EXPLORING THE IMPACT OF ARTIFICIAL INTELLIGENCE IN ENHANCING THE EFFECTIVENESS OF DISTANCE EDUCATION: THE MODERATING ROLE OF STUDENT ENGAGEMENT

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ABSTRACT

As a result of the Covid-19 pandemic, the approach to learning in education has transitioned from traditional to online (distance learning). It is undeniable that distance education has become a new approach to learning. In the past decade, many institutions have offered distance learning approaches. However, the effectiveness of distance education is still doubted and questioned due to the lack of direct physical contact between teachers/lecturers and students. This research aims to examine the impact of artificial intelligence and student engagement in enhancing the effectiveness of distance education and to test whether student engagement strengthens the impact of artificial intelligence usage in improving the effectiveness of distance education. In this study, criteria for respondents were established, namely students who use AI and have undergone online learning for at least one semester, and the research involved 281 participants as the research sample. The collected data was then analyzed using SmartPLS v.4 by running bootstrapping and the PLS algorithm. The results of the study prove that the impact of artificial intelligence and student engagement can enhance the effectiveness of distance education, and student engagement also plays a role in strengthening the impact of artificial intelligence usage in improving the effectiveness of distance education, with p-values < 0.10, < 0.05, and < 0.05, respectively. This study highlights the importance of synergy between AI technology and student engagement, thus providing insights for educators and policymakers to optimize distance education strategies to improve the effectiveness of distance education.

Keywords: AI, artificial intelligence, distance education, student engagement.

INTRODUCTION

Online learning has increased rapidly in the last decade. The learning process has undergone a change from being conducted in a classroom to transitioning to virtual environments. Furthermore, distance education is becoming increasingly popular, especially with the advancement of technology and global situations that necessitate online learning (e.g., Covid-19). Distance education has evolved from offline to online with internet access, and Covid-19 has made online learning a common delivery method worldwide (Bulunmaz & Bilge, 2024; Martin et al., 2020). Distance education is a teaching and learning process where the teacher/lecturer is far from the students, communicating ideas and instructions through correspondence, radio, television, or internet-enabled computers (Ngubane & Adigun, 2024). Also, distance education is an educational approach where teachers and students engage in learning and teaching activities from different locations without time or place constraints (Adzobu, 2014; Varlik, 2024).

In recent years, the integration of Artificial Intelligence (AI) into various sectors has triggered transformative changes, including in the field of education (Chen et al., 2020c). AI technology has been well-received and increasingly utilized in education (Al Algaithi et al., 2024). AI is one of the latest technological advancements believed to be significant in solving problems (Schmidt & Strasser, 2022), one of which is the issue of difficult access to equitable education. The presence of AI brings positive impacts for students, such as increasingly flexible learning access (Hinojo-Lucena et al., 2019). With the proliferation of online learning platforms (Zoom, Google Meet, Coursera, edX, etc.) and the increasing demand for flexible education options, distance

education has emerged as a prominent teaching method. However, the effectiveness of distance education often depends on factors such as student engagement, interaction, and personalized learning experiences. In this context, AI presents itself as a promising tool to enhance the effectiveness of distance education (Dogan et al., 2023) (such as ChatGPT, Perplexity, Consensus, Gemini, Bing, DataBot, etc.) by offering customized learning experiences, personalized feedback, and adaptive learning pathways (Bhutoria, 2022).

Recently, researchers have utilized the Technology Acceptance Model (TAM) to investigate education-related issues such as student satisfaction with online learning (Drennan et al., 2005), student acceptance of online course companion sites over textbooks (Gao, 2005), and this study aims to expand the investigation concerning the enhancement of distance education effectiveness. This study aims to investigate the intersection between AI and distance education, specifically exploring how AI technology can enhance the effectiveness of distance learning environments. An important aspect of this exploration is the moderating role of student engagement. Although AI has the potential to revolutionize educational practices, the extent to which AI provides a positive impact on learning outcomes may depend on the level of student engagement with AI-based tools and resources.

Understanding the moderating influence of student engagement is crucial in designing integrated distance education systems with AI and effectively meeting diverse student needs. By investigating the interplay between AI technology, student engagement, and learning outcomes, this research aims to provide valuable insights for educators, policymakers, and educational technology developers seeking to harness the full potential of AI in the context of distance learning. This introduction lays the groundwork for a comprehensive study on how AI can function as a catalyst for innovation in distance education, with a specific focus on the crucial role of student engagement in shaping the effectiveness of AI-based educational interventions. Through empirical analysis and theoretical frameworks, this research makes several contributions. First, it offers insights into the integration of AI technology in distance education environments. By examining the impact of AI on learning outcomes, instructional design, and student engagement, it contributes to a deeper understanding of how AI can be effectively utilized to enhance the overall effectiveness of distance learning environments.

