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The Effect of AI-Based Digital Teaching Materials on the Motivation and Learning Outcomes of High School Students

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Abstract: This research was designed not only to measure the direct impact of Artificial Intelligence (AI)-based digital teaching materials on motivation and learning outcomes but also to identify the factors influencing the effectiveness of their implementation in the context of a high school in an island area. The objectives of this study are: (1) To determine the significant effect of using Artificial Intelligence (AI)-based digital teaching materials on the learning motivation of Class XII students at SMAN 1 Kepulauan Selayar. And (2) To determine the significant effect of using Artificial Intelligence (AI)-based digital teaching materials on the learning outcomes of Class XII students at SMAN 1 Kepulauan Selayar. This study uses a quantitative approach through an experimental design to test the hypothesis regarding the significant effect of using Artificial Intelligence (AI)-based digital teaching materials on student motivation and learning outcomes in Economics. A sample of 30 Class XII students will be randomly selected. Data collection techniques include Questionnaires, Tests, observation, and documentation. The results of this study indicate (1) A significant and positive effect of the use of Artificial Intelligence (AI)-based digital teaching materials on the learning motivation of Class XII students at SMAN 1 Kepulauan Selayar. (2) The use of Artificial Intelligence (AI)-based digital teaching materials (X) significantly influences Economics learning outcomes (Y2).

Keywords: Artificial Intelligence (AI); Digital Teaching Materials; High School Students; Learning Motivation; Learning Outcomes.

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1. Introduction

The rapid advancement of information and communication technology has fundamentally transformed educational systems worldwide, compelling schools and universities to continuously adapt to the evolving demands of the digital era. Digital transformation in education is no longer optional but has become a strategic necessity to ensure learning relevance, flexibility, and competitiveness (Jusmawati et al., 2024)fah. Through digitalization, learning processes are no longer confined by time and space, enabling broader access to educational resources and fostering more inclusive and efficient learning environments. Global educational discourse increasingly emphasizes that technology integration is essential for preparing future generations to thrive in knowledge-based and technology-driven societies. In this context, technology serves not merely as a supplementary tool, but as a central component of contemporary pedagogical innovation (Hamzah et al., 2024; Maulana et al., 2025; Yusuf, 2023).

In Indonesia, the acceleration of educational digitalization has been actively supported through national policies and large-scale initiatives, including the provision of online learning platforms, digital content development, and continuous professional training for teachers (Malviya, 2025). The Merdeka Belajar policy further reinforces this transformation by grant-

ing schools and educators greater autonomy to design innovative, adaptive, and context-sensitive learning experiences (Suarlin et al., 2025). Technology plays a pivotal role in actualizing this vision, enabling student-centered learning and enhancing educational quality across diverse regions. Miao & Holmes (2021) emphasizes that the integration of technology in education is inevitable and constitutes an urgent requirement to equip learners with competencies necessary for the digital future. Despite these efforts, the effectiveness of digital integration remains uneven, particularly across geographically challenged regions such as island and remote areas.

Digital teaching materials offer significant pedagogical advantages compared to conventional instructional resources. Their interactive nature—incorporating videos, animations, simulations, and interactive quizzes—allows students to actively engage with learning content, thereby fostering deeper conceptual understanding and sustained attention. These characteristics align with learner-centered pedagogical principles, where students are positioned as active participants rather than passive recipients of information. Digital materials also provide flexibility in access and ease of content updates, ensuring that learning resources remain relevant and responsive to curriculum developments. Empirical evidence supports these advantages; Mayer (2020) demonstrates that multimedia-based learning can enhance information retention by up to 40% compared to traditional instructional methods due to multisensory engagement.

More recently, artificial intelligence (AI) has emerged as a transformative force in the development of digital learning materials. AI enables personalized and adaptive learning by analyzing student data to tailor content, pacing, and feedback to individual needs. It also enhances engagement through features such as gamification, intelligent feedback systems, and realistic simulations. From a theoretical perspective, constructivist learning theory underscores the importance of active student involvement in knowledge construction, a principle that is strongly supported by well-designed AI-based digital materials. Furthermore, Skinner (2019) highlights that educational technologies incorporating gamification elements can significantly enhance students' intrinsic motivation by providing clear reward systems and enjoyable learning experiences. However, the pedagogical effectiveness of AI-based materials depends heavily on instructional design quality, user interface usability, interactivity levels, and alignment with learner characteristics, as articulated by Clark & Mayer (2016)

Despite growing evidence of the effectiveness of digital learning materials in improving academic outcomes, empirical research focusing on student motivation—particularly at the senior high school level—remains limited, especially in geographically isolated contexts. This gap is evident in island regions such as the Kepulauan Selayar, where logistical constraints hinder the distribution of conventional teaching materials. Preliminary observations at SMAN 1 Kepulauan Selayar reveal that approximately 25% of Grade XII students experienced a decline in learning motivation during the even semester, accompanied by a downward trend in average academic performance. Data from the past three semesters indicate relatively low utilization of digital teaching materials alongside stagnant motivation levels and modest learning outcomes. Although the school possesses adequate infrastructure, including computer laboratories and stable internet access, the pedagogical use of digital resources remains suboptimal, often limited to static PDF documents uploaded to learning platforms.

