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Research Article

The Influence of the Deep Learning Approach on Students' Problem-Solving Skills, Digital Literacy, and Learning Outcomes

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Abstract: This research aims to analyze the influence of Deep Learning on problem-solving skills, digital literacy, and student learning outcomes. The background of this research is based on the educational needs of the 21st century, which require students' critical thinking skills, adequate digital literacy, and optimal academic achievement. This research was conducted quantitatively using a quasi-experimental method. The study involved 121 tenth-grade students, and the total sampling method was used to select the research sample. The research instruments consist of questionnaires on the Deep Learning approach to problem-solving skills, digital literacy, and learning outcomes tests. Data analysis using the MANOVA test to determine the partial and simultaneous influence of Deep Learning on the dependent variables. The research results show that Deep Learning has a significant effect on students' problem-solving skills, digital literacy, and learning outcomes, both partially and simultaneously. The results indicate that the application of Deep Learning can improve students' higher-order thinking skills and prepare them to face the challenges of the digital era. Therefore, to achieve sustainable improvement in learning processes and outcomes, teachers and educational institutions must integrate this approach into their teaching strategies.

Keywords: Deep Learning; Digital Literacy; Higher-Order Thinking Skills; Learning Outcomes; Problem-Solving Skills

1. Introduction

Global developments characterized by the Fourth Industrial Revolution, rapid technological advancement, and the growing complexity of socio-economic challenges have profoundly influenced the education system in the 21st century. School graduates can no longer rely solely on rote memorization; instead, they require higher-order thinking skills and the ability to adapt to dynamic digital environments. Organizations such as the OECD, UNESCO, and the World Economic Forum consistently emphasize the importance of three key competencies for students: problem-solving, digital literacy, and meaningful learning outcomes that reflect mastery of competencies rather than mere test scores.

Based on the results of PISA 2022 (Kemendikbudristek, 2024), in terms of reading literacy, the PISA 2022 results showed that Indonesia's reading literacy ranking improved by five positions, with an average score of 359. However, this score represents the lowest ever recorded since Indonesia's participation in PISA, indicating that the quality of literacy has declined compared to previous cycles despite the increase in ranking. In response, the Ministry of Education, Culture, Research, and Technology (Kemendikdasmen) issued Regulation No. 13 of 2025, which mandates the gradual implementation of the Deep Learning Approach beginning in the 2025/2026 academic year. This policy aims to shift the learning orientation from quantity to quality by emphasizing mindful, meaningful, and joyful learning through essential and in-depth material, while integrating the use of digital technology in the learning process.

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On the other hand, many educational institutions still rely on conventional learning approaches that are teacher-centered, focusing on one-way information delivery, rote memorization, and preparation for standardized tests. When classroom instruction remains teacher-dominated, many students fail to internalize long-term learning, struggle with unstructured problems, and become vulnerable to digital misinformation (Rakhmawati et al., 2024). This phenomenon reveals a gap between the outcomes of formal education and the demands of real-world contexts. Furthermore, teachers are expected to be capable of utilizing technology to enhance learning and improve educational quality (Rakhmawati et al., 2024). In line with this, the use of digital technology is expected to make the learning process more flexible, effective, and responsive to students' diverse learning needs (Arikarani & Amirudin, 2021).

To address these challenges, Deep Learning (DL) has emerged as a promising pedagogical paradigm. According to Rahayu in Maelasari & Lusiana (2025), DL in education does not refer to artificial intelligence, but rather to a cognitive approach that emphasizes critical and reflective problem-solving, deep conceptual understanding, and the interconnection between concepts. The principles of DL include project-based learning, real-world problem-solving, critical interaction, metacognitive awareness, and the application of technology as an instrument for knowledge construction. Maelasari in Maelasari & Lusiana, (2025) further summarized various studies which collectively indicate that the implementation of the Deep Learning approach contributes positively to improving students' conceptual understanding and learning outcomes. Similarly, Suwandi (2024) added that the implementation of the Deep Learning model in Indonesia aligns with the foundation of the Merdeka Curriculum, which emphasizes learner autonomy and project-based learning methods.

