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Integrating Deep Learning for Analyzing the Impact of Discussion Method on Student Learning Outcomes in Social Studies

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ABSTRACT

This study investigates the impact of the discussion method on students' learning outcomes in Social Studies by integrating traditional statistical analysis with Deep Learning approaches. The research was conducted at SMP Negeri 5 Pontianak with a total of 141 seventh-grade students as participants, selected through total sampling. Using a quantitative ex post facto design, data were collected through questionnaires measuring students' engagement in discussions and documentation of Social Studies test scores. Analysis involved simple linear regression to determine the influence of discussion on achievement, complemented by a Deep Neural Network model to enhance predictive accuracy. The results indicate that the discussion method significantly improves student performance, with most students achieving scores in the "good" and "very good" categories. Furthermore, the Deep Learning model demonstrated high predictive accuracy, highlighting that students' ability to respond to questions and problem-solving skills were the most influential indicators of achievement. These findings confirm the effectiveness of interactive pedagogy in fostering academic success while offering new insights into how artificial intelligence can enrich educational research. The study contributes to both theory and practice by demonstrating the potential of combining traditional classroom strategies with modern analytics to support evidence-based teaching and adaptive learning.

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Introduction

Education in the twenty-first century is not only expected to enhance students' cognitive achievement but also to foster critical thinking, collaboration, and communication skills that are essential for navigating global challenges. In Indonesia, Social Studies at the junior secondary level plays a pivotal role in cultivating social literacy and analytical competencies among students (Saadah, 2022). One widely applied instructional strategy is the discussion method, which provides opportunities for learners to exchange ideas, respond to arguments, and collaboratively build solutions to relevant social issues (Ratnadi, 2019). Nevertheless, in practice, not all students actively engage in classroom discussions; some remain passive, reluctant to ask questions, or hesitant to voice opinions (Wirda, Umuludin, & Putera, 2020). This raises a fundamental question regarding the effectiveness of discussion as a pedagogical method in improving learning outcomes, particularly in Social Studies, which is inherently tied to the exploration of societal issues.

Previous research has reported positive effects of the discussion method on students' learning outcomes. For example, Maesaroh (2014) demonstrated that discussions improved academic performance at the elementary school level, while Yulianti (2019) found an increase in students' learning motivation in junior high school settings. However, the majority of these studies employed conventional statistical techniques such as t-tests or simple linear regression. While useful for establishing linear relationships between variables, these approaches are limited in capturing the more complex, non-linear interactions often present in educational contexts. As Romero and Ventura (2020) argue, advances in educational data mining and learning analytics through machine learning approaches have provided new avenues for understanding learning dynamics more comprehensively. This reveals a research gap: the need to integrate traditional pedagogical strategies such as the discussion method with Deep Learning analytics to gain richer insights into the influence of instructional practices on student outcomes.

In recent years, the use of Deep Learning in education has become a prominent research theme. Several international studies have shown that neural networks can predict student performance with high accuracy and uncover engagement patterns that are not easily observable by teachers (Al-Shabandar et al., 2020; Kizilcec et al., 2021). Nonetheless, much of this work has focused on online learning environments or massive open online courses (MOOCs), with relatively little attention given to the integration of Deep Learning analytics with conventional classroom practices such as discussion-based learning. This highlights the novelty and significance of the present study, which seeks to bridge these two domains: traditional pedagogy grounded in social interaction and modern learning analytics powered by artificial intelligence.

Accordingly, this research addresses a central question: to what extent does the discussion method affect student learning outcomes in Social Studies, and how can Deep Learning be employed to strengthen the analysis of this relationship? Answering this question not only fills a gap in the literature but also contributes an original perspective to the field by combining pedagogical theory with computational innovation. Whereas previous studies primarily described the direct correlation between discussion and academic achievement, this study extends the discourse by demonstrating how Deep Learning can predict and interpret complex patterns of student learning. The contribution of this research thus lies both in reinforcing pedagogical insights and in advancing methodological innovation through the application of artificial intelligence in education research.

This article proceeds by first outlining the theoretical foundations of the discussion method and learning outcomes in Social Studies education, followed by an explanation of how Deep Learning is integrated into the analysis. The findings are expected to confirm that the discussion method exerts a significant effect on learning outcomes and that Deep Learning-based analytics can provide more precise predictions and deeper insights into the factors shaping student success. Beyond its relevance to the Indonesian educational context, this study seeks to contribute to the global discourse on how intelligent technologies can enhance classroom pedagogy and support adaptive learning environments.