Further challenges emerge from disparities in students' digital competencies and limited teacher training in developing interactive and AI-based instructional materials. While students demonstrate high interest in AI-based digital learning resources, many lack sufficient understanding of how to effectively use AI tools for academic purposes. Technical limitations, unfamiliarity with technology-centered learning approaches, and insufficient pedagogical guidance contribute to a significant skills gap. These issues underscore the need for structured support systems that empower both teachers and students to utilize AI meaningfully in learning contexts. Pilot study data indicate that after two months of implementing AI-based digital teaching materials, student attendance increased from 90% to 97%, while participation in classroom discussions rose from 45% to 72%, suggesting a positive association between AI-based learning and student motivation.

Given these conditions, there is a clear empirical gap concerning the impact of AI-based digital teaching materials on both learning motivation and academic achievement among senior high school students in island regions. Existing studies have largely focused on learning outcomes without sufficiently examining motivational dimensions, despite motivation being a critical determinant of academic success. Moreover, limited attention has been given to

contextual factors influencing AI implementation in geographically dispersed areas. Addressing this gap is crucial not only for improving instructional practices at SMAN 1 Kepulauan Selayar but also for informing broader educational strategies in similar contexts. Therefore, this study aims to examine the effect of AI-based digital teaching materials on students' learning motivation and learning outcomes in Economics among Grade XII students at SMAN 1 Kepulauan Selayar. By empirically investigating these relationships, the study seeks to contribute both theoretically to the discourse on technology-enhanced learning and practically to the optimization of digital education in island and remote regions.

2. Literature review

2.1. Digital Teaching Materials

Within the framework of teacher professionalism, the development of instructional materials cannot be separated from the competencies expected of educators—namely pedagogical, personal, social, and professional competencies—as mandated by regulation and reaffirmed in the scholarship of Aisyah et al (2020). Instructional materials, therefore, should not be understood merely as "content" to be delivered, but rather as pedagogical instruments designed systematically to ensure the attainment of competencies and sub-competencies in their full complexity (Cahyadi, 2019). This view aligns with the argument that instructional materials constitute an essential element of the learning environment that students must study, observe, and understand in order to build mastery of knowledge (Hernawan et al., 2008). Accordingly, instructional materials function as a bridge connecting curriculum demands, students' evolving learning needs, and the rapid development of information technology, while simultaneously shaping the quality of students' learning experiences.

Functionally, instructional materials guide teachers' pedagogical actions and serve as a reference point for learning evaluation; thus, their role extends beyond administrative completeness and becomes a strategic instrument for efficient learning (Jogiyanto, 2014). From the learners' perspective, instructional materials support comprehensive understanding of carefully organized content, thereby strengthening competency attainment (Setiawaty & Wahyudi, 2018). Their benefits are further supported by the broad scope of instructional materials as written and non-written learning resources that assist both educators and students (Mulyati, 2022). When developed in alignment with students' needs and curriculum criteria, instructional materials can reduce boredom, facilitate learning processes, and enhance the attractiveness of classroom instruction (Setiawan, 2009). Critically, the effectiveness of learning is influenced not simply by whether instructional materials exist, but by how well they are designed to promote engagement, comprehension, and meaningful assessment.

Digital instructional materials reflect a shift from print-based media to electronic formats that utilize digital devices such as computers and smartphones without necessarily changing the core structure of content (Kosasih, 2021; Sriwahyuni, 2019). In a broader sense, digital instructional materials operate within the e-learning ecosystem, commonly defined as technology-supported learning that employs various tools and networks, including computer-assisted instruction and online learning (Rusman, 2016). Empirical evidence indicates that digital-based instructional materials can enhance students' learning capacities (Maskur & Safitri, 2021), while also offering high accessibility, contextual relevance, and environmental benefits through reduced reliance on paper. Nevertheless, the literature also notes limitations—such as narrow content coverage in certain contexts—highlighting that "digital" does not automatically mean "comprehensive."

