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The Effectiveness of AI-Based Education Management Systems in Implementing Deep Learning Curriculum in Elementary Schools

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Abstract

The purpose of this study is to evaluate the effectiveness of artificial intelligence (AI) in supporting elementary school teachers in implementing the deep learning curriculum. Two groups from a public elementary school in Sumedang Regency participated in a quantitative, quasi-experimental design. While the control group employed traditional teaching techniques, the experimental group used AI-based support. Pretest and posttest tools for learning outcomes were used to gather data. The Shapiro-Wilk normality test, Levene's homogeneity test, Wilcoxon signed-rank test, and N-Gain effectiveness analysis were among the methods used to analyze the data. The results show that students in the experimental group outperformed those in the control group in terms of their learning outcomes. A significant difference between the pretest and posttest scores was indicated by the Wilcoxon test's significance value of 0.000. The experimental group's average N-Gain score was 0.58 (58.13%), which was considered moderate and higher than the control group's 0.37 (37.48%). These findings show that integrating AI not only increases student learning effectiveness but also gives teachers the ability to evaluate learning data in real time and modify their lessons to meet the needs of their students. It is determined that deep learning curricula in elementary schools can be successfully supported by the application of AI. To guarantee long-term implementation, schools are urged to improve their digital infrastructure and offer sufficient teacher training.

INTRODUCTION

Education is one of the many facets of human life that has been profoundly impacted by the rapid development of science and technology. The delivery of education has evolved due to digital transformation, particularly in elementary schools in Indonesia. These modifications necessitate the modification of instructional strategies that incorporate digital technologies. According to Siringoringo and Alfaridzi (2024), the development of digital tools necessitates a change in the educational approach. Schools must thus adjust by implementing technology-based learning models that satisfy contemporary needs.

Critical, creative, and reflective thinking skills are crucial for students to succeed in the twenty-first century. These higher-order thinking abilities are now required to navigate a world that is becoming increasingly dynamic and complex. According to King et al. (in Ilmi & Puspita, 2020), these abilities help students think critically, solve new problems, and make wise decisions. According to Rahardhian (2022), students who possess advanced thinking skills can assess data, analyze situations, and develop creative solutions. According to Anandayu and Muslim (2021), these abilities serve as the cornerstone of adaptability and lifelong learning, enabling students to develop continuously and remain relevant in a rapidly changing society.

The integration of digital technology into the curriculum is essential to meet these demands and enhance students' cognitive development. According to Saraswati and Agustika (2020), incorporating technology into the classroom fosters students' critical and creative thinking skills in addition to their use of digital tools. This is further supported by Muhasim (2017), who emphasized how digital learning environments can boost student motivation, engagement, and active participation. The deep learning method appears to be a suitable remedy for this situation. It prioritizes depth over breadth, promotes deep interaction with the material, and incorporates digital media to improve students' problem-solving skills. This method helps students become more capable and prepared for the future by creating reflective and empowering learning environments.

The increasing need to change traditional learning into a more purposeful, student-centered approach makes this study significant. According to Otto et al. (2020), deep learning integrates knowledge and encourages reasoning and concept application beyond memorization. Its role in the development of cognitive, social, and emotional skills was highlighted by Nabila et al. (2025). Students are encouraged to be active, reflective, and involved in contextual learning processes through deep learning. Additionally, it promotes self-awareness, empathy, teamwork, and critical thinking. To promote adaptive, customized learning that is in line with 21st-century skills, it is pertinent to examine the application of AI-based deep learning in elementary schools.

Few studies have examined the practical application of artificial intelligence (AI) in the context of elementary education, especially in Indonesia, despite prior research highlighting AI's potential to support deep learning. According to Lubis (2021), artificial intelligence (AI) is a simulation of human cognitive processes used to carry out challenging educational tasks. According to Fatmawati et al. (2024), AI enables real-time adaptive instruction, providing students with individualized support and feedback. However, a gap exists in the practical implementation at the primary level because these studies frequently concentrate on theoretical frameworks or secondary education contexts.

While Syuhada et al. (2024) and Maola et al. (2024) highlight AI's role in fostering teaching efficiency and innovation, Diantama (2023) demonstrates how AI increases student confidence and engagement. Despite these realizations, there is a dearth of empirical data employing quantitative methods to assess the true effects of AI-based deep learning in elementary schools. To close this gap, this study uses a quasi-experimental approach to evaluate efficacy using quantifiable results. This innovation lies in the systematic integration of AI and deep learning to enhance the quality of basic education, providing a fresh framework for fusing digital resources with instructional techniques.

