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Capability for Exploration Students in Statistical Literacy: A Case of Quantitative Reasoning

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Abstract

This study aims to analyze effectiveness of four learning strategies namely tutorial learning, presenter learning, project online learning, and project face to face learning in improving students' statistical literacy skills. This study used a quantitative approach with a posttest group design research design involving 140 students who were divided into four treatment groups. The analysis technique used is MANOVA (Multivariate Analysis of Variance) with the stages of normality test, homogeneity, multiple comparisons, and Tukey HSD further test. The results show that Tutorial Learning, Presenter Learning, and Project Face to Face Learning strategies have a more significant impact on improving statistical literacy. The three strategies show a relatively balanced effectiveness in improving students' statistical literacy skills. These findings emphasize the importance of choosing appropriate teaching strategies to enhance students' statistical literacy skills in a deep and meaningful way. This research provides an empirical contribution to the development and selection of appropriate learning strategies, especially in statistics education at the tertiary level. It also recommends further exploration of innovative, contextual, and adaptive combinations of learning strategies to students' needs.

Keywords: Face to Face Learning; Online Learning; Presenter Learning; Statistical Literacy; Tutorial Learning.

Abstrak

Penelitian ini bertujuan untuk menganalisis efektivitas empat strategi pembelajaran yaitu tutorial learning, presenter learning, project online learning, dan project face to face learning dalam meningkatkan kemampuan literasi statistik mahasiswa. Penelitian ini menggunakan pendekatan kuantitatif dengan desain penelitian posttest group design yang melibatkan 140 mahasiswa yang terbagi ke dalam empat kelompok perlakuan. Teknik analisis yang digunakan yaitu MANOVA (Multivariate Analysis of Variance) dengan tahapan uji nornalitas, homogenitas, multiple comparisons, dan uji lanjut Tukey HSD. Hasil menunjukan bahwa strategi Tutorial Learning, Presenter Learning, dan Project Face to Face Learning memberikan dampak lebih signifikan terhadap peningkatan kemampuan literasi statistik dibandingkan Project Online Learning. Ketiga strategi tersebut menunjukan efektivitas yang relatif seimbang dalam meningkatkan kemampuan literasi statistik mahasiswa. Temuan ini menegaskan pentingnya pemilihan strategi pembelajaran yang sesuai untuk meningkatkan kemampuan literasi statistik mahasiswa secara mendalam dan bermakna. Penelitian ini memberikan kontribusi empiris dalam pengembangan serta pemilihan strategi pembelajaran yang tepat, khususnya dalam pendidikan

statistik di tingkat perguruan tinggi. Penelitian ini juga merekomendasikan eksplorasi lebih lanjut terhadap kombinasi strategi pembelajaran yang inovatif, kontekstual, dan adaptif terhadap kebutuhan mahasiswa.

Kata Kunci: Pembelajaran Tatap Muka; Pembelajaran Online; Pembelajaran Presentasi; Literasi Statistik; Pembelajaran Tutorial.

1. INTRODUCTION

Statistics have an important role in supporting data-driven decision-making in areas such as social, economic, industrial, and especially education (Hidayati et al., 2021). The rapid development of technology has changed the way humans process and understand information, thus requiring individuals to have skills in processing and analyzing data effectively. In this context Statistical Literacy is a competency that is urgently needed in various fields, including higher education. The development of statistical literacy is now the focus in various science-based fields of study, such as Medicine, Social Sciences, and Economics, to prepare students for academic and professional challenges (Berndt et al., 2021).

Statistical literacy is a complex construct because it not only requires basic skills such as reading, understanding, and conveying information, but also demands high-level cognitive abilities such as interpreting, predicting, and thinking critically (Gould, 2017; Sharma, 2017). For decades, statistical literacy has been the focus of attention in the world of education, and in the current era its need is increasingly urgent as data science develops as a basis in various disciplines. Statistical literacy also plays an important role in shaping individuals who are able to make data-driven decisions and be critical of quantitative information in daily life.

Student necessary have basic statistical competencies in order to be able to respond, understand, analyze, interpret, and make conclusions to various information related to statistics, and be able to give meaning to the problems that are appeared (Hidayati et al., 2021). This competency is important, because it can be used as a basis for decision-making in various fields. Without adequate competence, students will have difficulty in understanding complex quantitative phenomena. Therefore, the development and improvement of teaching quality through the right learning strategies is a matter important to strengthen students' understanding of statistics as a discipline (Hasim et al., 2024).