Pedagogically, improving learning quality through digital instructional materials requires strengthening educators' capacities to create engaging and effective learning environments (Wijaya & al., 2021). This reinforces the argument that digital instructional materials are not merely technological artifacts, but components of instructional strategy that require intentional design, integration, and facilitation by teachers. Their significance has grown in contemporary learning contexts because technology supports the production of materials that combine text, graphics, audio, animation, and video in appealing and easily accessible electronic formats (Asrial et al., 2020; Mella & al., 2022). At the level of learning resources, digital instructional materials are also intertwined with a broader ecosystem of digital resources—such as e-books and e-journals (Saefullah, 2017), online learning platforms including Moodle, Google Classroom, or Canvas (Achmad & Sari, 2022), podcasts as alternative learning media (Sukmawati et al., 2022), and educational games that promote problem solving and learner

engagement (Yusrillia & Wathon, 2018). Consequently, evaluating digital instructional materials should consider not only their format, but also how they foster learning interaction and the quality of students' cognitive experiences.

In the context of utilizing digital instructional materials for Economics learning, a comprehensive approach is essential: beginning with selecting relevant, high-quality resources aligned with curriculum demands (Ghozali et al., 2024), reinforcing teachers' roles as facilitators (Napitupulu, 2019), and developing students' digital literacy so they can search for and critically evaluate information effectively (Zebua, 2023). Effective utilization also requires ongoing evaluation to ensure that technology integration remains relevant and produces measurable learning impact (Farid, 2023).

2.2. The Role of Artificial Intelligence (AI) in Learning and Teaching Material Development

Artificial intelligence (AI) is commonly understood as the simulation of human intelligence in machines designed to think and learn; in education, it extends beyond a supportive tool to become an innovation driver for learning experiences (Roll et al., 2018). The scope of educational AI includes machine learning, natural language processing, and neural networks, which enable adaptive systems to respond to individual learner needs and provide real-time feedback (Baker & Inventado, 2014). The growth of AI-driven platforms has shifted learning from static formats toward more dynamic, interactive, and data-informed environments (Holmes & al., 2019), and evidence suggests that AI-based approaches can significantly improve learning outcomes (Luckin & al., 2016). Personalization is a central proposition, as AI analyzes learning patterns, identifies strengths and weaknesses, and recommends tailored learning materials (Chen & al., 2020). In assessment contexts, automated essay scoring improves the objectivity and efficiency of evaluation processes (Shermis & Burstein, 2016).

AI expands teachers' capacity to develop instructional materials through automated content generation and learning analytics. AI-assisted content production enables teachers to generate text and visuals more efficiently, potentially reducing workload and enriching instructional variety (Molenaar, 2022). Practice in certain contexts indicates that AI can support the creation of interactive modules for project-based learning (OECD, 2021) and increase engagement and deeper learning (Kearney & al., 2020). Barriers to AI adoption in education include technical and infrastructural constraints, ethical and data privacy concerns, and teacher readiness. Inequitable access to internet connectivity and devices remains a major obstacle, making cross-sector collaboration essential to strengthening digital infrastructure (Selwyn, 2019). At the same time, AI introduces risks of algorithmic bias and data misuse, necessitating robust governance and regulatory frameworks. Limited teacher training further weakens classroom-level utilization; thus, national initiatives that promote instructional transformation may serve as pathways for improving teachers' digital literacy. Overall, the literature indicates that AI challenges are not merely technical but also institutional, involving how schools design policy, train teachers, and ensure ethical, pedagogically grounded AI use.

2.3. Learning Motivation

Learning motivation is a psychological variable that shapes the intensity, direction, and persistence of students' learning behaviors (Sardiman, 2018). Within Self-Determination Theory, motivation is conceptualized along a continuum of intrinsic and extrinsic motivation, where intrinsic motivation tends to foster perseverance, creativity, and deeper understanding because learning is driven by curiosity and personal satisfaction (Deci & Ryan, 2013). Motivation is also closely related to self-regulated learning; motivated learners are more capable of setting goals, selecting appropriate learning strategies, and independently monitoring their learning progress (Zimmerman, 2017). In classroom settings, motivation does not operate in isolation but is influenced by contextual factors such as the quality of the learning environment, social relationships, clarity of short-term goals, positive feedback, and active student engagement (Schunk & al., 2021). Teachers play a critical role in nurturing motivation by cultivating a positive learning climate and recognizing individual learner characteristics (Nugroho & Riyadi, 2019). This framework is highly relevant for examining how instructional innovations—particularly digital and AI-enabled materials—may function as motivational stimuli through interactivity, immediate feedback, and more personalized learning experiences.