Second, one of the main contributions of this research lies in its investigation into the moderating role of student engagement in the context of AI-supported distance education. By elucidating how variations in levels of student engagement influence the effectiveness of AI-based educational interventions, this research provides actionable insights for educators and learners aiming to optimize student engagement in online learning environments. Third, this research offers practical guidance for educational practitioners and policymakers looking to integrate AI technology into distance education initiatives. By highlighting the importance of considering student engagement as a critical factor in the implementation of AI-based educational tools and platforms, this research informs decision-making processes aimed at fostering innovation and improving educational outcomes in distance learning environments. Lastly, this research contributes to theory development. Through its empirical analysis and theoretical frameworks, this research contributes to a theoretical understanding of the interplay between AI, student engagement, and learning outcomes in distance education. By synthesizing existing literature and generating new empirical evidence, this research advances theoretical frameworks that can guide future research efforts in the field of AI-integrated education.

This study's remaining sections: the second section present the literature review and hypothesis development, and third section present the research method. In the fourth section, the authors present the statistical results and discussion. The last section discusses the conclusion, limitations, suggestions, theoretical and practical implications.

LITERATURE REVIEW

Technology Acceptance Model (TAM)

The theoretical framework of the Technology Acceptance Model (TAM), developed by Davis (1986, 1989), is utilized and adopted for this research, proposing ways to predict technology usage. Research employing the TAM model as a theoretical lens generally tends to measure usage through the intention to use compared to actual usage (Turner et al., 2010). TAM provides a useful analytical framework for the usage and adoption of information technology through variables such as perceived usefulness, perceived ease of use, and intention to use (Han & Sa, 2022). TAM has played a leading role in explaining users' behavior toward technology (Marangunic

& Granic, 2015). Furthermore, TAM can explain differences in intentions to use or actual use of technology, specified within a structural equation modeling framework (King & He, 2006; Marangunic & Granic, 2015). TAM is a powerful tool for describing technology adoption (Scherer et al., 2019). Recently, researchers have used TAM to investigate education-related issues such as student satisfaction with online learning (Drennan et al., 2005), student acceptance of online course companion sites over textbooks (Gao, 2005), and this research aims to expand the investigation concerning the enhancement of distance education effectiveness.

The application of TAM to AI in distance education provides a valuable framework for understanding the factors influencing technology acceptance. From Figure 1, the authors argue that the use of AI for distance education is inseparable from the aspect of ease of access/operation of the technology used. Distance education will be challenging to implement if the platform used is not easy to access or use. This is because the ease of using technology will make both teachers and students comfortable using it (Saif et al., 2024). The ease of technology use will consequently impact the perceived benefits or usefulness by teachers and students (Saif et al., 2024). It is acknowledged that technology use that does not provide benefits will result in low technology usage. The use of AI to facilitate the continuity of distance education (e.g., ChatGPT, Bing, Perplexity, Gemini, Consensus, etc.) inherently provides its own benefits for teachers and students. The benefits provided by AI will drive its usage intensity and eventually AI will be used in actual practice within the scope of distance education.

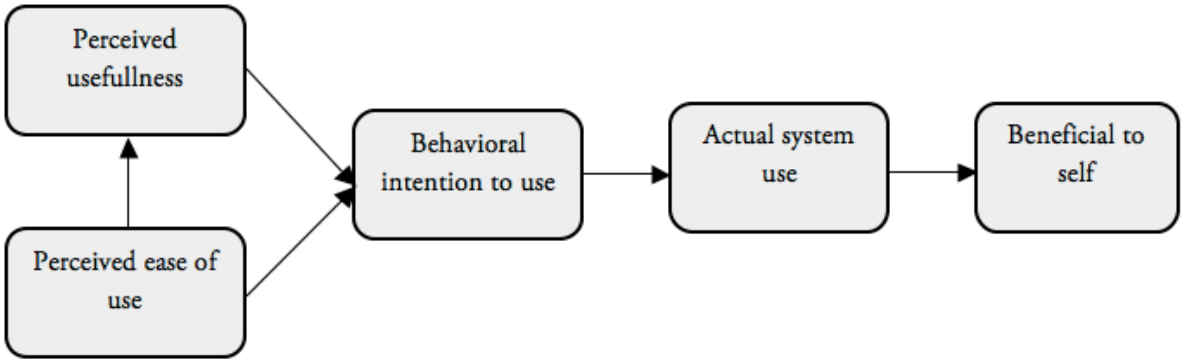

Figure 1. Adapted from technology acceptance model (Davis, 1989)