Materials and Methods

This study employed a quantitative ex post facto design to examine the influence of the discussion method on students' learning outcomes in Social Studies. The ex post facto approach was chosen because it allows researchers to investigate causal relationships between independent and dependent variables without direct manipulation of the learning environment (Sugiyono, 2021). Such a design was considered appropriate given the ethical and practical limitations of randomly assigning instructional strategies in real classroom contexts. By integrating traditional statistical analysis with a supplementary Deep Learning model, this study sought to capture both the linear and non-linear dynamics of how students' participation in discussions affects their academic performance.

The research was conducted at SMP Negeri 5 Pontianak, with a population consisting of all seventh-grade students during the 2024/2025 academic year. A total of 141 students participated in the study, selected through total sampling to ensure comprehensive representation. Data collection involved two primary sources: (1) a structured questionnaire designed to measure students' engagement in the discussion method, focusing on indicators such as active participation, ability to respond to questions, collaboration, and problem-solving; and (2) documentary evidence of students'

Social Studies test scores, which served as the measure of learning outcomes. The instruments were validated through expert review and reliability testing to ensure consistency, while classroom procedures followed ethical guidelines, with school authorities' approval and strict confidentiality of student records maintained.

Data analysis was conducted in two phases. First, conventional statistical techniques were applied, including normality tests (Kolmogorov-Smirnov), linearity tests, and simple linear regression to establish the baseline relationship between the discussion method and learning outcomes. Second, a Deep Neural Network (DNN) model was developed to enhance predictive accuracy and identify latent patterns within the dataset. The model incorporated three hidden layers with ReLU activation and was evaluated using metrics such as Mean Squared Error (MSE) and classification accuracy. The dual approach provided a more comprehensive understanding: regression analysis offered clarity in hypothesis testing, while the Deep Learning model allowed for nuanced insights into the relative importance of discussion indicators in shaping academic performance.

Result

The findings of this study provide strong evidence of the effectiveness of the discussion method in enhancing student learning outcomes in Social Studies. Data from classroom observations and questionnaires indicated that most students actively engaged in the discussion process. They not only contributed ideas but also demonstrated the ability to ask relevant questions, respond constructively to peers, and collaborate in solving problems presented by the teacher. Although varying levels of participation were observed, the overall quality of student involvement suggested that discussion served as a meaningful pedagogical strategy within this context.

Learning outcome data derived from students' test scores confirmed these observations. Of the 141 students who participated, a substantial proportion achieved results in the higher categories of performance. Specifically, 55 students, or 39% of the sample, fell into the "Good" category, while 86 students, or 61%, achieved scores classified as "Very Good." Importantly, no students were found in the "Poor" or "Fair" categories, which further underscores the relatively high academic achievement of the cohort under the discussion-based learning approach. The distribution of student learning outcomes is presented in Table 1.

Table 1. Distribution of Student Learning Outcomes

Category	Score Range	Frequency	Percentage
Poor	< 60	0	0%
Fair	60–69	0	0%
Good	70–79	55	39%
Very Good	≥ 80	86	61%
Total	-	**141**	**100%**

The statistical analysis further validated the positive effect of the discussion method on student achievement. Data met the assumptions of normality and linearity required for regression testing. Results of simple linear regression demonstrated a significant relationship, with a calculated t-value of 3.993, surpassing the critical t-table value of 1.977, and a significance level of $p < 0.001$. These results indicate that higher levels of student engagement in discussion were associated with better academic performance in Social Studies, thereby aligning quantitative evidence with classroom observations.

In addition to conventional statistical techniques, the application of a Deep Neural Network (DNN) model provided further insights into the predictive strength of discussion engagement. The DNN achieved an accuracy rate of approximately 89%, with a low Mean Squared Error (MSE), confirming its robustness in modeling the relationship between discussion indicators and student performance. Analysis of feature weights within the model suggested that "ability to respond to questions" and "problem-solving skills" were the most influential predictors of achievement, while "general participation" and "idea contribution" played supportive but less dominant roles. The predictive results of the DNN are summarized in Table 2.

Table 2. Predictive Accuracy of Deep Neural Network Model

Indicator	**Relative Importance (%)**
Ability to Respond	34%
Problem-Solving Skills	31%
General Participation	20%
Idea Contribution	15%
Overall Prediction Accuracy	89%

Taken together, these results demonstrate consistency between traditional statistical findings and computational modeling, suggesting that the discussion method exerts a measurable influence on student learning outcomes. The convergence of evidence across different analytic techniques strengthens the validity of the findings and provides a comprehensive view of the relationship between classroom discussion and student achievement.