Several international studies have demonstrated the positive impact of the Deep Learning approach on students' critical thinking skills and learning motivation. However, research that specifically examines its simultaneous influence on problem-solving skills, digital literacy, and learning outcomes remains limited. Based on these empirical facts, the researcher seeks to investigate The Influence Of The Deep Learning Approach On Students' Problem-Solving Skills, Digital Literacy, And Learning Outcomes. This study is expected to contribute to the development of more effective learning strategies in schools that align with the demands of 21st-century education.

In Indonesia, the Merdeka Belajar (Freedom to Learn) policy has created opportunities for the emergence of various learning innovations. Therefore, this study holds significant urgency in addressing the existing research gap. The purpose of this research is to provide a deeper understanding of the simultaneous influence of the Deep Learning approach on students' problem-solving skills, digital literacy, and learning outcomes.

The findings of this study are expected to provide theoretical contributions to the development of educational science, as well as offer practical recommendations for teachers, schools, and policymakers in designing learning processes that align with the needs of the digital era.

2. Research Method

This study employed a quantitative method using a quasi-experimental approach. The quantitative method is a type of research that utilizes numerical data or data that can be analyzed statistically. This approach is often referred to as a traditional method, as it has long been used and remains one of the most common approaches in scientific research (Ahmad Nizar Rangkuti, 2016). Meanwhile, the quasi-experimental design aims to reveal cause-and-effect relationships, but unlike a true experimental design, it does not use random assignment of subjects; instead, it relies on pre-existing groups (Hastjarjo, 2019).

In this study, the Deep Learning approach (X) serves as the independent variable, while the dependent variables are problem-solving skills (Y1), digital literacy (Y2), and students' learning outcomes (Y3). The research involved Grade 10 students from SMAN 1 Anjongan, located in Mempawah Regency, West Kalimantan. The sample consisted of 121 students. The research instruments included questionnaires measuring the Deep Learning approach, digital literacy, and problem-solving skills, as well as a learning outcomes test administered to the students.

Data analysis in this study was conducted using the MANOVA (Multivariate Analysis of Variance) test. MANOVA is an extension of the ANOVA technique. While ANOVA is limited to examining the effect of an independent variable (X) on a single dependent variable

(Y), MANOVA allows for the simultaneous examination of the effects on multiple dependent variables. Therefore, this test is highly relevant for the present study, as there are three dependent variables involved. The researcher expects that the findings of this study will provide valuable contributions to the advancement of education.

3. Results and Discussion

This study was initiated in response to the policy issued by the Ministry of Education, Culture, Research, and Technology (Kemendikdasmen) through Regulation No. 13 of 2025, which governs the gradual implementation of the Deep Learning approach beginning in the 2025/2026 academic year. This policy is designed to shift the focus of education from quantity to quality by emphasizing mindful, meaningful, and joyful learning through essential and in depth material, as well as by integrating the use of digital technology into the learning process.

This study employed a quantitative approach, with data collected in numerical form. The data were analyzed using SPSS statistical software. The research was conducted in August 2025 at SMAN 1 Anjongan, involving 121 respondents from Grade 10 who completed the questionnaire. The distribution of the questionnaire was carried out in a closed format using a Likert scale ranging from 1 to 5 via Google Form. The questionnaire consisted of four instruments, namely: a Deep Learning approach scale (20 items), a Problem-Solving Skills scale (18 items), a Digital Literacy scale (18 items), and a Student Learning Outcomes scale (20 items).

To ensure the research assumptions were met, the researcher selected students from SMAN 1 Anjongan based on the consideration that these students had already been exposed to the Deep Learning approach during their learning process. The selection of Grade 10 students as respondents was made because they are currently in a transitional phase of learning approaches having previously experienced the Differentiated Learning approach at the junior high school level. The questionnaire scores obtained were then analyzed for validity and reliability. The validity test aimed to determine the extent to which the instrument accurately measured what it was intended to measure. An instrument is considered valid if the calculated r-value exceeds the r-table value at the 5% significance level. Conversely, if the calculated r-value is smaller than the r-table value, the instrument is deemed invalid (Arikunto, 2010). The following are the results of the validity test for variables X, Y1, Y2, and Y3, using the Pearson Product Moment test.