From being a simple technological tool, artificial intelligence (AI) is developing into a pedagogical partner that actively influences learning environments. In line with how AI promotes information flow and adaptive feedback, this study is based on the connectivism learning theory, which highlights the importance of digital networks in knowledge construction. According to Fajriati et al. (2024), AI makes real-time monitoring possible and allows teachers to modify their methods in response to the needs of their students. The Technological Pedagogical Content Knowledge (TPACK) framework provides a foundation for effectively incorporating AI into teaching methods, ensuring that technology use is balanced with subject matter and pedagogy. According to Dinata et al. (2024), AI promotes the development of 21st-century abilities, such as creativity and critical thinking, which are essential elements of deep learning. In support of the transition to a more dynamic, student-centered learning model, Anas and Zakir (2024) emphasized AI's role in fostering teamwork and problem-solving skills.

Given the foregoing, there is much promise for enhancing teaching and learning through the incorporation of AI into elementary education. To help teachers implement a deep learning curriculum, this study intends to design an AI-based Educational Management Information System (EMIS). The goal of the system is to assist in the analysis of current student data and suggest effective teaching methods for the same. This method can improve the effectiveness, impact, and personalization of the learning process itself. The ultimate goals are to improve overall learning outcomes and student engagement.

METHODS

This study used a quasi-experimental design and quantitative methodology. The design was chosen to assess how Artificial Intelligence (AI) can help elementary school teachers implement the deep learning curriculum. The quasi-experimental approach was selected because it allows comparison between an experimental group that used AI-based support and a control group that did not, even in the absence of complete random assignment. All elementary school teachers in Sumedang Regency, West Java, comprised the study population. The sample was purposively selected based on technological preparedness and school accessibility. The school granted the researcher permission, and the respondents provided informed consent. Data confidentiality was maintained in accordance with research ethics guidelines, and participation was entirely voluntary.

The study included 63 students from the same public elementary school in Sumedang Regency. The participants were split into two groups: 30 students in the control group and 33 in the experimental group. The goal of this sampling method was to obtain a good idea of how AI integration works in different teaching situations. The AI tool used in this study was designed for teachers to use when planning lessons, and it is based on deep learning principles. We conducted a small test of this system to determine how well it works and ensure that it meets the needs of teachers.

We obtained data using pre-test-post-test tools and student questionnaires. The test comprised 20 multiple-choice questions that were meant to measure how well students had learned, and the questionnaire measured how interested students were and what they thought of the AI-based approach. Correlation coefficients between 0.45 and 0.78 showed that the instrument was valid, and Cronbach's alpha showed that it was reliable with a score of 0.812, indicating that it was very reliable. The Wilcoxon signed-rank and Normalized Gain (N-Gain) tests were used to analyze the data.

The significance of the differences between the two sets of paired data was assessed using the Wilcoxon test, a non-parametric statistical technique that is especially useful when the normal distribution assumption is not satisfied. The test was used in this instance to compare the learning outcomes of the experimental and control groups. Under non-normal circumstances, this approach is a suitable substitute for the paired t-test, according to Sulaiman and Darwis (2019). Additionally, by examining the rise in scores between the pre- and post-tests, the N-Gain test was utilized to evaluate the success of the learning intervention. According to Sukarelawan et al. (2024), the N-gain test offers a precise framework for gauging the extent to which a teaching strategy improves student comprehension. This analysis aims to ascertain whether a deep learning model aided by AI considerably raises the academic achievement of elementary school pupils.

RESULTS

This study aimed to analyze the effectiveness of Deep Learning design based on Artificial Intelligence (AI) in improving the learning outcomes of elementary school students. In this study, two groups were involved: an experimental group that used an AI-based Deep Learning approach and a control group that used conventional methods. The effectiveness was evaluated through pre- and post-tests, which were analyzed using various statistical tests, such as normality, homogeneity, Wilcoxon, and N-Gain calculations. The results of the analysis were used to determine the extent of the difference in learning outcomes between the two groups and to identify significant contributions from the application of AI technology in the learning process.