Self-Determination Theory

The Self-Determination Theory (SDT), pioneered by Ryan and Deci (2017), is a motivational theory in which individuals are viewed as proactive and create conditions that enable them to feel autonomous, competent, and connected to others. In the context of distance education, the authors argue that within SDT, the interaction between students and their virtual social contexts influences their motivation and development, such as understanding of materials, learning outcomes, online learning engagement, online discussion involvement, etc. Students may have different reasons for completing tasks or actively participating in class. In SDT, the reasons underlying this behavior are fundamental as they do not produce the same quality of outcomes (Guay, 2022). It is possible to distinguish various types of reasons (or motivations) that differ in terms of self-determination (Guay, 2022).

SDT is highly significant in the field of education, as students' natural inclination to learn may be the greatest resource that educators can leverage (Niemiec & Ryan, 2009). The Self-Determination Theory (SDT) is a motivational theory that emphasizes the importance of basic psychological needs in influencing individual motivation and engagement (Grasse et al., 2022; Peng et al., 2012; Tamborini et al., 2010). Within SDT, there is intrinsic motivation associated with the more productive forces behind any behavior (Deci & Ryan, 2000; Ryan & Deci, 2000) as intrinsic motivation triggers individuals' inner drive to engage in activities based on their personal interests (Deci & Ryan, 2008). In the context of distance education utilizing artificial intelligence (AI), the authors argue that SDT can provide profound insights into how student engagement can moderate the effectiveness of AI technology.

The Self-Determination Theory provides a robust framework for understanding how student engagement can moderate the effectiveness of AI in distance education. By fulfilling students' basic needs for autonomy, competence, and relatedness, AI can enhance intrinsic motivation and student engagement, ultimately improving learning outcomes (Li et al., 2024). Integrating the principles of SDT into the development and implementation of AI technology can help create a more effective and motivating learning environment.

Artificial Intelligence in Education

Education faces opportunities and challenges brought about by evolving artificial intelligence (AI) technology, which has the potential to fundamentally transform the structure, operations, and governance of educational institutions (Popenici & Kerr, 2017). Artificial intelligence refers to the capability of digital machines to perform tasks typically associated with intelligent beings, and its rapid growth is increasingly reshaping the ways people interact, communicate, live, learn, and work (Chiu et al., 2022; Xia et al., 2022). AI in education is widely used by students and educators today, involving various tools and applications (Chen et al., 2020b). AI in education supports learning by combining AI and various learning sciences, such as education, psychology, linguistics, and neuroscience, aiming to stimulate and advance the development of AI-based educational applications that exhibit flexibility, personalization, and effectiveness (Luckin & Holmes, 2016). AI technology provides opportunities for personalized learning experiences to meet individual learner needs (Ventura, 2017). The author argues that AI used in education encompasses not only virtual reality or augmented reality but also includes tools such as ChatGPT, Perplexity, Bing, and other chatbots. AI has three paradigms, in the first paradigm of AI, the focus is on AI directing cognitive learning, with learners serving as recipients of AI services. In the second paradigm, AI plays a supportive role, collaborating with learners who actively engage in the learning process. The third paradigm emphasizes AI's empowering role, where learners take charge of their learning while AI serves as a tool to enhance and facilitate their educational experience (Ouyang & Jiao, 2021). Here is the author's proposed design of AI in Education.

