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# The Impact of AI Use in Learning and Digital Material Accessibility on Students' Academic Achievement through Technology Engagement as A Mediating Variable : The Perspective of Theory of Planned Behaviour and UTAUT Theory

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**Abstract:** This study aims to analyze the impact of Artificial Intelligence (AI) and digital material accessibility on academic achievement through students' engagement with technology. The research employs a quantitative survey method a survey method using SEM-PLS data analysis to explore the relationships between the relevant variables. A purposive sampling technique is used to select samples that meet specific criteria. The research sample comprises of 162 students in Malang, Indonesia, with data collected via an online questionnaire. This study shows that the use of AI in learning among students in Malang, when combined with effective digital material accessibility, has been proven to have a positive and significant impact on their academic performance, with technology engagement serving as an important mediating variable. AI, by enhancing competence, autonomy, and intrinsic motivation, helps students achieve their academic goals, increases their efforts, and provides higher self-satisfaction. This research implies that effective integration of AI and accessibility of digital materials, supported by technology engagement, can significantly improve students' academic performance, so educational institutions urgently need to strengthen the use of technology in learning.

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## Introduction

In the rapidly evolving digital era, the use of Artificial Intelligence (AI) across various aspects of life has become a necessity. In the education sector, AI is utilized to streamline administrative processes, support learning, and enhance access to digital materials. AI enables personalized learning, where students can learn at their own pace and according to their own learning styles, potentially improving academic performance (Bhutoria, 2022). However, the effectiveness of AI in education depends on both the technology itself and how students engage with it, often referred to as technology engagement. This engagement includes how actively students use and leverage the technology provided and how they adapt to it in the learning context.

Globally, the integration of AI in education has become a major focus in many developed countries, where AI is used to personalize learning experiences, identify individual student needs, and provide more interactive and adaptive learning materials. In the United States, for instance, universities such as Stanford and MIT have developed AI-powered learning platforms that allow students to learn according to their preferences and needs (Kamalov et al., 2023). In the UK, the University of Edinburgh has implemented AI to provide real-time feedback to students during the learning process (Edinburg, 2023). Meanwhile, in Singapore, the government has launched the Smart Nation initiative, which aims to improve the quality of education through the use of AI (Sipahi & Saayi, 2024). Studies conducted in these countries indicate that AI applications in education can enhance learning efficiency, enabling students to learn faster and more effectively. However, a major challenge is ensuring that students are truly engaged and making optimal use of the technology. Student engagement with AI technology remains a key factor in determining the success of AI implementation in education.

In Indonesia, the use of AI in education is still in its early stages of development. Although some leading universities, such as Universitas Indonesia and Institut Teknologi Bandung, have started adopting AI technology, its implementation is still limited to a few areas, such as academic guidance chatbots and data analysis for measuring student performance. Data from the Ministry of Education and Culture shows that only about 10% of universities in Indonesia have adopted AI technology in their educational processes (Pers, 2024). One of the biggest challenges is the lack of adequate infrastructure, particularly outside major cities. Limited access to digital materials, especially in remote areas, poses a significant barrier to the digitization of education in Indonesia. Additionally, technology engagement among students also needs improvement. Many students are not yet accustomed to using AI technology in learning, which leads to suboptimal use of the technology and, ultimately, no significant improvement in their academic performance (Hakim, 2022).

In Malang, efforts to increase AI use and digitalization of learning materials have been made by several higher education institutions, such as Universitas Brawijaya and Universitas Negeri Malang (Maulina, 2024). Both universities have begun implementing various AI technologies, including chatbots for academic consultations and AI-based learning systems aimed at facilitating students' access to educational materials. However, the effectiveness of these implementations remains uncertain. Despite the availability of technology and increasing access to digital materials, technology engagement among students remains relatively low. According to an internal survey conducted by Universitas Brawijaya, about 40% of students rarely use the provided AI technology, citing lack of understanding, inadequate training, and resistance to new technology as the main reasons.

Students in Malang, particularly at Universitas Brawijaya and Universitas Negeri Malang, still face challenges in adapting to this technology. Limited digital literacy, a lack of confidence in using new technology, and minimal support from the university are major barriers to their engagement with AI. Consequently, despite the significant potential to enhance academic performance through the use of AI, the anticipated outcomes have not yet been fully achieved. This observation suggests that higher education institutions in Malang need to develop more effective strategies to improve technology engagement among students. This could be achieved through more intensive training programs, more interactive learning approaches, and enhanced digital literacy, to ensure that AI implementation in education truly impacts students' academic performance positively.