To determine the effectiveness of the implementation of Deep Learning design based on Artificial Intelligence (AI) in Elementary Schools, student learning outcomes were measured by administering pre- and post-tests to both groups. The pre- and post-test data were used to determine the extent to which student understanding increased after participating in learning with each method. The following are the results of the pre- and post-tests for both groups as a basis for further analysis of the influence of the learning treatment.

Table 1. Student Learning Outcomes

	Control Group		Experimental Group	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Number of Students	30	30	33	33
Highest Score	91	98	90	100
Lowest Score	22	35	24	50
Average	52,10	68,25	56,40	76,85

To evaluate the effectiveness of the AI-based Deep Learning approach, a treatment was implemented in two groups over several sessions. The experimental group received instruction using an AI-integrated learning design that offered adaptive content, automated feedback, and interactive media to support a deep conceptual understanding. The control group, on the other hand, followed conventional methods involving lectures and written exercises without digital technology support.

After the intervention, learning outcomes were assessed using pre- and post-test scores. In the control group, the average score increased from 52.10 to 68.25, with the highest score increasing from 91 to 98 and the lowest score increasing from 22 to 35. Meanwhile, the experimental group showed a greater improvement, with the average score rising from 56.40 to 76.85 after the intervention. The highest score reached 100, and the lowest score improved from 24 to 50. These results indicate that both groups experienced progress, but the experimental group exhibited a more significant gain in performance, suggesting the effectiveness of the AI-based learning model.

Students' learning outcomes showed an increase in both the control and experimental groups from pre-test to post-test, but the improvement was more prominent in the experimental group. This group used an AI-based Deep Learning approach, which appeared to have a greater positive impact than the conventional method used in the control group. The average score in the experimental group increased from 56.40 to 76.85, whereas that in the control group increased from 52.10 to 68.25. In terms of mastery (defined as a score ≥ 70), only 24.2% of students in the experimental group reached it in the pretest, but this rose significantly to 81.8% in the post-test. Similarly, the control group showed improvement, with mastery levels increasing from 20% to 60% after the intervention.

The learning outcomes measured were based on three key aspects: conceptual understanding, analytical thinking, and knowledge application in problem-solving. These were assessed using a 20-item multiple-choice test, aligned with the learning objectives. To ensure accurate interpretation of the data, a normality test was conducted using the Shapiro-Wilk method, given the sample size of fewer than 50 students per group. As noted by Sugiyono (in Agustin & Permatasari, 2020), the Shapiro-Wilk test is ideal for small samples, offering a reliable assessment of data distribution. Souza et al. (in Ali & Juanda, 2025) also emphasized its sensitivity to detect non-normal distributions in sample sizes between 10 and 50. The next section presents the results of this test.

Table 2. Shapiro-Wilk Normality Test

Group	**Shapiro-Wilk**		
	Statistic	**df**	**Significant**
*Pretest*_Control	0,956	30	0,205
*Posttest*_Control	0,961	30	0,289
*Pretest*_ Experiment	0,958	33	0,164
*Posttest*_ Experiment	0,918	33	0,017

Table 2 demonstrates that the pre- and post-test results for the experimental and control groups have a significance value higher than 0.05, indicating that the data were normally distributed. The experimental group's post-test results, however, had a significance value of 0.024, which is less than 0.05, suggesting that the data were not normally distributed.

A homogeneity test was performed after a normality test revealed that one of the variables—the post-test in the experimental group— was not normally distributed. The purpose of the homogeneity test is to ascertain whether the variance of the two sample groups—the experimental and control groups —is the same (Usmadi, 2020). It is crucial to ensure that variations in learning outcomes are solely attributable to the treatment received and not to variations in the fundamental traits of the groups. Therefore, a homogeneity test is a crucial precondition before conducting additional hypothesis testing. The results of the homogeneity test for the two research groups are as follows.

Table 3. Homogeneity Test

Varians	**Homogenitas**	
	Skor Tes Levene's	**Significant**
Pretest	0,514	0,475

Table 3 shows that the homogeneity test yielded a significant value of 0.468, indicating that the two groups had an equivalent initial condition basis for comparison or homogeneity. Because they were unaffected by variations in the students' starting characteristics, the comparison results between the experimental and control groups can be regarded as legitimate.