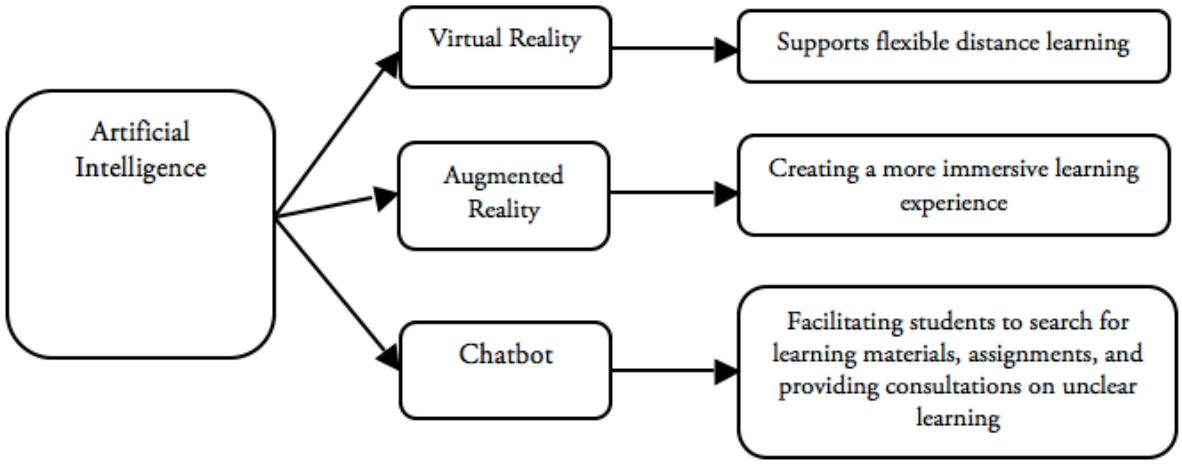

Figure 2. The model of artificial intelligence in education

Hypotheses Development

AI can be flexibly used anytime and anywhere depending on individual needs. It can be employed to address many challenges faced in online distance education and subsequently assist in optimizing the teaching and learning process (Dogan et al., 2023). When individuals encounter material they don't understand while studying and then use AI to find answers, this is a positive impact of AI usage. AI can present material and adjust learning content according to individual needs, provide immediate feedback, and create interactive learning experiences through chatbots, simulations, and educational games. The utilization of Artificial Intelligence (AI) in distance education will yield better educational outcomes (Chen et al., 2020a), measured by student engagement, speed of understanding, and overall academic performance compared to traditional online teaching methods without AI integration. AI in education has taken the form of adaptive

learning systems, intelligent tutoring systems, and other systems that enhance the quality of administration, instruction, and learning processes (Sharma et al., 2019). Moreover, AI has enabled the development and use of smart learning systems and adaptive content tailored to the needs and learning abilities of each student, such as smart virtual reality and the same use in teaching and learning simulations, which have been shown to have a positive impact on learning (Chen et al., 2020a; Pokrivcakova, 2019).

H1: Artificial Intelligence (AI) enhances the effectiveness of distance education

Student engagement has been considered key to student success (Garn et al., 2017). Engagement is grounded in the constructivist perspective, which posits that learning is shaped by an individual's active involvement in purposeful educational activities (Coates, 2005). Student engagement has been shown to be crucial for various positive learning outcomes, including academic achievement, self-esteem, general and cognitive abilities, psychosocial development, as well as students' well-being and satisfaction with the college experience (Lam et al., 2012; Li & Lerner, 2011; Zhoc et al., 2023). Student engagement in online classes is vital because it greatly impacts learning outcomes and overall effectiveness (Lasekan et al., 2024). Student engagement has been shown to be related to success in both online learning (Cerezo et al., 2016). Student engagement can enhance active participation in online discussions and activities, thereby promoting deeper understanding and retention of course material, leading to improved academic performance. Additionally, frequent interaction with instructors and peers fosters a supportive learning environment, resulting in increased satisfaction and motivation among students. Furthermore, student engagement encourages students to take responsibility for their learning process, which can reduce feelings of isolation often associated with distance education and decrease levels of active disengagement in class. Overall, student engagement plays a crucial role in maximizing the benefits of distance education by facilitating interaction, collaboration, and self-directed learning. Thus, the presence of student engagement in online classes will enhance the effectiveness of distance education.

H2: Student engagement enhances the effectiveness of distance education

The effectiveness of Artificial Intelligence in enhancing distance education is based on the synergistic interaction between active student engagement and AI's ability to personalize and enrich the learning experience. High student engagement enhances their responsiveness to AI interventions, such as instant feedback and customized materials, thereby improving understanding and retention of information. AI creates an interactive and engaging learning environment through features like chatbots, simulations, and gamification (Chen et al., 2020a), which in turn motivates students to participate more actively. When students are actively engaged, they are more likely to consistently follow and utilize the tools and resources provided by AI, ultimately reinforcing the effectiveness of distance education. In short, high student engagement and AI technology mutually support and enhance learning outcomes, creating a positive cycle that strengthens the overall impact of AI in distance education.

