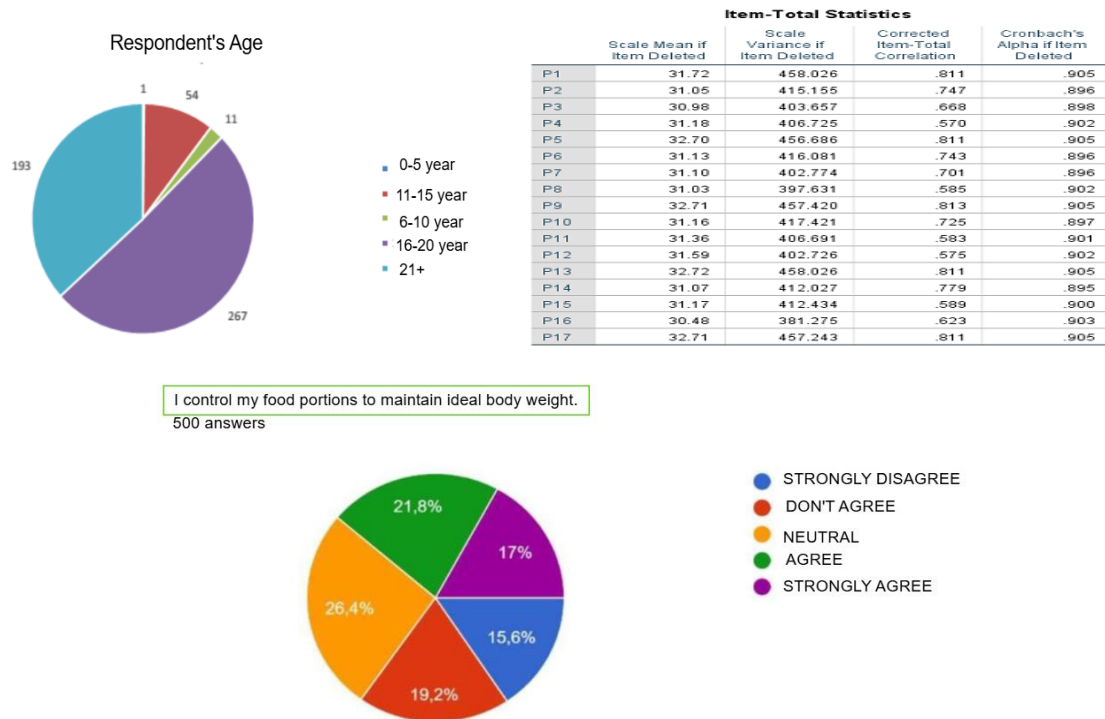


Figure 3. Data Interpretation and Data Testing Output

Figure 3 illustrates the results of data interpretation and testing, demonstrating how the integration of theory with practical learning enhances students' creativity. By applying theoretical concepts to specific topics or case studies, students are able to develop creative problem-solving skills. This is reflected in the pie chart, where different methods and techniques are presented, showing how various approaches contribute to students' creative development. The use of Microsoft Excel for data compilation from 500 respondents, as seen in the chart, further highlights students' ability to organize and analyze data effectively.

The figure also shows how students are guided to creatively process the data and present it in a simple, written form. This process ensures that students can not only interpret complex data but also communicate it clearly and concisely. The pie chart likely breaks down the data into categories, helping students practice organizing and simplifying information. Through these activities, students gain

valuable skills in data analysis and presentation, which are essential for both academic success and real-world applications.



Figure 4. Report of Data Processing Results

The application of case studies in teaching methods makes statistics education more structured and practical for students. Students tend to pay more attention in class when the tasks are engaging. Due to the abundance of exercises, every class activity requires active participation from students.