Following the normality test, it was discovered that the majority of the data, that is, the pre- and post-tests of the control and experimental groups, were normally distributed. However, the experimental group's post-test results showed a non-normal distribution, and the homogeneity test revealed that the variance of the data was homogeneous. Because the Wilcoxon non-parametric test is better suited for data that deviates from the normality assumption, it was selected to assess the differences in learning outcomes between the pre- and post-tests in the two groups based on the data distribution conditions. The Wilcoxon test was selected because it can handle data that are not normally distributed and yields reliable results when testing two paired samples (Nisa et al., 2022). The Wilcoxon test results for the two groups are as follows:

Table 4. Wilcoxon test

	Control Posttest - Control Pretest	***Posttest* Experiment - *Pretest* Experiment**
Significant	0,000	0,000

Table 4 indicates a significant difference between the pre- and post-test results in the control and experimental groups, with the Wilcoxon test results showing a significance value of 0.000 ($p < 0.05$) for both groups. However, N-Gain Score analysis is required to further determine the magnitude of the difference. The N-Gain Score test results for both groups are as follows:

Table 5. N-Gain Effectiveness Test

Group	**N**	**Mean of N-Gain**	**N-Gain Percentage (%)**	**Category**
Control Group	30	0,37	37,48	Low
Experimental Group	32	0,58	58,13	Moderate

Table 5 shows that the control group had an average N-Gain score of 0.37, with a standard deviation of 0.28, ranging from 0.08 to 1.00. When expressed as a percentage, the N-Gain ranged from 8.22% to 100%, with an average of 37.48% and a standard deviation of 26.75. This indicates that the control group, which received conventional instruction, experienced low to moderate improvement in student learning outcomes. Additionally, the relatively high standard deviation suggests that the gains were not evenly distributed among the students.

In contrast, the experimental group, taught using an AI-assisted Deep Learning approach, achieved an average N-Gain score of 0.58 with a standard deviation of 0.26, ranging from 0.18 to 1.00. When converted to percentages, the N-gain ranged from 18.18% to 100%, with an average of 58.13% and a standard deviation of 27.10. Based on the N-Gain classification, this value falls into the moderate category, indicating that the learning design integrating AI was more effective in improving students' learning outcomes compared to the conventional approach.

To evaluate user perceptions of the AI-assisted Deep Learning tool, a questionnaire was administered to students in the experimental group after the learning sessions. The questionnaire covered several aspects, including ease of access, usability, content clarity, feature functionality, suitability to learning needs, and perceived benefits in supporting the learning process.

The results revealed that 87.9% of the students agreed that the application was easy to access and use on their Android devices. A total of 84.8% of students stated that the content and interface were clear and easy to understand. Regarding feature functionality, 81.8% of the respondents reported that all the main features worked well without technical issues. Meanwhile, 75.8% of students felt that the available features were sufficiently complete and aligned with their learning requirements. Most notably, 90.9% of the students expressed that the use of this AI-assisted tool helped them better understand the material and made learning more enjoyable and engaging. These findings indicate a high level of acceptance and positive perception of innovation, suggesting that the integration of AI-based learning tools can significantly enhance the learning experience when designed in a user-friendly and pedagogically appropriate manner.

DISCUSSION

1. Interpretation of Findings and Theoretical Implications

According to this study, incorporating AI-assisted Deep Learning greatly improved student academic performance. AI-based learning had a positive impact on comprehension and retention, as evidenced by the experimental group's consistently higher post-test scores and N-Gain values compared to the control group. The framework developed by Trilling and Fadel, which highlights the role of technology in fostering critical thinking and individualized learning experiences, is supported by this finding. The AI platform utilized in this study offered learning scaffolds, interactive tasks, and adaptive feedback—all of which are critical components for encouraging profound and significant learning in elementary school pupils. Engaging, responsive, and visually appealing digital tools can help make abstract concepts easier to understand in early education, when cognitive development is still developing (Ma'amor et al., 2024).

It has been demonstrated that AI-integrated Deep Learning designs not only improve learning outcomes but also foster the growth of 21st-century skills like independent learning, creativity, critical thinking, and teamwork. AI makes it possible to create adaptive learning environments that modify both content and pedagogical approaches to fit the unique profiles of each learner (Luckin et al., 2016). Pratiwi and Yunus (2025) stated that integrating AI enables more effective and individualized learning that is in line with students' real needs. This is consistent with Vygotsky's Zone of Proximal Development and constructivist learning theory, which both hold that learners gain from directed assistance. Here, artificial intelligence (AI) serves as a digital scaffolding that encourages metacognitive awareness and learner autonomy by enabling students to take charge of their learning paths and pace.