Table 1. Summary of Validity Tests for the Deep Learning Approach, Problem-Solving Skills, Digital Literacy, and Students' Learning Outcomes

Variable	R-Value	R-Table	Remarks
Deep Learning (X)	0,485	0,176	Valid
Problem-Solving Skills (Y1)	0,459	0,176	Valid
Digital Literacy (Y2)	0,475	0,176	Valid
Student Learning Outcomes (Y3)	0,485	0,176	Valid

Based on the results of the validity test for variables X, Y1, Y2, and Y3 presented in Table 1, it can be concluded that all questionnaire items are valid, as the Pearson Correlation value for each item was greater than 0.176. Subsequently, the researcher conducted a reliability test using Cronbach's Alpha. In general, a commonly accepted standard for Cronbach's Alpha is greater than 0.70, which indicates good reliability (Guo et al., 2025). The total of 121 student respondents does not directly affect the standard interpretation of Cronbach's Alpha; however, a larger sample size tends to improve the accuracy and consistency of the reliability test results.

The interpretation guidelines for Cronbach's Alpha coefficients are as follows: a reliability coefficient value of less than 0.60 is categorized as low; the range of 0.60–0.70 indicates moderate reliability and is still acceptable; a value between 0.70–0.80 represents high reliability; while a range of 0.80–0.90 signifies very high reliability. A coefficient that reaches or approaches 0.90 is considered to represent excellent reliability.

Table 2. Summary of Reliability Tests for the Deep Learning Approach, Problem-Solving Skills, Digital Literacy, and Students' Learning Outcomes

Variable	R-Value	R-Table	Remarks
The Deep Learning Approach (X)	0,824	0,70	Valid
Problem-Solving Skills (Y1)	0,756	0,70	Valid
Digital Literacy (Y2)	0,783	0,70	Valid
Student Learning Outcomes (Y3)	0,812	0,70	Valid

Based on Table 2, it is clearly shown that all variable values are greater than 0.70. According to the results of the reliability analysis using Cronbach's Alpha, it can be concluded that all items in this research instrument are reliable, with interpretations ranging from high to very high reliability. Guo et al., (2025) stated that when the Cronbach's Alpha value is stable, each item demonstrates good internal consistency and contributes positively to the overall reliability of the instrument. Therefore, all questionnaire items were retained in this study.

After conducting the validity and reliability analyses of the instruments, the next stage of data analysis was the normality test, which aimed to ensure that the obtained data met the assumption of a normal distribution (Isnaini et al., 2013). The researcher applied the Kolmogorov–Smirnov test to examine the data in this study. The Kolmogorov–Smirnov test is one of the most commonly used statistical methods for assessing the normality of data distribution. If the p-value is greater than 0.05, the data are considered to be normally distributed.

Table 3. Normality Test Using the Kolmogorov–Smirnov Test

One-Sample Kolmogorov-Smirnov Test					
		Deep Learning	**Problem Solving**	**Digital Literacy**	**Student Learning Outcomes**
N		121	121	121	121
Normal Parameters[a,b]	Mean	69.85	68.98	67.16	82.58
	Std. Deviation	7.533	6.817	7.620	13.798
Most Extreme Differences	Absolute	.043	.057	.074	.218
	Positive	.043	.057	.074	.163
	Negative	-.042	-.052	-.067	-.218
Test Statistic		.043	.057	.074	.218
Asymp. Sig. (2-tailed)		.200[c,d]	.200[c,d]	.099[c]	.000[c]

Based on the results of the Kolmogorov–Smirnov test, it was found that the data for the Deep Learning approach, Problem-Solving Skills, and Digital Literacy variables had significance values greater than 0.05. Therefore, it can be concluded that these data sets follow a normal distribution. However, the data for Students' Learning Outcomes showed a significance value of 0.00, which is less than 0.05, indicating that the Learning Outcomes variable does not meet the assumption of normal distribution.

Since one of the data sets was not normally distributed, the analysis in this study could not be performed using MANOVA, as MANOVA can only be applied when the data meet the assumption of normality (Meyers et al., 2022). Therefore, to examine the correlations among variables, the researcher employed the Spearman's Rho test. The Spearman's Rho (ϱ or r_s) is a non-parametric correlation coefficient used to measure the strength and direction of the relationship between two variables based on their rank order, rather than their original numerical values. Consistent with the findings of Eltehiwy & Abdul-Motaal (2023), this test is appropriate when the data do not satisfy the normality assumption.