The teaching methods employed by these lecturers have proven effective in sparking students' interest and attention, even though some students continue to face challenges, particularly when responding to exercise questions (Hamdanah, 2020). This aligns with the principles of active learning, which emphasize that student engagement is critical for enhancing comprehension and retention of course content (Mouchantaf, 2020). Although some students initially struggle, lecturers take proactive measures by engaging less interested students directly, ensuring their continued participation in classroom activities. This reflects the scaffolding strategy, where structured support is provided initially and gradually reduced as students become more capable. Research shows that scaffolding fosters a supportive learning environment and encourages student engagement (Anisa, 2022).

To further enhance learning beyond the classroom, lecturers assign tasks that promote active student involvement, such as designing surveys or experiments, collecting data, and organizing findings into appropriate formats. This hands-on approach is consistent with the principles of experiential learning, which emphasize the importance of direct engagement with real-world tasks to enhance understanding and skill development (Korpiää et al., 2020). By actively participating in such tasks, students develop a deeper understanding of statistical concepts and their practical applications.

Additionally, problem-based learning (PBL) has been integrated into tasks requiring students to apply statistical concepts like hypothesis testing, regression, or analysis of variance. PBL significantly enhances critical thinking and problem-solving skills by encouraging students to solve real-world problems (Schäflein et al., 2018). This method aligns with constructivist principles, where students actively construct knowledge through meaningful tasks and application in diverse contexts.

Recent studies have highlighted the effectiveness of combining active participation, scaffolding, and real-world applications in teaching strategies to enhance student engagement and develop critical thinking and problem-solving skills. For instance, a study by (Amanda et al., 2023) demonstrated that implementing a Complexity Science-Problem Based Learning (CS-PBL) model significantly improved students' critical thinking and problem-solving abilities.

This process provides students with practical experience in applying statistical methods to address their research questions. In addition to enhancing their understanding of statistical concepts theoretically, these tasks also stimulate learning interest due to their relevance to real-world situations. The results reflect success in boosting students' motivation to learn and providing a sense of autonomy, while the outcomes of these tasks become more heterogeneous, at least in terms of the results achieved by students.

Table 2. Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|--------------------|----|---------|---------|---------|----------------|
| Nilai_NONCase | 70 | 69,00 | 80,00 | 74,2571 | 1,84694 |
| Nilai_STDCase | 70 | 74,00 | 82,00 | 78,8857 | 1,62001 |
| Valid N (listwise) | 70 | | | | |