Previous research indicates that AI in learning can significantly enhance academic outcomes by offering personalized content, real-time performance analysis, and adaptive feedback. These features create a tailored learning experience that increases motivation and engagement, which are closely linked to improved academic performance; engaged students tend to be more consistent in their studies and have a better grasp of the material (Seo et al., 2021). Additionally, the importance of technology engagement in maximizing AI's benefits is emphasized in Self-Determination Theory (SDT), particularly in fulfilling essential psychological needs like competence, autonomy, and relatedness. When students feel capable and have control over their AI-based learning, their intrinsic motivation grows, leading to better academic results (Chiu et al., 2023).

However, not all studies find a strong impact of AI on academic performance, especially in contexts where technology engagement is limited. Some researchers argue that AI cannot fully substitute human support; when students feel unsupported, they may not engage deeply with AI tools, reducing their academic benefits (Jaysone, 2024). Technical barriers and perceived complexity also affect engagement levels—if students view AI as difficult to use or feel a lack of support, they are less likely to use it actively, weakening its positive effects (Sampasa-Kanyinga et al., 2022). The Unified Theory of Acceptance and Use of Technology (UTAUT) highlights that ease of use and support availability are critical for effective technology engagement. Thus, the impact of AI on educational outcomes is heavily influenced by the quality of its application and the support provided in specific learning environments.

The research gap emerging from these findings lies in the need to gain a deeper understanding of the conditions and factors influencing the extent to which AI use and digital material accessibility can enhance academic performance. While there is evidence supporting positive effects, variables such as technology engagement are not yet fully understood in this context. Further research is needed to clarify where, when, and how AI and digital materials can significantly enhance academic performance and to identify barriers that may reduce their impact. Research should also explore the role of technology engagement as a mediator and the conditions that can strengthen or weaken this engagement in the learning process.

This study employs several relevant theories to support the accuracy of the results and impact of the research. The theory used for the variable of AI Use in Learning is the Theory of Planned Behavior (TPB). TPB is a social psychology theory introduced by Icek Ajzen in 1985 (Ajzen, 1985). TPB was developed as an extension of the Theory of Reasoned Action (TRA) by adding the concept of perceived behavioral control. TPB explains that an individual's behavior is influenced by the intention to perform that behavior, which is shaped by three main factors: attitude toward the behavior, subjective norm, and perceived behavioral control. In the context of learning, TPB helps understand how students decide to use AI in their learning process, considering their perceptions of the benefits and drawbacks of AI, social influences from their environment, and their self-efficacy in using the technology.

Next, the theory used for the variable of Digital Material Accessibility is the Unified Theory of Acceptance and Use of Technology (UTAUT). UTAUT, developed by (Venkatesh et al., 2003), integrates eight different theories and models related to technology adoption to explain technology use behavior. UTAUT states that the intention to use technology is influenced by four main constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. In the context of digital material accessibility, UTAUT can be used to understand the factors affecting students' access to and use of digital resources in their learning.

Third, for the variable of Technology Engagement, Self-Determination Theory (SDT) is used. SDT is a motivation theory developed by Edward Deci and Richard Ryan in 1985 (Watt & Richardson, 2015). SDT focuses on basic human psychological needs: competence, autonomy, and relatedness. The theory posits that individuals are motivated to engage in an activity when these needs are fulfilled. In the context of technology engagement, SDT explains how students engage with technology for learning, considering how capable they feel using the technology, their control over how they use it, and their sense of connection with others through technology.

The study's hypotheses are based on the assumption that AI use in learning can significantly enhance students' academic performance by personalizing and adapting learning materials to meet individual needs. AI provides real-time feedback and access to a wider range of relevant resources (Darvishi et al., 2024). According to Ajzen's TPB, positive attitudes, supportive subjective norms, and perceived behavioral control can encourage students to utilize AI tools more frequently, potentially boosting their academic outcomes. Consequently, it is hypothesized that the integration of AI in learning will have a positive and significant impact on students' academic performance.