2. Comparison with Prior Research: Supportive and Contrasting Views

The findings of this study are consistent with those of several earlier investigations that support AI's beneficial contribution to raising student outcomes and instructional efficacy. Nurhayati et al. (2024) and Naila et al. (2023) demonstrated how AI applications can boost student motivation and engagement through personalized interactive assignments. Additionally, Mambu et al. (2023) emphasized how AI improves instructional decision-making by offering real-time analytics and learning recommendations, which strengthens teachers' roles. Similarly, Yulianti et al. (2023) and Lowell et al. (2023) verified that AI systems can change the educational process to make it more dynamic and interesting. According to Sumarni and Muhibbin (2023), incorporating AI into civic education in elementary schools creates a more dynamic learning environment and enhances students.

Nonetheless, several studies present important arguments against it. According to Luckin et al. (2016), excessive dependence on AI could diminish the importance of teacher-student interactions, which are crucial for social and emotional growth, particularly in elementary school. In addition, teachers' limited digital competencies, infrastructure deficiencies, and digital inequality continue to be major obstacles to the equitable application of AI. Notwithstanding these reservations, our research supports Nugraha and Nurdyansyah's (2024) assertion that AI can efficiently optimize instructional planning and delivery when employed as a supplemental tool rather than as a substitute for teachers. Therefore, how well AI is incorporated into educational objectives and how responsive the system is to user needs are key factors in determining its effectiveness.

3. Practical Implications, Limitations, and Future Research

According to the findings, AI has the potential to be a useful instrument for enhancing the quality of instruction in elementary schools. In addition to learning materials, the application used in this study offered learning analytics, formative evaluations, and real-time suggestions. These characteristics enable teachers to modify their methods in response to the changing needs of their students, which is essential in classrooms with a diverse student body. AI-supported instruction improves individualized instruction and lessens administrative burdens, as noted by Mambu et al. (2023).

Furthermore, these results demonstrate the growing strategic relevance of technology-based support systems, such as artificial intelligence. While continuously tracking students' progress, this system helps teachers create lessons that are appropriate for their ability levels and learning preferences. Additionally, according to Mambu et al. (2023), AI offers learning analytics that support the identification of learning gaps, the development of suitable interventions, and the assessment of the efficacy of deep learning methodology. Based on past student performance, AI systems can also suggest pertinent resources, approaches, and media, allowing for more focused and interesting instruction that prioritizes conceptual knowledge and critical thinking skills.

According to Nugraha and Nurdyansyah (2024), artificial intelligence (AI) is a pedagogical innovation that facilitates the planning, coordination, and assessment of deep learning in educational institutions, in addition to being an administrative tool. With this assistance, teachers can apply deep learning more effectively and quantifiably. Therefore, the creation and use of AI is a key element in the successful application of deep learning, especially in elementary schools.

AI has also been successfully used in elementary schools to improve critical thinking skills and boost students' motivation to learn. Through adaptive feedback and individualized instruction, Nujum and Hadi (2025) discovered that AI-supported problem-based learning significantly enhanced students' critical thinking. Similar findings were reported by Setiawan and Sukmana (2024), who found that AI-integrated classrooms create dynamic and responsive learning environments that help teachers identify learning gaps more successfully. These results support the effectiveness of AI-enhanced learning strategies and are consistent with the experimental group's higher N-Gain scores.

Furthermore, Lowell et al. (2023) verified that AI-based adaptive learning continuously enhances learning outcomes compared to conventional techniques. According to Yulianti et al. (2023), artificial intelligence (AI) has improved teaching and learning in Indonesia by boosting productivity and quality. Sumarni and Muhibbin (2023) demonstrated how incorporating AI into civics lessons in elementary schools improved student engagement and made classrooms more flexible, which helped teachers with lesson planning. These studies demonstrate that artificial intelligence (AI) is a strategic tool that can be used to expand the use of Deep Learning curricula in elementary schools rather than just as a technical tool.