H3: Student engagement strengthens the impact of using Artificial Intelligence (AI) in enhancing the effectiveness of distance education

METHOD

Participants

The participants were students from undergraduate, master, and doctor programs from various universities in Indonesia, with a total of 281 respondents (male = 127 and female = 154) (see Table 1). The participant criteria were students who used AI and have undergone distance education (online) for at least one semester, so students who had never used AI and undergone online education were excluded from the data. Thus, out of the 302 respondents collected, 21 respondents were excluded because they did not meet the criteria, leaving a sample of 281 respondents. Respondent recruitment was done by distributing a Google Form to students via WhatsApp, Instagram, and Email to expand the respondent coverage. Participants were given one month to complete the Google form. Overall, the respondents were predominantly undergraduate students, totaling 186 individuals, and were mostly in the age range of 21-25 years, with 143 individuals (see Table 1).

Table 1. Demographics of respondents

		Frequency	%
Gender	Male	127	45.2%
	Female	154	54.8%
	Total	281	100%
Age	< 20	98	34.9%
	21 – 25	143	50.9%
	26 – 30	34	12.1%
	> 30	6	2.1%
	Total	281	100%
Education	Undergraduate	186	66.2%
	Master	88	31.3%
	Doctor	7	2.5%
	Total	281	100%
Province	North Sumatera	85	30.2%
	West Sumatera	7	2.5%
	Central Java	8	2.8%
	West Java	22	7.8%
	Jakarta	29	10.4%
	West Kalimantan	3	1.1%
	East Java	28	10.0%
	Riau	11	3.9%
	Yogyakarta	84	29.8%
	South Sumatera	4	1.4%
	Total	281	100%

Data Analysis

The statistical software employed for data analysis in the present study is the widely used statistical package for social sciences, in conjunction with Smart Partial Least Squares (SmartPLS) version 4. The first test carried out is factor loading with a value that must be above 0.50 (Templeton et al., 2002). Bootstrapping procedures are run to obtain significance (Hair et al., 2019). The alpha level for statistical significance is set at 0.05 (5%) and 0.10 (10%). The next step in the outer model is to differentiate validity. Discriminant validity is evaluated using three standard metrics: Fornell-Larcker, cross-loading, and Heterotrait-Monotrait ratio (HTMT) (Fornell & Larcker, 1981; Henseler et al., 2015). The diagonal value of constructs that increase should have a square root larger than the corresponding association coefficient. This sufficiently indicates that the two constructs are different or distinguishable (Fornell & Larcker, 1981). The HTMT statistic should be below 1 for all possible combinations of constructions (Henseler et al., 2015). The next step is related to the collinearity of the data. The collinearity can be assessed by examining the variance inflation factor (VIF) value. Based on existing research, it is recommended that VIF values should ideally be less than three or below five (Henseler et al., 2015).

Instrument

This study utilized instruments modified from previous research, and specifically, instruments for AI usage, distance education, and student engagement. The answers on the research instrument score use a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The AI instrument adapted from Al Algaithi et al. (2024), the distance education instrument adopted from Ozkaya et al. (2021), and finally the student engagement instrument adopted from Gunuc and Kuzu (2015) (see appendix 1). All instruments used met the criteria for validity and reliability with values above 0.70 and 0.60.

FINDINGS

Table 2. Fornell-larcker criterion

Variable	AI	DE	SE
AI	0.609		
DE	0.592	0.698	
SE	0.539	0.690	0.717

Note: AI: Artificial intelligence, DE: Distance education, SE: Student engagement

Discriminant validity analysis on the model indicates no discriminative issues. The first indicator of discriminant validity criteria, Fornell-Larcker (Fornell & Larcker, 1981), does not show any issues and demonstrates that all factors are significant (see Table 2). We can see this by ensuring that the value of each construct is greater than the correlation between constructs (e.g. 0.698 > 0.592).

Table 3. Heterotrait-monotrait ratio (HTMT)

	AI	DE	SE	SE × AI
AI	1			
DE	0.637	1		
SE	0.825	0.696	1	
SE × AI	0.330	0.429	0.323	1

Note: AI: Artificial intelligence, DE: Distance education, SE: Student engagement

The final discriminant indicator, HTMT, also does not show any discriminant validity problems because all combined construct values are below 1 – see Table 3 (Henseler et al., 2015).