Digital material accessibility is another key factor believed to influence academic success by offering students the flexibility to study anytime and anywhere. This access enables students to review lessons, enhance comprehension, and keep up with class content efficiently (Riyadi & Sudiyatno, 2023). Supported by the UTAUT by Venkatesh et al., this hypothesis suggests that expectations of performance, effort, and facilitating conditions motivate students to use digital materials effectively, subsequently leading to improved academic results. Therefore, the hypothesis posits that digital material accessibility positively and significantly impacts academic performance.

Technology engagement, which reflects students' active involvement with educational technology, is essential for academic achievement. Guided by SDT by Deci and Ryan, which highlights the need for competence, autonomy, and relatedness, students who actively engage with technology are more intrinsically motivated to study and achieve their goals (Balalle, 2024). Furthermore, AI can enhance this engagement, reinforcing the positive impact of AI use on academic performance. Similarly, when students can easily access digital materials, their technology engagement improves, facilitating more effective learning and better results (Sappaile et al., 2023). Thus, it is hypothesized that both AI use in learning and digital material accessibility positively impact academic performance, with technology engagement serving as a crucial mediating factor.

This study aims to investigate a model that integrates Theory of Planned Behaviour (TPB), Unified Theory of Acceptance and Use of Technology (UTAUT), and Self-Determination Theory (SDT) in the context of AI Use in Learning and Accessibility of Digital Materials on Student Academic Achievement, with a particular focus on the mediating role of Technology Engagement. Thus, this research is expected to contribute to the development of more effective learning strategies by leveraging AI technology and optimal digital accessibility.

## Research Method

The research employs a quantitative approach, as it requires the collection of numerical and statistical data to meet scientific standards characterized by empirical, objective, measurable, rational, and scientific attributes (Igwenagu, 2016). In this study, AI use in learning and digital material accessibility are considered external factors (independent variables), while students' academic performance is viewed as the dependent variable influenced by these external factors, with technology engagement acting as a mediating variable.

This study utilizes a survey design, with data collection conducted through an online questionnaire (Google Forms). The questionnaire, adapted from Venkatesh et al. (2012), is

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designed using a Likert scale to measure students' perceptions of AI use in learning, digital material accessibility, technology engagement, and academic performance, with data collected from June to August 2024. The population for this research consists of undergraduate students in Malang who are enrolled from 2021 to 2024, have taken courses related to technology, are active in technology-related organizations both on and off campus, and possess proficiency in using technology for learning. Purposive sampling techniques are used to select a sample that meets specific criteria. The sample comprises 162 students chosen from an initial 177 respondents who completed the online questionnaire.

The collected data is analyzed using Structural Equation Modeling-Partial Least Squares (SEM-PLS), facilitated by SmartPLS 3.0 software. SEM-PLS analysis includes two main categories of relationships: the outer model, which evaluates convergent validity, discriminant validity, and measurement reliability (Hair et al., 2011). Additionally, the inner model is assessed through R-square and Q-square analyses, and hypothesis testing to validate the proposed relationships.

**Table 1. Characteristics of the Respondents**

| Demographic | | Frequency | Percentage |
|---|---|---|---|
| **Institution** | Universitas Brawijaya | 71 | 43.83% |
| | Universitas Negeri Malang | 46 | 28.40% |
| | UIN Malang | 4 | 2.47% |
| | UMM | 11 | 6.79% |
| | Universitas Islam Malang | 7 | 4.32% |
| | Universitas Merdeka Malang | 11 | 6.79% |
| | Etc | 12 | 7.41% |
| | Total | 162 | 100% |
| **Year Class** | 2021 | 19 | 11.73% |
| | 2022 | 71 | 43.83% |
| | 2023 | 52 | 32.10% |
| | 2024 | 20 | 12.35% |
| | Total | 162 | 100% |
| **Gender** | Male | 77 | 47.53% |
| | Female | 85 | 52.47% |
| | Total | 162 | 100% |
| **Age** | 17-23 years | 138 | 85.19% |
| | 24-30 years | 19 | 11.73% |
| | 31-37 years | 5 | 3.09% |
| | >37 years | 0 | 0% |
| | Total | 162 | 100% |
| **Subject** | Economics | 10 | 6.17% |
| | Accounting | 12 | 7.41% |
| | Management | 22 | 13.58% |
| | Computer Science | 36 | 22.22% |
| | Business Administration | 67 | 41.36% |
| | Education Technology | 15 | 9.226% |
| | Total | 162 | 100% |
| **AI Usage & Digital Material Accessibility** | Chatbots | 162 | 100% |
| | Khan Academy | 162 | 100% |
| | edX | 162 | 100% |
| | Grammarly | 162 | 100% |
| | Quillbot | 162 | 100% |
| | IBM Watson | 162 | 100% |
| | Moodle | 162 | 100% |
| | Read&Write | 162 | 100% |
| | Google Scholar | 162 | 100% |