Table 4. Spearman's Rho Correlation Test

Correlations						
			Deep Learning	**Problem Solving**	**Digital Literacy**	**Student Learning Outcomes**
Spearman's rho	Deep Learning	*Correlation Coefficient*	1.000	.517**	.484**	.226*
		Sig. (2-tailed)	.	.000	.000	.013
		N	121	121	121	121
	Problem Solving	*Correlation Coefficient*	.517**	1.000	.596**	.205*
		Sig. (2-tailed)	.000	.	.000	.024
		N	121	121	121	121
	Digital Literacy	*Correlation Coefficient*	.484**	.596**	1.000	.230*
		Sig. (2-tailed)	.000	.000	.	.011
		N	121	121	121	121
	Student Learning Outcomes	*Correlation Coefficient*	.226*	.205*	.230*	1.000
		Sig. (2-tailed)	.013	.024	.011	.
		N	121	121	121	121

Table 5. Basis for Decision Making Spearman's Rho TestDecision-Making Criteria

Decision-Making Criteria		Criteria for the Level of Correlation Strength	
Significance Value	Decision	Correlation Coefficient Value	Correlation
Less than 0,05	Correlated	0,00 – 0, 25	Very Weak
Greater than 0,05	Not Correlated	0,26 – 0,50	Fair / Moderate
		0,51 – 0,75	Strong
		0,76 – 0,99	Very Strong
		1, 000	Perfect

Based on the results presented in Table 4 and Table 5, it can be seen that the independent variable X (Deep Learning approach) is correlated with the dependent variables Y1 ($r = 0.000$; $p < 0.05$), Y2 ($r = 0.000$; $p < 0.05$), and Y3 ($r = 0.013$; $p < 0.05$). This indicates that, empirically, the Deep Learning approach significantly influences students' problem-solving skills, digital literacy, and learning outcomes.

A detailed analysis of the correlation strength reveals that the Deep Learning approach has a strong influence on students' problem-solving abilities, as indicated by a Correlation Coefficient value of 0.517, which falls within the strong correlation category. This finding aligns with the study by Hayati & Almuslim (2025), which stated that the Deep Learning approach significantly contributes to improving students' abilities, particularly in identifying problems, designing solution strategies, and thinking flexibly skills that are not optimally developed through conventional learning approaches. Furthermore, Sanusi & Dirgantara (2025) support this finding through their research, which indicates that learning with a Deep Learning approach enhances students' analytical abilities.

The Deep Learning instructional approach shows an effect, though not a dominant one, on students' digital literacy, as indicated by a Correlation Coefficient value of 0.484, which falls within the moderate correlation category. This finding is consistent with Yustina E. (2025), who demonstrated that the use of Deep Learning strategies can serve as an effective alternative to enhance students' literacy by fostering active engagement and deeper understanding of learning materials. Similarly, Ginting (2025) found that the implementation of Deep Learning technology has a positive impact on stimulating learning motivation and strengthening students' fundamental literacy achievement.

The Deep Learning instructional approach shows only a slight effect on students' learning outcomes, as indicated by a Correlation Coefficient value of 0.226, which is interpreted as a very weak correlation. Empirical evidence from this study aligns with the findings of Zafirah et al. (2025), who stated that the application of Deep Learning strategies consistently has a positive impact on students' learning outcomes, particularly in enhancing conceptual understanding, higher-order thinking skills, and active engagement in the learning process.

Referring back to Table 4, it can be observed that all correlation values for variables Y1, Y2, and Y3 are positive. This indicates that changes in variable X tend to be followed by changes in the same direction in variables Y1, Y2, and Y3. In other words, when the value of X increases, the values of Y also tend to increase. Thus, it is proven that the Deep Learning instructional approach simultaneously influences students' problem-solving skills, digital literacy, and learning outcomes.

4. Conclusions

The findings of this study provide empirical evidence that the Deep Learning instructional approach significantly influences students' problem-solving skills, digital literacy, and learning outcomes simultaneously. These results carry important implications for educational practice and development. Moreover, the findings reinforce previous research conducted by experts at both national and international levels. This study can serve as a valuable reference for educators in designing interactive classroom learning plans that apply the Deep Learning approach, thereby helping them achieve the intended learning objectives more effectively

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