Table 4. Hypothesis testing

Hypothesis	Paths	Std. Dev.	T statistics	P values	Decision
H1	AI " DE	0.094	1.731	0.084**	*Supported*
H2	SE " DE	0.095	5.382	0.000*	*Supported*
H3	SE × AI " DE	0.044	2.601	0.009*	*Supported*

Note: AI: Artificial intelligence, DE: Distance education, SE: Student engagement

* significant at the level of 5%

** significant at the level of 10%

Table 4 presents the results of the hypothesis analysis. The findings of the hypothesis for this study indicate that *H1* (t= 1.731, p < 0.10), *H2* (t = 5.382, p < 0.05), dan *H3* (t = 2.601, p < 0.05) was supported. We can see that the significance value of AI on Distance education is 0.084, then the inclusion of student engagement makes the significance value close to 0, which is 0.009. This indicates that the presence of student engagement further enhancing the relationship between AI and distance education.

Table 5. R-square

	R-square	R-square adjusted
DE	0.532	0.527

Note: DE: Distance education

Table 5 presents the results of *R-square*. *R-square* value or commonly known as the coefficient of determination, it is the proportion of the variance in the dependent variable explained by the independent variables. The analysis of this research model found an *R-square* = 0.532 (53.2%), indicating a moderate influence (Hair et al., 2022), while the remaining 46.8% is explained by other variables not examined in this study.

Table 6. Multicollinearity test

Variable	t	P values	VIF
AI " DE	1.731	0.084	2.101
SE " DE	5.382	0.000	2.094
SE × AI " DE	2.601	0.009	1.129

Note: AI: Artificial intelligence, DE: Distance education, SE: Student engagement

Table 6 presents the collinearity statistics (VIF) in the inner model. The table shows that overall VIF values in the inner model are below 3, indicating no significant multicollinearity (Henseler et al., 2015). Therefore, the test results are considered reliable or trustworthy.

DISCUSSION

The findings of this study indicate that artificial intelligence is significantly positively related to enhancing the effectiveness of distance education. The hypothesis that artificial intelligence (AI) enhances the effectiveness of distance education has been supported. Students who utilize and use AI can make the process of distance education effective (Dogan et al., 2023). The use of AI can enhance the productivity and performance of students in the classroom. AI such as ChatGPT, Perplexity, Bing, Consensus, Gemini, etc., can be beneficial for students when they do not understand the material being presented. Students who do not understand the lesson material, then they use AI to find out about the material and study it until they understand it. It is common for there to be lesson material that is difficult to understand in distance education. However, the presence of AI makes it easier for students to access information about the lesson material they are studying (Maphoto et al., 2024). Thus, the presence of AI will serve as a support system for students undergoing distance education. Based on the Technology Acceptance Model (TAM), when students perceive that AI is easy to use and beneficial, they are more likely to accept and use the technology, which in turn enhances the effectiveness of distance education.

AI-powered virtual tutors and chatbots provide instant feedback and assistance to students. These systems can answer questions, explain complex concepts, and provide additional resources, mimicking the benefits of face-to-face tutoring (Hwang et al., 2020). This immediate support helps students quickly overcome obstacles related to difficulties in understanding the subject matter. The automated system can handle multiple-choice questions, essays, and even complex problem-solving tasks with increased accuracy (Seo et al., 2021). AI ensures that all students, regardless of their physical or language challenges, can access and engage with educational materials effectively. By utilising these capabilities, AI can create a more effective, inclusive, and engaging online learning environment.

Next, the findings of this study indicate that student engagement is significantly positively related to enhancing the effectiveness of distance education. The hypothesis that student engagement enhances the effectiveness of distance education has been supported. The self-determination theory views individuals as proactive and creating conditions that enable them to feel autonomous, competent, and connected to others, thus leading a student to actively engage in the learning process. The findings of this research are relevant to Cerezo et al. (2016), who stated that student engagement has been proven to be related to success in online learning. Success in online learning serves as a form of the effectiveness of distance education. This indicates that student engagement plays a crucial role in determining the effectiveness of distance education. Student engagement plays a crucial role in determining the effectiveness of distance education. When students are

actively engaged in the learning process, they tend to be more motivated, focused, and participate in learning activities, thereby enhancing learning outcomes (Fredricks et al., 2004; Vermeulen & Volman, 2024). High engagement increases learning motivation because students feel more interested and connected to the course, learning materials, and teaching methods (Dennen et al., 2007; Kehrwald, 2008; Robinson & Hullinger, 2008). This encourages them to access materials more frequently, complete assignments, and participate in discussions, helping them overcome challenges of distance learning such as boredom or lack of social interaction (Dixson, 2015). Additionally, active engagement with course materials reinforces understanding of concepts because students are more likely to ask questions, discuss with classmates, and seek additional sources, all of which contribute to better knowledge retention (Trowler, 2010).