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| | | | |
|---|---|---|---|
| | ResearchGate | 162 | 100% |
| | Google Drive | 162 | 100% |
| | Dropbox | 162 | 100% |
| | Zoom | 162 | 100% |
| | Google Meet | 162 | 100% |
| | Total | 162 | 100% |
| **Location** | Malang | 162 | 100% |

In the survey conducted, Universitas Brawijaya had the highest representation, with 71 participants, which comprised approximately 43.83% of the total respondents. Students from the 2022 cohort also accounted for 71 participants, reflecting the same percentage. Female participants were predominant, totaling 85 individuals and making up 52.47% of the respondents. The largest age group was between 17-23 years, with 138 participants or 85.19% of the total. Business Administration emerged as the most popular field of study, selected by 67 participants, representing 41.36% of the respondents. Notably, all 162 respondents reported using AI, indicating a strong adoption of technology. Additionally, all participants were from Malang, contributing to 100% of the survey's total.

## Results and Discussion

### Outer Model

In the initial phase of the Structural Equation Modeling-Partial Least Squares (SEM-PLS) analysis, the focus is on evaluating the outer model to ensure the constructs meet essential validity and reliability criteria. This stage is crucial for confirming that the data used is both accurate and consistent for further analysis.

### Convergent Validity

Convergent validity examines whether indicators within a construct have strong correlations with each other. To establish this, each manifest variable should ideally have a loading factor greater than 0.70 when assessed using SmartPLS 3.2 software. This criterion ensures that indicators are effectively measuring the same underlying construct. In our analysis, as detailed in Table 2, all indicators associated with the constructs demonstrate loading factor values above 0.70. This confirms that the constructs achieve the necessary level of convergent validity, indicating that the measures consistently reflect the intended constructs.

### Discriminant Validity

Evaluating discriminant validity involves comparing the square root of the Average Variance Extracted (AVE) for each construct with the correlations among constructs. Discriminant validity is confirmed if the square root of the AVE for a construct is greater than its correlations with other constructs. This comparison ensures that each construct is distinct and not overly correlated with others. According to the analysis shown in Table 3, the model meets the discriminant validity criteria, as evidenced by the higher squared AVE values relative to the correlation values. This finding indicates that each construct is sufficiently distinct from the others.

### Reliability Test

Reliability testing involves evaluating Cronbach's Alpha and Composite Reliability to ensure the consistency and dependability of the constructs. For constructs with reflexive indicators, acceptable reliability is indicated by values exceeding 0.60. This threshold ensures that the constructs reliably measure their respective variables. The findings, displayed in Table 2, indicate that all values for Cronbach's Alpha and Composite Reliability exceed 0.60. This confirms that the research constructs demonstrate satisfactory reliability, validating that the constructs are measured consistently across different indicators.

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**Table 2. Measurement Model Analysis**

| Variable | Item | Factor Loading | Cronbach's Alpha | Composite Reliability | AVE |
|---|---|---|---|---|---|
| **AI Usage (AI)** | AI.1 | 0,739 | 0,796 | 0,782 | 0,666 |
| | AI.2 | 0,822 | | | |
| | AI.3 | 0,810 | | | |
| **Digital Material Accessibility (DMA)** | DMA.1 | 0,731 | 0,762 | 0,761 | 0,647 |
| | DMA.2 | 0,749 | | | |
| | DMA.3 | 0,755 | | | |
| | DMA.4 | 0,771 | | | |
| **Technology Engagement (TE)** | TE.1 | 0,782 | 0,719 | 0,730 | 0,642 |
| | TE.2 | 0,784 | | | |
| | TE.3 | 0,739 | | | |
| | TE.4 | 0,725 | | | |
| **Academic Achievement (AA)** | AA.1 | 0,720 | 0,722 | 0,726 | 0,639 |
| | AA.2 | 0,776 | | | |
| | AA.3 | 0,785 | | | |