Effective statistical learning emphasizes not only on understanding concepts in depth, but also on the ability to apply them in real-world contexts. However, students often consider statistics to be one of the most challenging subjects (Mazouchová et al., 2021). The high level of statistics anxiety is one of the inhibiting factors in the statistical learning process, which can even encourage unethical academic behavior (Eshet et al., 2021; Steinberger et al., 2021). Many students struggle to develop statistical skills,

especially when it comes to understanding complex material and different types of data. Perhaps some people will be motivated by curiosity to study the data in their world (Garber, 2019). However, it should be noted that there are differences in the curriculum when in schools and lectures, the curriculum of statistical learning at the school level is generally still centered on basic concepts such as the size of concentration and the representation of data through plots. Meanwhile, at the higher education level, statistics teaching focuses more on the application of analytical procedures and inferential testing. Therefore, the application of strategy More contextual and responsive learning is needed to optimally support students' abilities.

Various active learning approaches have been researched as alternatives in statistical learning. Active learning strategies can strengthen students' understanding of statistical concepts through direct involvement with the material (Corbo & Sasaki, 2021). (Woodard et al., 2020) emphasizing the importance of assessing the understanding of statistical concepts through student writing. On the other hand, some previous studies have tried to apply learning models such as *blended learning* (Goode et al., 2018) and project-based active learning (Tsai, 2024), but most still focus on the general effectiveness of learning, not on the development of students' exploratory abilities in statistical literacy. In fact, exploratory skills are very important in statistical literacy because they allow students to independently explore, connect, and apply statistical concepts in real and complex contexts.

Based on these conditions, there is a gap in the literature related to the comparison of diverse learning strategies to ability students in Statistical Literacy. This research is important because it is in line with the direction of the global curriculum which increasingly emphasizes the importance of data and statistics literacy (Schreiter et al., 2024), as well as making practical contributions to teachers in choosing a more effective learning approach. The purpose of the study is to explore the differences of the four learning strategies, namely tutorial learning, presenter learning, online learning project, and face to face learning project in improving students' statistical literacy, assessing the significant differences between these strategies, and identifying the most effective strategies.

2. RESEARCH METHOD

This study uses a quantitative approach with a post-test group design research design. This design was used to compare the end results of four different learning strategies. This design was chosen because it allowed researchers to objectively and efficiently assess the direct effects of the treatment on different groups. The sample in this study amounted to 140 students who were divided into four groups with different learning strategies. The first group was 15% Tutorial Learning, 21% Presenter Learning, 21% of Project 0nline Learning, and 43% of Face to Face Projects. The sampling technique uses a saturation technique, because the entire population is used as a research sample

(Abdullah et al., 2022; Hardani et al., 2020). This approach is suitable to be applied when the population is relatively small and all members are considered relevant to be the subject of the study.

The data collection technique is carried out through project tests as a form of authentic assessment. Students are asked to complete final project assignments that are relevant to the learning material. The evaluation process is carried out through assessment components which include: attendance (20%), assignments (20%), UTS (25%), UAS (35%) with the overall reflecting the level of statistical literacy of students. This assessment reflects a holistic approach that emphasizes the mastery of competencies, not just the final results so that this instrument is considered able to capture student performance in a more authentic and contextual way.

This study uses the MANOVA (Multivariate Analysis of Variance) data analysis technique with the stages of normality test, homogeneity test, multiple comparisons, and Tukey HSD follow-up test. The normality test was carried out using the Kolmogorov-Smirnov test, with the criteria of p-value <0.05 = abnormal and p-value >0.05 = normal, homogeneity test with the provision of p-value <0.05 = inhomogeneous and p-value >0.05 = homogeneous, multiple comparisons p-value <0.05 = significant data and p-value >0.05 = insignificant and the follow-up test Tukey HSD (Honestly Significant Difference) results were said to be significant if the p-value < 0.05 (Hair et al., 2022).

3. RESULT AND DISCUSSION

3.1 RESULTS

Table 1 presents descriptive statistics of students' final scores based on four learning strategies applied, namely Tutorial Learning, Presenter Learning, Project Online Learning, and Project Face-to-Face Learning.

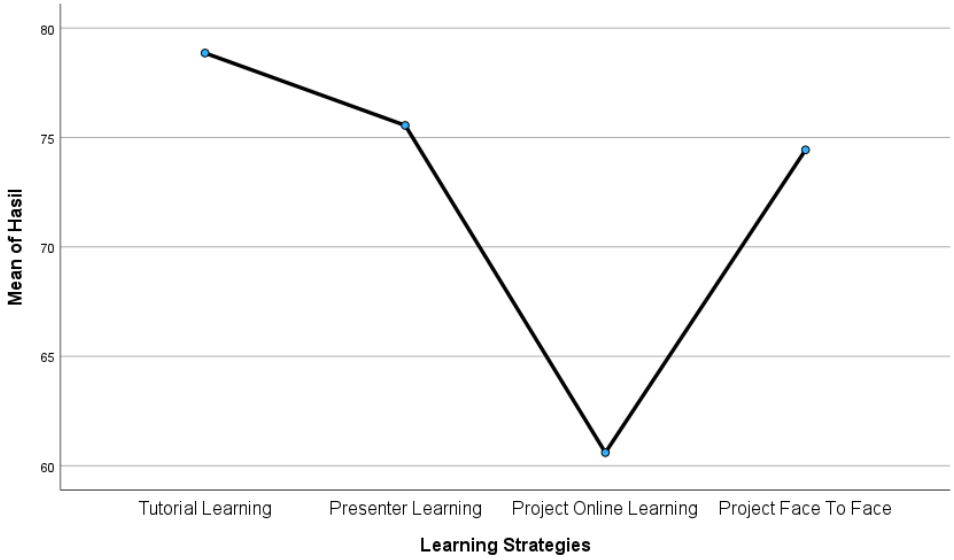
Table 1 Descriptive Statistics Based on Learning Strategies