Social interaction also increases with student engagement, where students participate in online discussions, group work, and collaborative projects. These interactions build a supportive learning community, making students feel more connected and more likely to remain committed to the course and support each other in the learning process (Sharma et al., 2023). Additionally, engaged students are usually better at managing their time, setting priorities, and completing tasks on time, developing essential time management skills in distance education that require independence and high discipline (Trammell & LaForge, 2017). Student engagement also enhances their satisfaction and well-being. Students who feel engaged with their courses tend to be more satisfied with their learning experiences, contributing to better emotional and mental well-being, which are important factors for long-term learning (Zhoc et al., 2020). This satisfaction fosters a positive attitude toward learning and motivates students to pursue their studies. Additionally, high engagement enables more effective and constructive feedback from instructors. Engaged students are more likely to give and receive feedback in a constructive manner, helping them improve academic performance and better understand the material.

Furthermore, student engagement fosters active learning where students are not only passive recipients of information but also actively participate in the learning process (Boulton et al., 2019). This active learning involves activities such as discussions, debates, simulations, and practical projects that help students develop critical thinking and problem-solving skills. Overall, student engagement is a key factor influencing the success and effectiveness of distance education (Lasekan et al., 2024; Vermeulen & Volman, 2024). By enhancing student engagement, educational institutions can ensure that students not only achieve better academic outcomes but also have more satisfying and meaningful learning experiences, thereby enhancing the effectiveness of distance education.

Finally, the findings of this research indicate that student engagement strengthens significantly with the impact of AI in increasing the effectiveness of distance education. The hypothesis that student engagement strengthens the impact of using Artificial Intelligence (AI) in enhancing the effectiveness of distance education has been supported. Student engagement plays a crucial role in positively moderating the relationship between artificial intelligence (AI) and the effectiveness of distance education. When students are actively engaged, AI can maximize its potential to enhance learning experiences and outcomes (Seo et al., 2021). Firstly, student engagement ensures that the personalized learning offered by AI is fully optimized. AI analyzes student interaction data to tailor the material to individual needs, and engaged students are more likely to utilize personalized materials, ask questions, and seek additional resources suggested by the AI system. High engagement ensures that this personalization positively impacts understanding and retention of material (Zepke, 2021). High engagement strengthens the positive effects of interactivity facilitated by AI, making learning more engaging and enjoyable (Gupta, 2023). Furthermore, high student engagement leads to students appreciating the learning process and motivating themselves to actively participate during learning (Schnitzler et al., 2021). When encountering less understood topics, students can interact with AI such as chatbots; then, as they grasp the learning material, they can contribute during the learning process. Based on the self-determination theory (SDT), student engagement influenced by the fulfillment of autonomy, competence, and relatedness needs reinforces the positive impact of AI in enhancing the effectiveness of distance education. Thus, student engagement ensures that AI can reach its potential to improve learning, provide better support, and make distance education more effective and satisfying.

CONCLUSION

Based on the hypothesis testing results and discussion of the research findings, it is concluded that AI can enhance the effectiveness of distance education, student engagement can improve the effectiveness of distance education, and student engagement can enhance the impact of AI in promoting the effectiveness of distance education. Additionally, these findings affirm that psychological, cognitive, and technological factors play a significant role in enhancing the effectiveness of distance education. This demonstrates that the combination of cognitive psychology with artificial intelligence will have a positive impact on the effectiveness of distance education.

This study is not without limitations. Firstly, data collection through surveys inherently comes with its own shortcomings. Secondly, the study did not utilize control variables such as gender or age, which could potentially have an impact on the research outcomes. Thirdly, the authors acknowledge the limited number of respondents, which cannot be considered representative of the entire student population in Indonesia. Fourthly, the diversity of educational contexts, including variations in subjects and educational levels, also poses challenges in generalizing the findings. Lastly, measuring student engagement is subjective and may rely on self-reported data, which could introduce potential bias. Caution is advised in interpreting the research results due to the study's limitations.