**Table 3. Discriminant Validity**

| Var/Ind | CH | EE | IB | SEI |
|---|---|---|---|---|
| AI.1 | **0,739** | 0,345 | 0,352 | 0,363 |
| AI.2 | **0,822** | 0,413 | 0,319 | 0,342 |
| AI.3 | **0,810** | 0,438 | 0,400 | 0,445 |
| DMA.1 | 0,417 | **0,731** | 0,462 | 0,429 |
| DMA.2 | 0,346 | **0,749** | 0,311 | 0,380 |
| DMA.3 | 0,359 | **0,755** | 0,333 | 0,354 |
| DMA.4 | 0,377 | **0,771** | 0,345 | 0,411 |
| TE.1 | 0,314 | 0,413 | **0,782** | 0,318 |
| TE.2 | 0,302 | 0,499 | **0,784** | 0,365 |
| TE.3 | 0,327 | 0,467 | **0,739** | 0,349 |
| TE.4 | 0,355 | 0,466 | **0,725** | 0,419 |
| AA.1 | 0,344 | 0,397 | 0,496 | **0,720** |
| AA.2 | 0,349 | 0,307 | 0,452 | **0,776** |
| AA.3 | 0,382 | 0,350 | 0,404 | **0,785** |

## Inner Model

The next phase of SEM-PLS analysis involves testing the inner model, which uses R-square, Q-square, and hypothesis testing methods to evaluate the model's performance.

## R-Square

R-square assesses the extent to which exogenous constructs influence endogenous constructs. According to Table 4, an R-square value of 0.502 indicates that variables such as AI Usage and Digital Material Accessibility account for 50.2% of the variance in Technology Engagement. The remaining 49.8% of the variance is attributed to factors not covered by this study. Additionally, an R-square value of 0.546 shows that AI Usage, Digital Material Accessibility, and Technology Engagement collectively explain 54.6% of the variance in Student Academic Achievement, with 45.4% of the variance attributable to external factors. As noted by (Hair et al., 2011), R-square values exceeding 0.50 signify that SEM models have acceptable explanatory power, demonstrating moderate-to-strong explanatory capability.

## $Q^2$ Predictive Relevance

Predictive relevance is evaluated by calculating the $Q^2$ value, where a value greater than 0 indicates adequate predictive capability (Hair et al., 2011). The formula for computing $Q^2$ is: $Q^2 = 1 – (1 – R1^2) \times (1 – R2^2)$. Using the obtained R-square values:

$Q^2 = 1 – (1 – R1^2) \times (1 – R2^2) = Q^2 = 1 – (1 – 0{,}502) \times (1 – 0{,}546)$

$Q^2 = 1 − (0{,}498) \times (0{,}454) = Q^2 = 1 – 0{,}226 = Q^2 = 0{,}774$

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A $Q^2$ value of 0.774 indicates the model's effectiveness in accurately predicting observed values (Hair et al., 2011).

**Hypothesis Testing**

Hypothesis testing assesses whether path coefficients are statistically significant, with a common threshold of a P-value less than 0.05 indicating a significant correlation (Hair et al., 2011). The results of hypothesis testing are detailed in Table 5. This evaluation ensures that the proposed relationships between variables in the model are significant and relevant, providing a robust foundation for further analysis.

**Table 4. R-Square Test**

| No | Variable | R-Square |
|---|---|---|
| 1 | TE | 0,502 |
| 2 | AA | 0,546 |

**Table 5. Hypothesis Testing Results**

| Hypothesis | Path Coefficient | T Value | P Values | Decision |
|---|---|---|---|---|
| **AI -> AA** | 0,499 | 6,912 | 0,000 | **Significant** |
| **DMA -> AA** | 0,387 | 7,162 | 0,000 | **Significant** |
| **TE -> AA** | 0,351 | 6,280 | 0,005 | **Significant** |
| **AI -> TE -> AA** | 0,212 | 3,511 | 0,015 | **Significant** |
| **DMA -> TE -> AA** | 0,240 | 2,882 | 0,025 | **Significant** |

The first hypothesis in Table 5 indicates that the integration of Artificial Intelligence (AI) in learning has a positive and significant impact on the academic performance of students in Malang, consistent with findings from previous studies (Sugiarso et al., 2024). This relationship is explained through the Theory of Planned Behavior (TPB), which identifies three main indicators: Attitude toward technology use, Subjective norm, and Perceived behavioral control. Students who display a positive attitude toward AI tools—such as chatbots, Khan Academy, edX, Grammarly, and IBM Watson—tend to leverage these resources to enhance comprehension, improve learning efficiency, and achieve better academic outcomes. For example, Grammarly and Quillbot are particularly useful in refining writing quality, reducing errors, and expediting the writing process, all of which contribute to improved performance indicators like goal achievement, effort exerted, and self-satisfaction.