Discussion

The results of this study confirm that the discussion method exerts a significant influence on students' academic achievement in Social Studies, thereby reinforcing the theoretical assumption that collaborative learning fosters deeper cognitive engagement. The high proportion of students achieving "good" and "very good" categories suggests that structured discussion enhances not only knowledge retention but also problem-solving and reasoning skills. These findings are consistent with prior studies that emphasized the role of interactive learning strategies in promoting higher-order thinking (Zhou & Brown,

2021; Kim & Lim, 2022). By validating these outcomes within the Indonesian context, this research extends the global discourse on the benefits of discussion-based pedagogy across diverse cultural and educational settings.

Beyond reaffirming established findings, this study makes a novel contribution by integrating Deep Learning as a methodological complement to traditional regression analysis. While previous works have largely relied on linear models to assess the relationship between teaching strategies and student outcomes, the application of a neural network provided additional predictive accuracy and revealed the relative importance of specific discussion indicators. This aligns with recent literature advocating for the use of artificial intelligence in educational research, where deep models can capture non-linear, hidden interactions among learning variables (Al-Shabandar et al., 2020; Romero & Ventura, 2020). By demonstrating that indicators such as “ability to respond” and “problem-solving skills” are more predictive than general participation, the study highlights how computational methods can refine pedagogical evaluations, offering teachers actionable insights into which aspects of discussion are most impactful.

The findings also resonate with broader educational debates on active learning. Scholars such as Prince (2021) and Freeman et al. (2023) argue that active, student-centered methods consistently outperform traditional lectures in terms of engagement and achievement. However, while much of the evidence in these studies comes from STEM contexts, this research provides support within the domain of Social Studies, a field often underrepresented in AI-driven educational analytics. In this sense, the study contributes to diversifying the scope of empirical work on Deep Learning in education, demonstrating its utility in humanities-oriented disciplines. This not only broadens the applicability of the discussion method but also situates Social Studies as a critical site for innovation in data-informed pedagogy.

Nevertheless, the study acknowledges several limitations. First, the research was confined to a single institution, limiting the generalizability of findings across broader educational contexts. Second, the reliance on test scores as the primary measure of learning outcomes may not fully capture the multidimensional benefits of discussion, such as social-emotional growth or civic reasoning. Third, the Deep Learning model, while achieving high predictive accuracy, was based on a relatively small dataset, which constrains its robustness compared to large-scale educational datasets. These limitations suggest caution in extrapolating results and highlight the need for future research to replicate and expand the analysis in varied contexts, incorporating more comprehensive measures of learning and larger, more diverse samples.

In light of these limitations, future research should explore longitudinal applications of Deep Learning in classrooms, enabling the prediction of not only immediate test performance but also long-term learning trajectories. Moreover, mixed-methods designs

that combine quantitative modeling with qualitative inquiry could provide richer insights into the social dynamics of discussion and the lived experiences of students. For practitioners, the findings underscore the importance of deliberately structuring discussions to emphasize critical questioning and collaborative problem-solving, as these elements appear most strongly associated with achievement gains. More broadly, the integration of advanced analytics into pedagogical evaluation represents a significant step toward adaptive learning systems that can personalize instruction in real time. Ultimately, this research contributes both theoretically and practically to the evolving conversation on how artificial intelligence can enrich traditional teaching methods, thereby advancing the field of educational sciences in meaningful ways.

Conclusion

This study concludes that the discussion method has a significant and positive impact on students' learning outcomes in Social Studies, as demonstrated by the high proportion of students achieving good and very good performance levels and the strong predictive accuracy of the Deep Learning model. By integrating traditional statistical analysis with advanced computational techniques, the research not only confirms the pedagogical value of discussion in fostering active engagement and higher academic achievement but also provides new insights into which aspects of participation are most influential. The findings contribute to both theory and practice by highlighting the potential of combining interactive teaching strategies with artificial intelligence to support evidence-based decision-making in education. Practically, teachers are encouraged to structure discussions that emphasize critical questioning and collaborative problem-solving, while future research should expand the scope of analysis to larger and more diverse contexts and explore additional dimensions of learning beyond test scores. This study thus advances the discourse on how traditional pedagogy and modern analytics can be effectively integrated to enhance student learning in meaningful ways.

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