However, this study has several limitations. The study only looked at academic results, ignoring affective or behavioral factors, and was carried out over a brief intervention period with a small sample size. Additionally, long-term retention and post-intervention engagement were not measured. User input on system accessibility, usability, feature functionality, and alignment with user needs should be included in future studies using a mixed-methods design that incorporates both quantitative and qualitative data. Assessing scalability across various subjects, student demographics, and regional contexts is also crucial, particularly in remote and underserved areas. For inclusive and sustainable educational innovation, it is essential to investigate the ethical, practical, and infrastructure issues surrounding the use of AI, such as algorithm bias, data security, and fair access.

CONCLUSION

The results of this study highlight the advantages of incorporating artificial intelligence (AI) into deep learning curricula at the elementary school level. By facilitating individualized, flexible, and responsive teaching methods, AI-supported instruction has the potential to greatly improve student learning outcomes. Teachers can adapt learning experiences to the various needs of their students by using real-time analysis of student performance. The effectiveness of AI-based instructional models was validated using statistical analyses that employed the Wilcoxon test and N-Gain scores to confirm a significant improvement in the experimental group's post-test performance. This study demonstrates that AI is a pedagogical partner that improves educational quality by creating personalized, feedback-driven learning environments rather than being a digital tool.

Furthermore, the application of AI supports more general objectives in education in the twenty-first century, such as the growth of digital competency, creativity, and critical thinking. By encouraging students to interact with relevant content and assisting them in comprehending their learning process, the AI system employed in this study promoted reflective learning. However, high levels of teacher digital literacy, supportive infrastructure, and innovative and sustainable school policies are necessary to fully realize AI's potential in elementary education. AI has the potential to strategically support transformative education in Indonesia, given the correct environment. It has the potential to enhance academic performance and create learners who are prepared for success in a fast-paced, technologically advanced world.

REFERENCES

Agustin, P., & Permatasari, R. I. (2020). Pengaruh Pendidikan dan Kompensasi terhadap Kinerja Divisi New Product Development (NPD) pada PT. Mayora Indah Tbk. *Jurnal Ilmiah M-Progress*, *10*(2), 174–184. https://doi.org/10.35968/m-pu.v10i2.442

Ali, E. Y., & Juanda, N. A. (2025). Pengaruh Rencana Pelaksanaan Pembelajaran terhadap Kualitas Pengajaran dan Hasil Belajar. *Jurnal Pemberdayaan Masyarakat*, *4*(1), 25–33. https://doi.org/10.46843/jmp.v4i1.354

Anandayu, R., & Muslim, A. B. (2021). Pengembangan Kemampuan Berfikir Tingkat Tinggi dalam Pembelajaran Daring Bahasa Inggris. *Jurnal Penelitian Pendidikan*, *21*(3), 110–121. https://doi.org/10.17509/jpp.v21i3.43329

Anas, I., & Zakir, S. (2024). Artificial Intelligence: Solusi Pembelajaran Era Digital 5.0. *Jurnal Sains Komputer & Informatika (J-SAKTI)*, *8*(1), 35–46. http://dx.doi.org/10.30645/j-sakti.v8i1.764

Diantama, S. (2023). Pemanfaatan Artificial Intelegent (AI) dalam Dunia Pendidikan. *DEWANTECH: Jurnal Teknologi Pendidikan*, *1*(1), 8–14. https://doi.org/10.61434/dewantech.v1i1.8

Dinata, R. R., Handayaningrum, W., & Rahayu, E. W. (2024). Peran Transformatif Artificial Intelligence (AI) dalam Membentuk Pendidikan Kreatif Abad 21. *EduTech: Jurnal Teknologi Pendidikan*, *23*(1), 16–25. https://doi.org/10.24114/jtp.v8i2.3329

Fajriati, A., Wisroni, W., & Handrianto, (2024). Pemanfaatan Teknologi Artificial Intelligence (AI) dalam Pembelajaran Berbasis Peserta Didik di Era Digital. *Wahana Pedagogika*, *06*(02), 71–85. https://doi.org/10.52166/wp.v6i2.7890

Fatmawati, Sari, M. N., Setianti, Y., Saleh, K., & Pitra, D. H. (2024). Peran Artificial intelligence (AI) dalam Personalisasi Proses Pembelajaran Mahasiswa di Pendidikan Tinggi. *Journal on Educatio*, *06*(04), 20148–20157. https://doi.org/10.31004/joe.v6i4.6070

Ilmi, A. R. M., & Puspita, E. (2020). Higher Order Thinking Skills in Science Learning. *GENAWUAN: Jurnal Pendidikan Dan Keguruan*, *2*(1), 1–13.