The TPB framework further highlights the role of subjective norms, where the influence of peers, lecturers, and the academic environment fosters students' motivation to use AI. Support from these social factors encourages students to incorporate AI in their learning, strengthening their commitment to achieving better outcomes. Additionally, perceived behavioral control reflects students' confidence in using AI tools, driven by their accessibility and user-friendly design. When students feel capable of effectively utilizing AI, such as Grammarly for writing corrections, they are more likely to engage deeply in learning tasks, resulting in enhanced academic performance. Overall, AI integration supports students in accessing learning resources, completing assignments, and receiving timely feedback, all of which reinforce motivation and satisfaction. Thus, by fostering positive attitudes, supportive social norms, and increased confidence, AI plays a crucial role in advancing students' academic goals, boosting learning efforts, and enhancing satisfaction with their achievements.

The second hypothesis in Table 5 shows that Digital Material Accessibility significantly boosts the academic performance of students in Malang, as explained by the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. This framework includes four indicators: Performance expectancy, Effort expectancy, Social influence, and Facilitating conditions. Performance expectancy reflects students' belief that digital platforms like Google Scholar, ResearchGate, Google Drive, and Dropbox enhance academic efficiency by simplifying access to essential resources. This belief encourages students to use these platforms regularly, which supports faster and more effective task completion, ultimately improving their performance. This finding supports the results of studies that have reported similar findings (Sappaile et al., 2023).

Effort expectancy emphasizes ease of use; platforms such as Moodle, Read&Write, and Google Drive simplify access to learning materials, reducing the effort needed and allowing students to focus more on content mastery. Social influence involves the impact of peers, lecturers, and family, who encourage technology use through platforms like Zoom and Google Meet, creating a supportive learning environment. Lastly, Facilitating conditions refer to adequate infrastructure and resources, such as internet access and necessary software, which enable smooth digital material access and improve learning quality. Altogether, these factors contribute to students' goal achievement, increased learning effort, and self-satisfaction, confirming that digital material accessibility positively impacts academic performance in Malang.

The third hypothesis in Table 5 suggests that Technology Engagement significantly enhances academic performance among students in Malang, explained through the Self-Determination Theory (SDT). This finding supports the results of studies that have reported similar findings (Teng & Wang, 2021). SDT comprises four key indicators—Competence, Autonomy, Relatedness, and Intrinsic Motivation—that drive students' engagement with technology and improve academic outcomes. Competence refers to students' confidence in using technology effectively, such as e-learning platforms and online assessment tools, which allows them to complete tasks more efficiently and understand course content better. For example, interactive simulations and self-directed learning apps boost students' skills and contribute to their goal achievement.

Autonomy involves students' freedom to select technologies that suit their learning styles, fostering a personalized and motivated approach to studies. Relatedness emphasizes the importance of social connection through technology, enabling students to engage with peers, lecturers, and the academic community via online discussions and study groups, which strengthens motivation. Intrinsic Motivation refers to the student's enjoyment and satisfaction derived from using technology, which promotes commitment to academic activities involving tech. Altogether, these SDT indicators positively impact academic performance by fostering academic goal achievement, increased study effort, and self-satisfaction among Malang students engaged with technology.

The fourth hypothesis in Table 5 suggests that AI Use in Learning significantly boosts academic performance among Malang students, with Technology Engagement acting as a mediating factor that amplifies this effect. AI tools like chatbots, Khan Academy, edX, Grammarly, and Quillbot provide accessible, personalized support that enhances learning, but their effectiveness is heightened when students are actively engaged with these technologies. Technology Engagement, grounded in SDT, encompasses four dimensions—Competence, Autonomy, Relatedness, and Intrinsic Motivation. Through Competence, students develop skills by using AI tools for specific tasks, such as improving writing with Grammarly, which boosts confidence and academic performance (Fitria, 2021).