Based on the limitations mentioned above, the authors suggest that future researchers should consider providing broader developments, such as adding new research variables (such as control and mediation variables, i.e., learning motivation, learning interest, etc.) and also consider adding additional data analysis techniques such as robustness tests and sensitivity tests, as well as including research subjects from other countries (such as East Asia). Subsequent studies may employ experimental designs or case studies and may also consider using qualitative methods (open questions) to expand the validity of the research findings. Furthermore, future research is expected to explore different theories such as the Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2) or other relevant theories to validate the findings and broaden knowledge expansion and generalization. Additionally, future research may consider incorporating the perceptions of teachers/professors, as this would provide valuable insights into how teachers/professors conduct activities and adopt distance education teaching strategies. Therefore, further research is needed to determine which strategies are most effective in improving the effectiveness of distance education. The findings of this study are expected to be developed and beneficial in the future.

The theoretical implications of this research include the emergence of a new perspective that the combination of cognitive psychology with AI can enhance the effectiveness of distance education and possibly its quality as well. The research findings demonstrate the alignment and validity of the theories used by the researchers. This study expands the Technology Acceptance Model (TAM) in the aspect of distance education. Furthermore, the practical implications of this research lie in the fact that the use of AI for the effectiveness of distance education is influenced by the cognitive psychology of students. Therefore, it is important to ensure that students are actively engaged in the learning process and provide space for them to think critically and express their opinions without any pressure. Based on these findings, educators and policymakers are encouraged to consider integrating AI with cognitive psychology aspects to support students in enhancing the effectiveness of distance education.

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APPENDIX 1

Artificial Intelligence (AI)

1. I find AI easy to use
2. Learning how to use AI is easy for me
3. It is easy to become skillful at using AI in learning
4. The interaction with AI in learning is clear and understandable
5. Using AI in learning would increase the students' learning performance
6. Using AI in learning would increase academic productivity
7. Using AI would make learning easier
8. Using AI in learning is useful for context-based interactions as in real-life
9. AI enable students to learn more quickly in learning
10. AI make it easier to innovate in online learning
11. The advantages of AI in online learning outweigh the disadvantages
12. I believe that using AI will increase the quality of online learning
13. I am completely satisfied in using AI for learning
14. Using AI in online learning is a good idea
15. I am positive towards using AI in learning

Distance Education

1. Distance learning is academically more interesting than face-to-face education
2. The quality of education increases with distance education
3. Programs should be opened in different fields in distance education
4. Distance education is essential to meet the need for trained manpower
5. I believe that in the future, distance education will be more preferred than traditional education
6. Compared to face-to-face education, the cultural diversity of students in distance education is greater
7. My experiences in distance education have positively changed my perspective on distance education
8. In the distance education environment, students get the opportunity to think analytically
9. Distance education students socialize more in electronic environment
10. Compared to face-to-face education, distance education provides students with flexibility in terms of resource use
11. Communication tools used in distance education are technologically sufficient
12. Communication tools used in distance education are educationally sufficient.
13. Distance education programs are well-planned in my institution.
14. The learning management system used in the presentation and execution of the courses is sufficient
15. Compared to face-to-face education, distance education provides students with flexibility in terms of time usage
16. Universities give students access to electronic material to support distance education
17. Universities prepare electronic materials such as e-books and e-journals to support distance education for students
18. Students are provided with sufficient technical support to solve technical problems they encounter in distance education

STUDENT ENGAGEMENT

Class Engagement

Cognitive Engagement

1. I motivate myself to learn
2. I determine my own learning goals
3. I try to do my best during classes
4. Besides doing my lessons, I further study for my lessons
5. What I learn in class is important for me
6. I discuss what I have learned in class with my friends out of class
7. I attend classes by geting prepared in advance
8. I try to do my homework in the best way
9. I enjoy intellectual difficulties I encounter while learning
10. I spend enough time and make enough effort to learn

Emotional Engagement

11. My teachers are always near me when I need them
12. I give importance to studying together with my classmates (in a group)
13. My classmates respect my thoughts/views
14. I think my courses are beneficial for me
15. I respect my classmates
16. I respect my teachers
17. I am interested in my courses
18. I feel myself as a part/member of a student group
19. I feel anxious when I don't attend classes

Behavioral Engagement

20. I am an active student in class
21. My teachers behave fairly to all my friends
22. I attend classes willingly
23. I carefully listen to my teacher in class
24. My teachers interact/communicate with me
25. I follow the rules in class
26. I do my homework/tasks in time
27. I carefully listen to other students in class
28. I try to do my best regarding my responsibilities in group work
29. I share information with my classmates