Lowell, H., Astuti, W., & Nasution, F. M. (2023). Pengembangan Media Pembelajaran Berbasis AI untuk Meningkatkan Hasil Belajar Siswa Sekolah Dasar. Jurnal Nasional Komputasi dan Teknologi Informasi (JNKTI), 8(3), 1334-1337. https://doi.org/10.32672/jnkti.v8i3.9107

Lubis, M. S. Y. (2021). Implementasi Artificial Intelligence pada System Manufaktur Terpadu. *Seminar Nasional Teknik (SEMNASTEK) UISU*, *4*(1), 1–7. https://jurnal.uisu.ac.id/index.php/semnastek/article/view/4134

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). *Intelligence Unleashed: An Argument for AI in Education*.

Ma'amor, H., Achim, N., Ahmad, N. L., Roszaman, N. S., Anuar, N. N. K., Azwa, N. C. A.

K., Rahman, S. N. A., & Hamjah, N. A. A. (2024). The Effect of Artificial Intelligence (AI) on Students' Learning. *Information Management and Business Review*, *16*(3), 856–867. https://doi.org/10.22610/imbr.v16i3S(I)a.4178

Mambu, J. G. Z., Pitra, D. H., Ilmi, A. R. M., Nugroho, W., Leuwol, N. V, & Saputra, A. M. A. (2023). Pemanfaatan Teknologi Artificial Intelligence (AI) dalam Menghadapi Tantangan Mengajar Guru di Era Digital. *Journal on Education*, *06*(01), 2689–2698. https://doi.org/10.31004/joe.v6i1.3304

Maola, P. S., Karai Handak, I. S., & Herlambang, Y. T. (2024). Penerapan Artificial Intelligence Dalam Pendidikan Di Era Revolusi Industri 4.0. *Educatio*, *19*(1), 61–72. https://doi.org/10.29408/edc.v19i1.24772

Muhasim. (2017). Pengaruh Tehnologi Digital, Terhadap Motivasi Belajar Peserta Didik. *Palapa: Jurnal Studi Keislaman Dan Ilmu Pendidikan*, *5*(2), 53–77. https://doi.org/10.36088/palapa.v5i2.46

Nabila, S. M., Septiani, M., Fitriani, & Asrin. (2025). Pendekatan Deep Learning untuk Pembelajaran IPA yang Bermakna di Sekolah Dasar. *Primera Educatia Mandalika*, *2*(1), 9–20. https://jiwpp.unram.ac.id/index.php/primera/article/view/269

Naila, I., Atmoko, A., Dewi, R. S. I., & Kusumajanti, W. (2023). Pengaruh Artificial Intelligence Tools terhadap Motivasi Belajar Siswa Ditinjau dari Teori Rogers. *At-Thullab : Jurnal Pendidikan Guru Madrasah Ibtidaiyah*, *7*(2), 150–159. https://doi.org/10.30736/atl.v7i2.1774

Nisa, M., Handoyo, A. W., & Conia, P. D. D. (2022). Pengaruh Bimbingan Kelompok dengan Teknik Problem Solving untuk Meningkatkan Kemandirian Belajar. *Jurnal Bimbingan Dan Konseling Indonesia*, *7*(2), 1–9. https://doi.org/10.23887/jurnal_bk.v7i2.1467

Nugraha, A. P., & Nurdyansyah. (2024). A Utilization of Artificial Intelligence in Basic Education Learning Planning Management. *UMSIDA Preprints Server*, *1*(1), 1–13. https://doi.org/10.21070/ups.5705

Nujum, N. ., & Hadi, M. S. . (2025). Pengaruh Pembelajaran Berbasis Masalah Berbantuan Media AI terhadap Peningkatan Keterampilan Berpikir Kritis Siswa di Sekolah Dasar. JIIP - Jurnal Ilmiah Ilmu Pendidikan, 8(2), 1333-1341. https://doi.org/10.54371/jiip.v8i2.6870

Nurhayati, Suliyem, M., Hanafi, I., & Susanto, T. T. D. (2024). Integrasi AI dalam Collaborative Learning untuk Meningkatkan Efektivitas Pembelajaran. *Academy of Education Journal*, *15*(1), 1063–1071. https://doi.org/10.47200/aoej.v15i1.2372