Autonomy allows students to choose AI tools that fit their learning needs, fostering commitment to the learning process and increasing academic effort. Relatedness enhances students' social connections with peers and teachers, as collaborative AI platforms create supportive learning environments. Intrinsic Motivation further encourages students to engage with AI, driven by enjoyment and satisfaction beyond academic demands. Overall, AI's impact on academic performance is mediated by technology engagement, which enables students to utilize AI more effectively, thereby improving academic achievement, effort, and self-satisfaction by enhancing their competence, autonomy, connectedness, and motivation.

The fifth hypothesis in Table 5 posits that AI Use in Learning has a significant positive effect on the academic performance of students in Malang, with Technology Engagement amplifying this impact. AI tools, such as Khan Academy, Grammarly, and Quillbot, offer personalized content, real-time feedback, and adaptive support, making learning more efficient and tailored to students' needs. However, this positive effect relies heavily on students' active engagement with these technologies. Technology Engagement encompasses key elements such as competence, autonomy, social relatedness, and intrinsic motivation, which help students fully leverage AI resources to enhance learning outcomes (Darvishi et al., 2024).

Competence in using AI tools, for instance, builds students' confidence, allowing them to effectively apply features that support academic tasks, like improving writing skills with Grammarly. Autonomy is fostered as students can select AI tools aligned with their learning styles, enhancing their motivation and flexibility in managing study time. Social relatedness is also strengthened through AI-supported collaboration, fostering a supportive learning environment where students can share insights and receive help, which boosts motivation. Intrinsic motivation arises as students find enjoyment and tangible benefits in using AI, encouraging greater focus and commitment. Therefore, while AI directly improves academic performance, Technology Engagement acts as a critical mediator, enabling students to optimize AI use across competence, autonomy, connectedness, and motivation—leading to substantial academic gains for Malang students.

The findings of this study have significant conceptual and practical implications, both in understanding student engagement with AI and digital tools in learning and in formulating education sector policies. Conceptually, the results reinforce the relevance of the TPB, UTAUT, and SDT in explaining how attitudes, social influences, and motivations affect technology adoption in education. Each theory highlights a particular mechanism linking technology use to academic performance, providing an overarching view of factors such as convenience, competence, and motivational support that drive positive outcomes in student learning. Practically, these results advise educational institutions to invest in building environments that support technology adoption and facilitate access to AI tools. For example, positive social norms related to AI use can be reinforced through lecturer support and peer support programmes, as was the case in Malang. In addition, training that enhances students' behavioural control and competence with digital tools can encourage them to integrate technology into academic routines. This study also emphasises the importance of active participation with AI to maximise its potential, for example by providing freedom in choosing tools that suit their individual learning preferences. These programmes can increase student motivation and engagement, making AI and digital access an essential element in modern educational practices.

## Conclusion

The use of AI in learning among students in Malang, when combined with effective digital material accessibility, has proven to have a positive and significant impact on their academic performance, with technology engagement serving as an important mediating variable. AI, through enhancing competence, autonomy, and intrinsic motivation, helps students achieve their academic goals, increase their efforts, and provide greater self-satisfaction. By utilizing technologies and digital platforms such as Moodle, Google Scholar, and other online collaboration tools, students can access and use learning materials more efficiently, ultimately improving their academic outcomes.

## Recommendation

To further optimize the positive impact of AI in learning, educational institutions in Malang should integrate specialized training programs that enhance students' proficiency with AI tools and improve accessibility to digital materials. This includes providing essential infrastructure support, such as high-quality internet access and sufficient technological devices, ensuring all students can fully utilize learning resources. Developing a more adaptive and flexible curriculum that aligns with technological advancements is also crucial, as this can keep students engaged and motivated to achieve better academic performance. Lecturers play a key role in supporting these efforts by actively incorporating AI tools into their teaching methods to build students' confidence and familiarity with digital resources. They could assign projects or activities that involve AI applications, like Grammarly for writing support or Khan Academy for supplemental learning, to normalize AI-assisted study. Additionally, lecturers should participate in professional development to stay updated on emerging AI technologies and trends, enabling them to guide students effectively. Collaborating with colleagues to design flexible learning modules that adapt to students' needs and technological developments will further encourage students to integrate AI resources into their studies, leading to enhanced academic outcomes.

## References

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In Action Control (pp. 11–39). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-69746-3_2

Balalle, H. (2024). Exploring student engagement in technology-based education in relation to gamification, online/distance learning, and other factors: A systematic literature review. Social Sciences & Humanities Open, 9, 100870.