2.4. Learning Outcomes

Learning outcomes represent educational results across cognitive, affective, and psychomotor domains and have traditionally been framed within the taxonomy of learning. In educational literature, learning outcomes are commonly understood as changes in learners' capacities and behaviors after instruction, encompassing knowledge, skills, and attitudes (Karim, 2021; Sudjana, 2016; Susanto, 2016). The concept of learning outcomes also emphasizes the competencies and skills students possess after a specific learning period (Molstad & Karseth, 2016), while definitions of learning as a process of change through experience and interaction underscore the importance of instructional quality. The achievement of learning outcomes is strongly influenced by teacher–student interaction and teacher professionalism (Purwanto, 2016), as well as complex internal and external factors ranging from maturity, intelligence, and motivation to family environment and learning facilities.

From an assessment standpoint, comprehensive evaluation—both formative and summative—is necessary so that learning outcomes are not reduced to numerical scores but instead provide diagnostic information for instructional improvement (Arifin, 2020). In Indonesia, exam-oriented assessment systems have been criticized for potentially undermining creativity and student motivation (Prasetyo, 2021), although more integrative curriculum policies have shown potential to improve outcomes in certain subject areas (Lestari & Ramdhani, 2021). Strategies to enhance learning outcomes also emphasize active learning and the integration of technology, both of which are empirically associated with stronger achievement than passive learning approaches. Specifically, AI-based digital instructional materials have been shown to improve both motivation and learning outcomes, particularly for subjects requiring complex conceptual understanding.

2.5. Hypotheses

H_1: There is a statistically significant effect of AI-based digital instructional materials on the learning motivation of Grade XII students at SMAN 1 Kepulauan Selayar.

H_2: There is a statistically significant effect of AI-based digital instructional materials on the learning outcomes of Grade XII students at SMAN 1 Kepulauan Selayar.

3. Proposed Method

This study employed a quantitative experimental design to examine the effects of AI-based digital instructional materials on students' learning motivation and Economics learning outcomes. The research was conducted at SMAN 1 Kepulauan Selayar, South Sulawesi, Indonesia, over a two-month period from October to November 2025, with data collected after one month of instructional intervention. The population consisted of all Grade XII students (approximately 320 students), from which 30 Economics-track students were selected using simple random sampling. Data were collected through a four-point Likert-scale questionnaire measuring learning motivation, an achievement test assessing Economics learning outcomes aligned with the instructional content, and classroom observation to document student interaction and participation. Descriptive statistics (mean and standard deviation) were used to summarize the data, followed by inferential analysis using a t-test to compare learning motivation and achievement before and after the implementation of AI-based instructional materials, with analyses conducted using SPSS or R. Instrument validity was assessed through item–total correlation by comparing r_calculated with r_table at a 5% significance level, while reliability was evaluated using Cronbach's alpha, with coefficients exceeding 0.60 indicating acceptable internal consistency. Classical assumption tests, including normality (P–P plot), multicollinearity (tolerance and VIF), and heteroscedasticity (scatterplot), were conducted prior to hypothesis testing to ensure the robustness of the statistical analysis.

4. Results and Discussion

4.1. Results

4.1.1. Normality Test

Based on the results of the One-Sample Kolmogorov–Smirnov test for the regression of X on Y1, the Asymp. Sig. (2-tailed) value was 0.161. Because the significance value exceeded 0.05, the regression model satisfied the normality assumption. This result was further supported by the Normal P–P Plot of Regression Standardized Residuals (see Appendix), which showed that the data points were distributed closely around the diagonal line, indicating a normal distribution of residuals.

4.1.2. Heteroscedasticity Test

Based on the scatterplot of the regression of X on Y1 (see Appendix), the data points were randomly dispersed above and below zero on the Y-axis and did not form a specific pattern. This finding indicates that the regression model did not exhibit heteroscedasticity, confirming that the variance of the residuals was constant across observations.

4.1.3. Hypothesis Testing (Simple Regression Analysis)

Effect of AI-Based Digital Instructional Materials (X) on Learning Motivation (Y1)

Table 1. t-Test Results for the Effect of AI-Based Digital Instructional Materials (X) on Learning Motivation **(Y1)**

Model	R-Square (R^2)	F	Sig. (p)	Regression Coefficient (B)	t-value
1	0.887	219.016	0.00017	1.152	14.799

Source: Processed data, 2025.

Table 1. shows that the significance value (Sig.) was 0.00017, which is less than 0.05. This result indicates that the alternative hypothesis (H_1) is accepted, meaning that the use of AI-based digital instructional materials has a statistically significant effect on the learning motivation of Grade XII students at SMAN 1 Kepulauan Selayar. The R^2 value of 0.887 indicates that 88.7% of the variance in learning motivation (Y1) is explained by the use of AI-based digital instructional materials (X). This finding suggests that 88.7% of the increase or decrease in students' learning motivation can be attributed to the effectiveness of AI-based instructional materials, while the remaining 11.3% is explained by other factors not examined in this study. Narratively, this result demonstrates that AI constitutes a dominant factor in stimulating students' learning enthusiasm. The resulting regression equation is:

$$\mathbf{Y1 = 14.908 + 1.152X}$$

The positive regression coefficient (B = 1.152) indicates a positive relationship between the variables. This equation illustrates both the direction and magnitude of the effect of AI-based digital instructional materials on students' learning motivation. The constant (α) value of 14.908 implies that when the use of AI-based instructional materials (X) is zero or absent, the predicted average learning motivation score (Y1) remains at 14.908. Practically, this reflects a baseline level of motivation that students possess prior to AI-based instructional intervention. The regression coefficient (b) of 1.152 indicates that for every one-unit increase in the use of AI-based instructional materials, learning motivation is predicted to increase by 1.152 points. Based on the t-test results, this coefficient is statistically significant ($p < 0.05$), indicating that the observed effect is real and not due to random chance.

Effect of AI-Based Digital Instructional Materials (X) on Economics Learning Outcomes (Y2)

Table 2. t-Test Results for the Effect of AI-Based Digital Instructional Materials (X) on Economics Learning Outcomes (Y2)

Model	R-Square (R^2)	F	Sig. (p)	Regression Coefficient (B)	t-value
1	0.856	166.826	0.00023	0.865	12.916

Source: Processed data, 2025.

Table 4.7 indicates that the significance value (Sig.) was 0.00023, which is less than 0.05. This result confirms that the alternative hypothesis (H_1) is accepted, meaning that the use of AI-based digital instructional materials has a statistically significant effect on students' Economics learning outcomes. The R^2 value of 0.856 shows that 85.6% of the variance in Economics learning outcomes (Y2) is explained by the use of AI-based digital instructional materials (X). This relationship is highly linear and consistent, indicating that the precise use of AI technology in presenting Economics content—such as accounting cycles or fiscal policy—effectively minimizes students' learning barriers. This explains why the class average score reached 86.63, as AI functioned as a cognitive tool that optimized students' understanding of complex economic concepts. The resulting regression equation is:

$$\mathbf{Y2 = 28.581 + 0.865X}$$

The positive regression coefficient (B = 0.865) indicates a positive relationship between AI-based instructional materials and Economics learning outcomes. The constant (α) value of 28.581 suggests that when the use of AI-based digital instructional materials (X) is assumed to be zero, the predicted average Economics learning outcome score (Y2) is 28.581. This reflects students' baseline Economics knowledge without AI-supported instructional assistance. The regression coefficient (b) of 0.865 indicates that each one-unit increase in the use of AI-based instructional materials is predicted to increase Economics learning outcomes by 0.865 points. Based on the ANOVA results, the significance value was 0.000 ($p < 0.05$), indicating that the effect of AI on learning outcomes is statistically significant and results from a systematic and effective learning process rather than random variation.

4.2. Discussion

4.2.1. The Effect of AI-Based Digital Instructional Materials on Learning Motivation

The findings of this study demonstrate that the use of AI-based digital instructional materials has a positive and significant effect on the learning motivation of Grade XII students at SMAN 1 Kepulauan Selayar, as indicated by a very high coefficient of determination (R^2 = 0.887). This result suggests that the substantial increase in students' learning motivation is largely attributable to the effectiveness of AI-based instructional materials. Behavioral observations further corroborate the statistical findings, revealing higher levels of learning focus, persistence in task completion, and consistent use of instant feedback during the learning process. These behavioral indicators confirm that AI integration not only enhances students' perceived motivation but also translates into observable changes in learning behavior.

These findings are consistent with the study by Hussain et al (2025) entitled The Impact of AI-Based Learning Tools on Student Motivation and Academic Self-Concept, which reported a strong positive correlation between the use of AI-based learning tools and student motivation. Their study emphasized that AI tools significantly enhance student motivation, particularly when supported by appropriate teacher guidance and encouragement. This alignment underscores that, while AI plays a critical role in stimulating motivation, the pedagogical function of teachers as facilitators remains essential to ensure that AI is meaningfully integrated into instructional practice rather than used merely as a technological supplement.

From a theoretical perspective, the observed increase in learning motivation can be explained through the framework of Self-Determination Theory (SDT). AI-based instructional materials effectively support students' basic psychological needs for competence and autonomy by providing immediate, adaptive feedback and allowing flexible control over learning pace and sequence. These features enhance students' self-efficacy and sense of ownership over their learning process, which are key drivers of intrinsic motivation. Consequently, the implementation of AI-based digital instructional materials proves to be an effective strategy for addressing the decline in learning motivation commonly observed among Grade XII students nearing the completion of their secondary education.