Learning Strategies	N	Mean	Std. Deviation	Min	Max
Learning Tutorials	21	78.86	11.092	58	88
Presenter Learning	29	75.55	8.296	58	89
Project-Online Learning	30	60.60	12.184	29	82
Project-Face to Face Learning	60	74.43	7.158	56	89

Based on these results, it was shown that Tutorial Learning produced the highest average final score followed by Presenter Learning and Project-Face to Face Learning. In terms of grade diversity, Project-Online Learning had the largest spread of scores (SD= 12,184), indicating that student scores in this group were more diverse. In contrast, the Project-Face to Face Learning group showed the narrowest distribution of scores (SD = 7,158), which indicates the consistency of student achievement in the group. The minimum and maximum scores also showed that in the Project-Online Learning group,

there were students with very low scores (mean = 29), while the highest maximum scores were found in several other groups (max = 89), indicating that certain learning strategies allow for consistently higher academic achievement.

Figure 1 Average Graph of Learning Outcomes by Learning Strategy



learning strategies used. The Tutorial Learning Strategy produced the highest average of 78.86 from 15% of students, followed by Presenter Learning with an average of 75.55 from 21% of students, and Project Face to Face Learning with an average of 74.43 from 43% of students. In contrast, Project Online Learning showed the lowest average of 60.60 out of 21% of students.

Table 2 Normality Results (Kolmogorov-Smirnov)

Strategy	Statistics	Df	Sig.
Learning Tutorials	.407	21	<.001
Presenter Learning	.144	29	.129
Project Online Learning	.114	30	.200*
Project Face To Face Learning	.168	60	<.001

Based on the results of the Kolmogorov-Smirnov test, the distribution of student scores in the Presenter Learning and Project-Online Learning strategies is said to be normal. Meanwhile, the distribution in Tutorial Learning and Project-Face to Face Learning is abnormal. These findings indicate that not all groups meet the assumption of normality, so it is necessary to consider them in advanced statistical analysis to maintain the validity of the results. This study also conducted a homogeneity test to find out whether the four strategies have homogeneous variance.

Table 3 Homogeneity Test Results with Levene's Test

Result	Living Statistic	df1	df2	Sig.
Based on Mean	5.122	3	136	.002
Based on Median	2.007	3	136	.116
Based on Median and with adjusted df	2.007	3	76.722	.120
Based on trimmed mean	4.603	3	136	.004

Based on the results of the homogeneity test as seen in Table 2. whose results show that the significance value is Based on Mean 0.002<0.05, then the data variant is not homogeneous, which means that the homogeneity test assumption is not met. The next stage is that the multiple comparisons test is used to find out specifically which strategies differ significantly from each other.

Table 4 Multiple Comparisons Test Results

(I)Strategies	(J)Strategies	Mean Difference	Std. Error	Sig.	95% CI	
					Lower	Upper
Learning Tutorials	Presenter Learning	3.305	2.659	.216	-1.95	8.56
	Project Online Learning	18.257*	2.641	<.001	13.03	23.48
	Project Face to Face Learning	4.424	2.353	.062	-.23	9.08
Presenter Learning	Learning Tutorials	-3.305	2.659	.216	-8.56	1.95
	Project Online Learning	14.952*	2.417	<.001	10.17	19.73
	Project-Face to Face Learning	1.118	2.099	.595	-3.03	5.27
Project Online Learning	Learning Tutorials	-18.257*	2.641	<.001	-23.48	-13.03
	Presenter Learning	-14,952*	2.417	<.001	-19.73	-10.17
	Project Face to Face Learning	-13,833*	2.075	<.001	-17.94	-9.73
Project Face to Face Learning	Learning Tutorials	-4.424	2.353	.062	-9.08	.23
	Presenter Learning	-1.118	2.099	.595	-5.27	3.03
	Project Online Learning	13.833*	2.075	<.001	9.73	17.94

Based on the results obtained, as seen in Table 3. which shows that there is a statistically significant difference between the Project-Online Learning learning strategy and the other three strategies. The Project-Online Learning strategy resulted in significantly lower average scores compared to Tutorial Learning, Presenter Learning, and Project-Face to Face Learning. Meanwhile, the differences between the other strategies, e.g. Tutorial Learning vs Presenter Learning, or Presenter Learning vs Project-Face to Face showed no statistical significance ($p > .05$), meaning there was no meaningful difference in mean final scores between the three strategies.