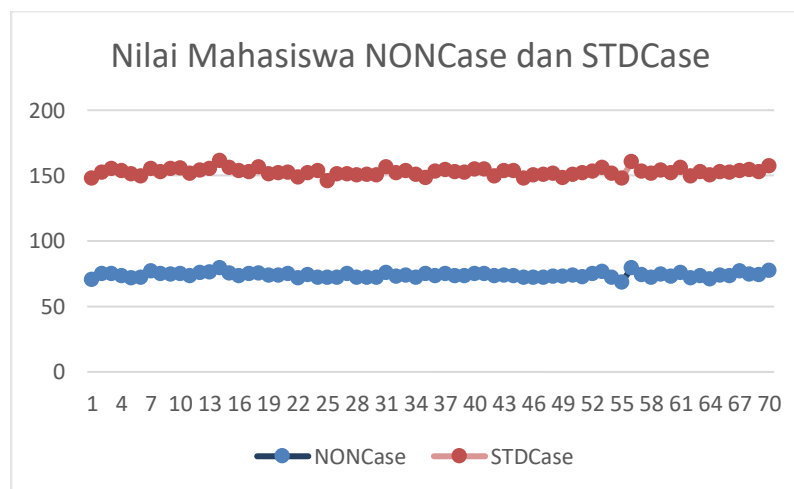


Figure 5. Comparison of NONCase and STDCase Scores

As done in previous research, descriptive statistical analysis was conducted using SPSS 25 and MS Excel to generate comprehensive findings and insights that align with the researcher's objectives in this study. Only the best or most complete data was utilized for the research, as fully verified data is essential for testing purposes (Harizahayu, 2020), ensuring that the data leads to the expected conclusions. Table 2 presents the conclusions drawn from the descriptive statistical analysis findings, indicating that 70 students uploaded their assignments via SIPADI. Due to frequent collaboration among students in completing assignments, the scores of students who did not use case studies and relied solely on Excel ranged from 69 to 80, resulting in nearly identical scores among students. Furthermore, the lowest score was 74 and the highest was 82 when using case studies with the assistance of SPSS software, showing a range of scores among students, thus leading to more varied results. This is clearly illustrated in the line graph in Figure 5, where assignments completed with case studies and SPSS assistance yielded higher and more varied scores compared to students' scores before using case studies. This is supported by the Mean obtained in Table 2, Mean Nilai_STDCase (78,8857) > Mean Nilai_NONCase (74,2571).

To strengthen the analysis of the relationship between NONCase learning and the utilization of SPSS application, as well as STDCase, the hypotheses of this research will be determined as follows.

H_0 = There is no difference in the average learning outcomes between NONCase and STDCase, indicating that there is no influence of using case-based learning strategies in improving learning outcomes for statistics courses in the Department of Computer Engineering and Informatics at Medan State Polytechnic.

H_1 = There is a difference in the average learning outcomes between NONCase and STDCase, meaning that there is an influence of using case-based learning strategies in improving learning outcomes for the statistics course in the Department of Computer Engineering and Informatics at Medan State Polytechnic.

Through paired sample test and linearity test, the following results were obtained.

Table 3. Pair Sample Correlation

| Paired Samples Correlations | | N | Correlation | Sig. |
|-----------------------------|-------------------------------|----|-------------|------|
| Pair 1 | Nilai_NONCase & Nilai_STDCase | 70 | ,272 | ,023 |

The correlation test results, showing a value of 0.272 with a significance level of 0.023 ($p < 0.05$), suggest a relatively low but significant relationship between the NONCase and STDCase scores. This means that although there is a noticeable relationship between the two learning methods, the relatively small correlation could indicate that other factors are also influencing students' learning outcomes.

The correlation coefficient of 0.272 indicates that the relationship between the use of case studies in learning and students' learning outcomes is not very strong. This could be influenced by several factors:

Variability in Concept Mastery: Students using case studies with the help of SPSS may have a deeper understanding of the application of statistics in real-world contexts. However, other factors, such as prior academic experience or comfort with statistical software, could also affect their learning outcomes. Meanwhile, in the NONCase group, students who only used Excel in their assignments may feel more comfortable with the simpler method, although this does not fully reduce the variation in outcomes.

Different Learning Approaches: While the use of case studies may enhance students' understanding of real-world statistical applications, (Fitriyanti et al., 2021) suggest that collaboration in statistical learning can improve Critical and Problem-Solving Skills, which may have a more significant impact on students' ability to achieve better results. However, this difference is not large enough to generate a high correlation between the two groups.

This correlation coefficient may also reflect the complexity of applying a deeper learning method such as, case studies which requires more time and effort from students to understand abstract concepts and apply them in more practical contexts. In this case, additional training or further guidance may be necessary to maximize the impact of using case studies in improving learning outcomes.

Table 4. *Pair Sample Test*

| Paired Samples Test | | | | | | | | | |
|----------------------------|--------------------|--------------------|----------------|-----------------|---|----------|---------|----|-----------------|
| | | Paired Differences | | | 95% Confidence Interval of the Difference | | t | Df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair 1 | NONCase STDCase | -4,62857 | 2,10018 | ,25102 | -5,12934 | -4,12780 | -18,439 | 69 | ,000 |

The results of the Paired Samples Test, which show a value of 0.000 ($p < 0.05$), indicate that there is a significant difference between the students' learning outcomes before and after using the case study method. This difference is most likely due to the impact of active learning, which involves problem-solving and practical application using SPSS. However, the differences in standard deviation values and correlation coefficients still suggest that, although there is a significant difference in the means between the two groups, the impact of this learning method on students' outcomes is not entirely consistent.