4.2.2.The Effect of AI-Based Digital Instructional Materials on Economics Learning Outcomes

The results further indicate that the use of AI-based digital instructional materials has a positive and very strong effect on students' Economics learning outcomes, as reflected by an R^2 value of 0.856. This finding implies that AI-based instructional materials constitute a dominant factor in explaining improvements in students' academic achievement in Economics. Classroom observations revealed that students actively engaged with AI-supported features such as adaptive exercises, simulations, and instant feedback, which facilitated deeper understanding of abstract and analytical economic concepts.

These findings align with the work of Suntharalingam (2024) in Enhancing Digital Learning Outcomes Through the Application of Artificial Intelligence: A Comprehensive Review, which highlights that AI-driven interventions—such as intelligent tutoring systems and adaptive learning platforms—positively influence learning outcomes by increasing student engagement and satisfaction. Although that review did not specifically address Economics learning outcomes, the present study extends the empirical evidence by demonstrating that the effectiveness of AI-based instructional materials also applies to Economics education, particularly when digital content is systematically designed and adaptively delivered.

From a cognitive learning perspective, the improvement in Economics learning outcomes can be explained through Cognitive Load Theory and Multimedia Learning Principles. AI-based instructional materials manage students' cognitive load by segmenting complex economic content into manageable units and presenting it through integrated textual, visual, and interactive representations. Moreover, the significant increase in learning motivation induced by AI use likely functions as a mediating factor that enhances students' persistence, engagement, and time-on-task, ultimately leading to higher cognitive achievement. Therefore, the implementation of AI-based digital instructional materials not only strengthens students' motivation but also substantially improves their academic performance in Economics, particularly within the context of upper secondary education in geographically remote regions.

6. Conclusions

This study concludes that the use of AI-based digital instructional materials has a significant and positive effect on both learning motivation and Economics learning outcomes among Grade XII students at SMAN 1 Kepulauan Selayar. The findings demonstrate that AI functions as a dominant factor in explaining substantial improvements in students' affective and cognitive learning outcomes. By providing interactive, adaptive, and responsive learning environments, AI-based instructional materials effectively address students' psychological needs for autonomy and competence, thereby overcoming the decline in learning motivation identified at the outset of the study. Overall, the results confirm that AI integration in classroom instruction represents a transformative pedagogical solution, particularly relevant for upper secondary education in geographically remote and island-based contexts.

From a theoretical perspective, this study reinforces technology-enhanced learning frameworks that emphasize the role of AI in supporting motivation and cognitive achievement through adaptive feedback and effective cognitive load management. The findings contribute to the development of digital learning models by empirically demonstrating that AI can function as an adaptive tutor bridging motivational processes and academic performance. From a managerial and practical standpoint, the results suggest important implications for schools and educational policymakers, including the need for systematic integration of AI-based instructional materials across subjects, continuous professional development for teachers in AI-supported pedagogy, and strengthened digital infrastructure to ensure equitable access and flexible, self-directed learning opportunities for all students.

Despite its contributions, this study has several limitations, including a relatively small sample size, the absence of a control group in the experimental design, and a primary focus on cognitive learning outcomes. In addition, the mediating role of learning motivation between AI use and academic achievement was not explicitly tested. Future research is therefore encouraged to employ more robust experimental designs with control groups, examine mediation and moderation models, and integrate qualitative approaches to explore students' experiences and contextual factors underlying the effectiveness of AI. Longitudinal studies are also recommended to assess the sustainability of AI's impact over time and to extend outcome measures to affective and psychomotor domains for a more holistic understanding of student learning.

References

Achmad, M., & Sari, D. (2022). Platform Pembelajaran Online dalam Meningkatkan Kualitas Pendidikan. *Jurnal Teknologi Pendidikan*, *15*(2), 45–60.

Aisyah, N., Sari, R. A., & Rahman, A. (2020). Kompetensi Guru dalam Penyusunan Rencana Pelajaran. *Jurnal Pendidikan Dan Pembelajaran*, *7*(1), 1–10.

Arifin, Z. (2020). Evaluasi Pembelajaran: Teori dan Praktik. *Jurnal Pendidikan*, *12*(3), 123–135.

Asrial, A., Rahman, A., & Sari, D. (2020). Peran Bahan Ajar Digital dalam Proses Belajar Mengajar di Era Digital. *Jurnal Pendidikan Dan Teknologi*, *11*(1), 75–84.

Baker, R. S., & Inventado, P. S. (2014). Educational Data Mining and Learning Analytics. In *Learning, Design, and Technology* (pp. 1–24). Springer.

Cahyadi, A. (2019). Pengertian Bahan Ajar dalam Proses Pembelajaran. *Jurnal Pendidikan Dasar*, *8*(2), 45–55.

Chen, L., & al., et. (2020). The Impact of Artificial Intelligence on Education: A Review. *Journal of Educational Technology & Society*, *23*(1), 1–12.