Table 5 Results of the HSD Tukey Test between Learning Strategies

Method	N	Subset for alpha = 0.05	
		1	2
Project-Online Learning	30	60.60	
Project-Face to Face Learning	60		74.43
Presenter Learning	29		75.55
Learning Tutorials	21		78.86
Sig.		1.000	.253

The results of Tukey HSD's follow-up test on variance analysis showed that the Project-Online Learning strategy was significantly in a separate group (Subset 1), which indicates that the learning outcomes of students with this strategy were statistically lower than other learning strategies. Meanwhile, the Presenter Learning, Tutorial Learning, and Project-Face to Face Learning strategies are included in the Subset 2 group, which means there are no significant differences between the three. These findings indicate that online project-based learning tends to be less effective in generating student learning outcomes than other strategies that involve in-person interaction or active presentations.

3.2 DISCUSSION

This study aims to determine the effectiveness of four different learning strategies: Tutorial Learning, Presenter Learning, Project Online Learning, and Project Face to Face Learning on student learning outcomes in Statistics courses. The results of the analysis showed that there were significant differences between the learning groups, especially between the Project Online Learning strategy and the other three strategies. One of the important findings of this study is the low learning outcomes of students who follow the Project Online Learning strategy compared to other strategies.

These findings indicate that project-based strategies carried out online have not been able to provide sufficient learning support for students. Instructors, learning designers, and systems designers need to know which engagement strategies are most effective for engaging students in online classrooms (Abou-Khalil et al., 2021). This is also related to previous research that showed that online learning, especially in the form of independent projects, often faces challenges in the form of low active student engagement, lack of direct supervision, and technical and communication barriers (Zalat et al., 2021).

The lack of face-to-face interaction may also play a role in the low understanding of statistical concepts that are abstract and require direct guidance.

In contrast, the Tutorial Learning and Presenter Learning strategies showed higher results. This can be explained through Vygotsky's theory of the proximal developmental zone (ZPD), which emphasizes the importance of the role of the tutor or facilitator in providing scaffolding to learners (Damanik et al., 2025; Salsabila & Muqowim, 2024). When students get direct support from lecturers or peers through presentations or tutorials, they tend to understand the material better, be more confident in completing assignments, and be more active in the learning process. Students who are actively involved in discussions, presentations, and guidance tend to experience improved understanding. Even Project Face to Face Learning strategies that combine projects with face-to-face meetings have shown relatively positive results, suggesting that in-person social interaction remains an important factor in the success of project-based learning.

Therefore, it is important to choose the right techniques in order to improve students' understanding of statistical ideas and allow them to gain a deeper understanding. Like (Nguyen et al., 2023) which emphasizes that the application of project- and problem-based learning methodologies allows students to engage in collaborative learning experiences, encourages the development of teamwork skills, and facilitates the completion of complex projects through the exchange of diverse perspectives and ideas. In this context, learning focuses not only on understanding concepts, but also on strengthening critical thinking and problem-solving skills. These findings are also consistent with the results of the study (Biza & Vande Hey, 2015; Suh et al., 2020) which states that statistical knowledge is closely related to the ability to reason, reflective thinking, and active statistical consultation.

From a practical perspective, the results of this study encourage educators to be more selective in choosing project-based learning strategies, especially in the online context. Adjustments need to be made by considering the characteristics of the material and the readiness of students in managing independent learning. Thus, this research not only contributes to the development of statistical learning theory, but also provides practical implications for more adaptive and effective teaching in education.

4. CONCLUSION

This study shows that learning strategies have a significant influence on students' statistical literacy achievements. These findings reinforce the understanding that approaches that involve direct interaction and targeted learning structures, such as *Tutorial Learning* and *Project Face to Face Learning*, are more effective in building statistical literacy skills. In contrast, *Project Online Learning* strategies tend to be less supportive of these outcomes, likely due to limited interaction and supervision. This research contributes to the development of statistical learning practices in higher education, especially in designing strategies that can increase student engagement and understanding.

5. RECOMMENDATIONS

Based on the findings of this study, it is recommended that educators consider choosing a learning strategy that is more in line with student characteristics and learning objectives, especially in the context of developing statistical literacy. Further research is suggested to explore more varied learning strategies, including combining two or more learning strategies such as *tutorial learning* with *project-based learning* in person or online, in order to find a more adaptive learning model that is able to increase student engagement and understanding in the context of statistical literacy.

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