Bhutoria, A. (2022). Personalized education and Artificial Intelligence in the United States, China, and India: A systematic review using a Human-In-The-Loop model. Computers and Education: Artificial Intelligence, 3, 100068.

Chiu, T. K. F., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2023). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. Interactive Learning Environments, 1–17. https://doi.org/10.1080/10494820.2023.2172044

Darvishi, A., Khosravi, H., Sadiq, S., Gašević, D., & Siemens, G. (2024). Impact of AI assistance on student agency. Computers & Education, 210, 104967.

Edinburg, T. U. of. (2023, June). Generative Artificial Intelligence guidance for students. Www.Ed.Ac.Uk. https://www.ed.ac.uk/bayes/ai-guidance-for-staff-and-students/ai-guidance-for-students

Fitria, T. N. (2021). Artificial Intelligence (AI) In Education: Using AI Tools for Teaching and Learning Process. Prosiding Seminar Nasional & Call for Paper STIE AAS, 134–147.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2011). An assessment of the use of partial least squares structural equation modeling in marketing research. Journal of the Academy of Marketing Science, 40(3), 414–433.

Hakim, L. (2022, December). Peranan Kecerdasan Buatan (Artificial Intelligence) dalam Pendidikan. Ppg.Kemdikbud.Go.Id. https://ppg.kemdikbud.go.id/news/peranan-kecerdasan-buatan-artificial-intelligence-dalam-pendidikan

Igwenagu, C. (2016). Fundamentals of Research Methodology and Data Collection. LAP Lambert Academic Publishing. https://www.researchgate.net/publication/303381524

Jaysone, C. M. B. (2024). The Relationship Between Artificial Intelligence (AI) Usage and Academic Performance of Business Administration Students. International Journal of Asian Business and Management, 3(1), 27–48.

Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New Era of Artificial Intelligence in Education: Towards a Sustainable Multifaceted Revolution. Sustainability, 15(16), 12451.

Maulina, R. (2024, August). Memahami Kecerdasan Buatan, UM Siapkan Mahasiswa Baru Hadapi Era Digital. Um.Ac.Id. https://um.ac.id/berita/memahami-kecerdasan-buatan-um-siapkan-mahasiswa-baru-hadapi-era-digital/

Pers, P. S. (2024, April). Tingkatkan Pembelajaran Digital melalui Pemanfaatan GenAI dalam Perguruan Tinggi. www.kemdikbud.go.id. https://www.kemdikbud.go.id/main/blog/2024/04/tingkatkan-pembelajaran-digital-melalui-pemanfaatan-genai-dalam-perguruan-tinggi

Riyadi, A., & Sudiyatno, S. (2023). The impact of online learning on students learning motivation. Jurnal Pendidikan Vokasi, 13(1), 36–43.

Sampasa-Kanyinga, H., Hamilton, H. A., Goldfield, G. S., & Chaput, J.-P. (2022). Problem Technology Use, Academic Performance, and School Connectedness among Adolescents. International Journal of Environmental Research and Public Health, 19(4), 2337.

Sappaile, B. I., Lasinggaru, E. D. F., & Mokodenseho, S. (2023). Analyzing the Influence of Digital Learning Platforms on Student Engagement and Academic Performance. West Science Interdisciplinary Studies, 1(6), 65–73.

Sipahi, E. B., & Saayi, Z. (2024). The world's first "Smart Nation" vision: the case of Singapore. Smart Cities and Regional Development (SCRD) Journal, 8(1), 41–58.

Sugiarso, B. A., Nurjamin, A., Judijanto, L., Firdausiyah, L., & Hidayat, A. Al. (2024). The Effect of Artificial Intelligence in Improving Student Learning Achievement in High School. World Psychology, 3(1), 1–14.

Teng, Y., & Wang, X. (2021). The effect of two educational technology tools on student engagement in Chinese EFL courses. International Journal of Educational Technology in Higher Education, 18(1), 27.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27(3), 425–478. http://about.jstor.org/terms

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. Forthcoming in MIS Quarterly, 36(1), 157–178.

Watt, H. M. G., & Richardson, P. W. (2015). Teacher Motivation. In International Encyclopedia of the Social & Behavioral Sciences (pp. 64–71). Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.26082-0