Clark, R. C., & Mayer, R. E. (2016). *E-Learning and the Science of Instruction*. Wiley.

Deci, E. L., & Ryan, R. M. (2013). *Intrinsic Motivation and Self-Determination in Human Behavior*. Springer Science & Business Media.

Farid, M. (2023). Evaluasi Pemanfaatan Bahan Ajar Digital dalam Pembelajaran. *Jurnal Pendidikan Dan Teknologi*, *10*(1), 30–40.

Ghozali, M., Santoso, H., & Wulandari, D. (2024). Pemanfaatan Bahan Ajar Digital dalam Pembelajaran Ekonomi: Pendekatan Komprehensif dari Perencanaan hingga Evaluasi. *Jurnal Pendidikan Ekonomi*, *12*(1), 23–37.

Hamzah, F., Abdullah, A. H., & Ma, W. (2024). Advancing Education through Technology Integration, Innovative Pedagogies and Emerging Trends: A Systematic Literature Review. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *41*(1), 44–63. https://doi.org/10.37934/araset.41.1.4463

Hernawan, H., Supriyadi, S., & Sari, D. (2008). Pengembangan Materi Ajar dalam Pembelajaran. *Jurnal Pendidikan Dan Pembelajaran*, *15*(2), 123–135.

Holmes, W., & al., et. (2019). Ethics of AI in Education. *International Journal of Artificial Intelligence in Education*, *29*(1), 1–10.

Hussain, S., Zia, M., Zaki, N., & Iqbal, M. W. (2025). The Impact of AI-Based Learning Tools on Student Motivation and Academic Self-Concept. *The Critical Review of Social Sciences Studies*, *3*(3), 1570–1584. https://doi.org/10.59075/vkgapf12

Jogiyanto. (2014). *Pengembangan Bahan Ajar: Teori dan Praktik*. Andi Offset.

Jusmawati, J., Baharuddin, I., Mahdi, M., & W, M. F. (2024). Pengembangan Pendidikan Karakter dan Profil Pelajar Pancasila Berwawasan Kearifan Lokal. *Jurnal Education and Development Institut Pendidikan Tapanuli Selatan*, *12*(1), 1–7. https://journal.ipts.ac.id/index.php/ED/article/view/5127%0Ahttps://journal.ipts.ac.id/index.php/ED/article/view/5127/3111

Karim, R. (2021). The Effect of Work Motivation and Leadership Styles on Employee Perfor mance (Case Study at the Class III Port Administration Unit Office - S erui, Yapen Regency, Papua). *Budapest International Research and Critics Institute (BIRCI-Journal) : Humanities and Social Sciences*, *4*(2), 2854–2868. https://doi.org/10.33258/birci.v4i2.1995

Kearney, M., & al., et. (2020). The Role of Artificial Intelligence in Education: Current Trends and Future Directions. *Educational Technology Research and Development*.

Kosasih, E. (2021). *Bahan Ajar Digital: Konsep dan Implementasi dalam Pembelajaran*. Rajawali Pers.

Lestari, A., & Ramdhani, M. A. (2021). *Integrasi Sains dan Sosial dalam Kurikulum Sekolah Dasar*. Deepublish.

Luckin, R., & al., et. (2016). *Intelligence Unleashed: An Argument for AI in Education*. Pearson Education.

Malviya, S. B. (2025). *Unlocking the Future Classroom: Exploring the Landscape of Digital Education in India*. *1*(3), 1–14. https://doi.org/10.63539/isrn.2025018

Maskur, M., & Safitri, R. (2021). Pengaruh Penggunaan Bahan Ajar Berbasis Digital terhadap Kemampuan Belajar Siswa. *Jurnal Pendidikan Dan Teknologi*, *12*(2), 145–156.

Maulana, I., Sofyan, A., & Lughowi, R. A. (2025). Integrasi Teknologi dalam Pengembangan Kurikulum. *Religion, Education, and Social Laa Roiba Journal (RESLAJ)*, *7*(9). https://doi.org/10.47467/reslaj.v7i9.8751

Mayer, R. E. (2020). *Multimedia learning* . *Cambridge University*.

Mella, R., & al., et. (2022). Digital Learning Resources and Student Engagement. *Jurnal Pendidikan Dan Teknologi*, *10*(2), 50–60.

Miao, F., & Holmes, W. (2021). *International Forum on AI and the Futures of Education, developing competencies for the AI Era, 7-8 December 2020: synthesis report*.

Molenaar, I. (2022). The impact of AI tools on educational material creation. *Journal of Educational Technology*, *15*(3), 45–58.

Molstad, K., & Karseth, B. (2016). Learning outcomes in higher education: A critical review. *Journal of Education and Work*, *29*(1), 101–115.