Otto, S., Körner, F., Marschke, B. A., Merten, M. J., Brandt, S., Sotiriou, S., & Bogner, F. X. (2020). Deeper learning as integrated knowledge and fascination for Science. *International Journal of Science Education*, *42*(5), 1–28. https://doi.org/10.1080/09500693.2020.1730476

Pratiwi, R. T. L., & Yunus, M. (2025). Manfaat dan Tantangan Penggunaan Artificial Intelligence (AI) Bagi Guru dan Peserta Didik di Era Society 5.0. *Journal of Innovation and Teacher Professionalism*, *3*(2), 488–494. https://doi.org/10.17977/um084v3i22025p488-494

Rahardhian, A. (2022). Kajian Kemampuan Berpikir Kritis (Critical Thinking Skill)

Dari Sudut Pandang Filsafat. *Jurnal Filsafat Indonesia*, *5*(2), 87–94. https://doi.org/10.23887/jfi.v5i2.42092

Richter, O. Z., Marin, V. I., Bond, M., & Gouverneur, F. (2019). Systematic Review of Research on Artificial Intelligence Applications in Higher Education – Where are the Educators? *International Journal of Educational Technology in Higher Education*, *16*(39), 1–27. https://doi.org/10.1186/s41239-019-0171-0

Saraswati, P. M. S., & Agustika, G. N. S. (2020). Kemampuan Berpikir Tingkat Tinggi dalam Menyelesaikan Soal HOTS Mata Pelajaran Matematika. *Jurnal Ilmiah Sekolah Dasar*, *4*(2), 257–269. https://ejournal.undiksha.ac.id/index.php/JISD/article/view/25336/15392

Setiawan, R., & Sukmana, N. Kebijakan Penggunaan Teknologi Artificial Intelligence (AI) dalam Pembelajaran di Sekolah Dasar. Kalam Cendekia: Jurnal Ilmiah Kependidikan, 13(2). https://doi.org/10.20961/jkc.v13i2.102104

Siringoringo, R. G., & Alfaridzi, M. Y. (2024). Pengaruh Integrasi Teknologi Pembelajaran terhadap Efektivitas dan Transformasi Paradigma Pendidikan Era Digital. *Jurnal Yudistira: Publikasi Riset Ilmu Pendidikan dan Bahasa*, *2*(3), 66–76. https://doi.org/10.61132/yudistira.v2i3.854

Sukarelawan, M. I., Indratno, T. K., & Ayu, S. M. (2024). *N-Gain vs Stacking: Analisis Perubahan Abilitas Peserta Didik dalam Desain One Group Pretes-Post-test*.

Sulaiman, A. Y., & Darwis, H. (2019). Perubahan Tingkat Likuiditas Saham dan Abnormal Return yang Dipengaruhi Oleh Peristiwa Pemecahan Saham. *Jurnal Akuntansi*, *8*(2), 135–145. https://doi.org/10.37932/ja.v8i2.73

Sumarni, Y., & Muhibbin, A. (2024). Mengintegrasikan Teknologi Ai Untuk Pembelajaran Pkn Yang Interaktif Di Sekolah Dasar. Pendas: Jurnal Ilmiah Pendidikan Dasar, 9(4), 223-239. https://doi.org/10.23969/jp.v9i4.20728

Syuhada, S. A., Siregar, D., Jumardi, A., Darmawati, Nabbil, S., Al Ayubi, Z. S., Prasetyo, D., Tauri, D. S., Samsudin, Firdaus, B., & Albaras, M. R. (2024). Dampak AI pada Proses Belajar Mengajar di Era Digital. *APPA: Jurnal Pengabdian Kepada Masyarakat*, *2*(1), 20–24.

Usmadi. (2020). Pengujian Persyaratan Analisis (Uji Homogenitas dan Uji Normalitas). *Inovasi Pendidikan*, *7*(1), 50–62. https://doi.org/10.31869/ip.v7i1.2281

Yulianti, G., Bernardi, B., Permana, N. ., & Wijayanti, F. A. K. W. (2023). Transformasi Pendidikan Indonesia: Menerapkan Potensi Kecerdasan Buatan (AI). Journal of Information Systems and Management (JISMA), 2(6), 102–106. https://doi.org/10.4444/jisma.v2i6.1076