The results of the ANOVA test, which show no significant deviation from linearity ($p > 0.05$), strengthen the argument that there is a strong linear relationship between the use of case studies and students' learning outcomes, although the effect is more limited and not uniform across all groups.

Table 5. *Uji Anova*

| ANOVA Table | | | Sum of Squares | df | Mean Square | F | Sig. |
|----------------------|----------------|--------------------------|----------------|----|-------------|-------|------|
| STDCase * NONCase | Between Groups | (Combined) | 32,766 | 9 | 3,641 | 1,473 | ,179 |
| | | Linearity | 13,351 | 1 | 13,351 | 5,401 | ,024 |
| | | Deviation from Linearity | 19,415 | 8 | 2,427 | ,982 | ,459 |
| | Within Groups | | 148,320 | 60 | 2,472 | | |
| | Total | | 181,086 | 69 | | | |

Based on the significance values from the table above, a deviation from linearity of 0.459 was obtained, which is greater than 0.05. Therefore, it can be concluded that there is a significant linear relationship between the NONCase method and the STDCase learning method using SPSS software. Based on the calculated F-value of 0.982 > the tabular F-value of 1.507, it can be inferred that there is a significant linear relationship between the STDCase learning method using SPSS software.

These findings are consistent with research conducted by (Fitriyanti et al., 2021), which states that collaborative learning strategies in statistics content can enhance 4C skills (Critical and Problem Solving Skills, Collaboration Skills, Communication Skills, and Creativity and Innovation Skills). Teachers can utilize collaborative learning techniques as an alternative to traditional teaching approaches to create a lively, effective, and engaging learning environment. Additionally, according to (Riyanto & Fatim Nugrahanti, 2018), the statistical learning model based on SPSS application practicum with multimedia assistance helps Computer Engineering students at the Faculty of Engineering, PGRI

University Madiun, in understanding basic statistical concepts, SPSS analysis steps, and interpreting statistical data.

Furthermore, the case study results presented in the introductory material highlight several key advantages of applying case studies and utilizing SPSS software in data representation testing. First, integrating case studies into the learning process or addressing current relevant topics helps transform monotonous and less engaging statistics systems, making them more interesting and relatable for students. Second, this approach trains students to design simple research, a valuable skill for their academic and professional development. Third, the use of social media enables students to gather factual data anytime, accelerating and streamlining task completion. Additionally, it develops their ability to interpret data and draw conclusions by comparing specific cases or themes with real-life situations. Moreover, SPSS software is utilized not only for generating descriptive data analysis outputs but also for assessing the suitability of data for further processing. Finally, the study demonstrates that teaching problem-solving skills enhances students' interest in learning statistics. This process fosters an enjoyable educational experience that encourages students to take greater initiative and independence. It is evident that teaching advanced statistics through problem-solving strategies improves student understanding, as both the learning process and student grades show improvement, particularly in the designs of the NONCase and STDCase groups.

Conclusion

The findings indicate that the integration of technology-based learning approaches, such as the STDCase method, can effectively enhance students' understanding and performance in statistical analysis. The results underscore the importance of case-based learning supported by tools like SPSS in promoting better comprehension and higher engagement in statistical education.

Institutions are encouraged to consider the adoption of similar strategies to address gaps in learning outcomes and foster critical thinking skills. Additionally, instructional designs should account for students' diverse capabilities in accessing and utilizing digital learning materials, ensuring inclusivity and equity in learning opportunities. These implications highlight the need for continuous innovation in teaching methodologies to prepare students for real-world applications of statistical analysis.

Suggestions for future research include exploring the long-term impact of technology-assisted learning methods on students' analytical skills and academic performance. Future studies could also investigate the effectiveness of integrating other advanced statistical tools or programming languages, such as Python or R, to broaden students' skillsets. Furthermore, comparative studies involving larger and more diverse sample sizes across different educational contexts could provide more generalizable insights into the efficacy of such learning approaches.

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