Mulyati, E. (2022). Pengembangan Bahan Ajar untuk Meningkatkan Kualitas Pembelajaran. *Jurnal Pendidikan Dan Pembelajaran*, *10*(1), 45–56.

Napitupulu, F. (2019). Pengaruh harga dan kualitas produk terhadap kepuasan pelanggan pada pt. ramayana lestari Sentosa. *Kinerja*, *16*(1), 1–9.

Nugroho, A., & Riyadi, S. (2019). Pengaruh Iklim Belajar terhadap Motivasi Siswa. *Jurnal Pendidikan Dan Pembelajaran*, *9*(2), 30–40.

OECD. (2021). *The Future of Education and Skills: Education 2030*. OECD Publishing.

Prasetyo, E. (2021). Ujian Nasional dan Kreativitas Siswa. *Jurnal Pendidikan Dan Pembelajaran*, *12*(1), 20–30.

Purwanto. (2016). *Evaluasi Pembelajaran*. Pustaka Pelajar.

Roll, I., Russell, D. M., & Gašević, D. (2018). Learning at Scale. *International Journal of Artificial Intelligence in Education*, *28*(4), 471–477.

https://doi.org/10.1007/S40593-018-0170-7

Rusman. (2016). *Model-Model Pembelajaran: Mengembangkan Profesionalisme Guru*. Rajawali Pers.

Saefullah, M. (2017). *E-Book: Inovasi dalam Pembelajaran Modern*. Pustaka Pelajar.

Sardiman, A. M. (2018). *Interaksi dan Motivasi Belajar Mengajar*. Rajawali Pers.

Schunk, D. H., & al., et. (2021). *Learning Theories: An Educational Perspective*. Pearson.

Selwyn, N. (2019). *Should Robots Replace Teachers? AI and the Future of Education*. Polity Press.

Setiawan, A. (2009). Inovasi dalam Pengembangan Bahan Ajar. *Jurnal Pendidikan*, *8*(2), 123–130.

Setiawaty, E., & Wahyudi, S. (2018). Fungsi dan Manfaat Bahan Ajar dalam Pembelajaran. *Jurnal Pendidikan Dasar*, *7*(1), 15–25.

Shermis, M. D., & Burstein, J. (2016). *Handbook of Automated Essay Evaluation: Current Applications and Future Directions*. Routledge.

Skinner, B. F. (2019). Gamification in Educational Technology: Enhancing Intrinsic Motivation through Engaging Learning Experiences. *Journal of Educational Technology & Society*, *22*(3), 45–58.

Sriwahyuni, S. (2019). Pengembangan Bahan Ajar Berbasis PowerPoint untuk Pembelajaran Efektif. *Jurnal Pendidikan Dan Pembelajaran*, *7*(3), 201–210.

Suarlin, MY, N., & Arsyad, M. N. F. (2025). Analisis Program Pengembangan Kompetensi Guru dalam Penerapan Kurikulum Merdeka. *EDUKATIF: Jurnal Penelitian Dan Pembelajaran*, *01*(03), 85–94.

Sudjana. (2016). Penilaian Hasil Proses Belajar Mengajar. In *Rosdikarya*. Rosdikarya.

Sukmawati, S., Hidayati, N., & Prabowo, A. (2022). Pemanfaatan Podcast dalam Pembelajaran: Peluang dan Tantangan. *Jurnal Pendidikan Dan Pembelajaran*, *13*(3), 200–210.

Suntharalingam, H. (2024). Enhancing Digital Learning Outcomes Through the Application of Artificial Intelligence: A Comprehensive Review. *International Journal of Innovative Science and Research Technology*. https://doi.org/10.38124/ijisrt/ijisrt24apr530

Susanto, H. (2016). *Belajar dan Pembelajaran*. Kencana.

Wijaya, A., & al., et. (2021). Meningkatkan Kualitas Pendidikan Melalui Teknologi Digital. *Jurnal Pendidikan Dan Teknologi*, *9*(2), 45–55.

Yusrillia, R., & Wathon, A. (2018). Game Edukasi dalam Pembelajaran. *Jurnal Pendidikan Dan Pembelajaran*, *8*(1), 15–25.

Yusuf, M. (2023). Peningkatan keterampilan berpikir kritis siswa SD. *Jurnal Ilmiah Sekolah Dasar*, *2*(1), 18–29.

Zebua, A. (2023). Pengembangan Keterampilan Digital Siswa. *Jurnal Pendidikan Dan Teknologi*, *11*(1), 20–30.

Zimmerman, B. J. (2017). Theories of self-regulated learning and academic achievement: An overview and analysis. In *Handbook of Self-Regulation of Learning and Performance* (pp. 1–12). Routledge.