

## The Impact of Artificial Intelligence Use on Students' Innovative Behavior and Well-Being: The Mediating Role of Digital Literacy and the Moderating Role of Happiness

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### Article Info

#### Article type:

Original Research

#### How to cite this article:

Abbasi Bibalan, S. & Pali, S. (2026). The Impact of Artificial Intelligence Use on Students' Innovative Behavior and Well-Being: The Mediating Role of Digital Literacy and the Moderating Role of Happiness. *International Journal of Innovation Management and Organizational Behavior*, 6(4), 1-13.  
<https://doi.org/10.61838/kman.ijimob.5558>



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### ABSTRACT

**Objective:** The present study aimed to investigate the effect of artificial intelligence use on students' innovative behavior and well-being through the mediating role of digital literacy and the moderating role of happiness.

**Methods and Materials:** This study was applied research in terms of purpose and descriptive-survey in terms of methodology. The statistical population consisted of all male and female lower and upper secondary school students in Langarud during the 2025–2026 academic year. Based on the Krejcie and Morgan table, 367 students were selected through stratified random sampling. Data collection instruments included the Innovative Behavior Questionnaire by Ng and Lucianetti (2016), Student Well-Being Questionnaire by Zheng et al. (2015), Artificial Intelligence Use Questionnaire by Long and Magerko (2020), Digital Literacy Questionnaire by Ibrahim et al. (2024), and the Happiness Questionnaire by Hills and Argyle (2002). Data analysis was conducted using descriptive statistics, the Kolmogorov–Smirnov test, and structural equation modeling (SEM) through SmartPLS software at a 95% confidence level.

**Finding:** The results indicated that artificial intelligence use had a positive and significant effect on innovative behavior ( $\beta = 0.357$ ,  $t = 6.165$ ), digital literacy ( $\beta = 0.541$ ,  $t = 14.222$ ), and student well-being ( $\beta = 0.387$ ,  $t = 6.984$ ). In addition, digital literacy positively and significantly affected innovative behavior ( $\beta = 0.245$ ,  $t = 4.786$ ) and student well-being ( $\beta = 0.301$ ,  $t = 5.339$ ). The findings further demonstrated that digital literacy mediated the relationship between artificial intelligence use and both innovative behavior and student well-being. Moreover, happiness significantly moderated the relationship between artificial intelligence use and innovative behavior ( $\beta = 0.113$ ,  $t = 2.298$ ), indicating that higher levels of happiness strengthened the positive effect of artificial intelligence use on innovative behavior.

**Conclusion:** The findings suggest that artificial intelligence use can improve students' innovative behavior and well-being when accompanied by higher levels of digital literacy and happiness. Digital literacy plays a crucial role in facilitating the positive outcomes of AI-based educational environments, while happiness strengthens students' innovative responses to technology use.

**Keywords:** artificial intelligence, innovative behavior, student well-being, digital literacy, happiness

## 1 Introduction

Artificial intelligence has rapidly transformed educational environments and has become one of the most influential technological developments affecting teaching, learning, and student development in contemporary educational systems. The integration of artificial intelligence technologies into educational processes has expanded beyond administrative and instructional functions and now influences students' behavioral, psychological, and cognitive outcomes. Educational institutions increasingly employ artificial intelligence-based systems such as intelligent tutoring systems, adaptive learning platforms, chatbots, recommendation systems, and automated feedback mechanisms to enhance learning quality and improve educational efficiency (Al Shamsi et al., 2022; Von Garrel & Mayer, 2023). The rapid expansion of these technologies has created new opportunities for students to engage in personalized learning experiences, improve problem-solving abilities, and strengthen creativity and innovation within academic environments (Ma et al., 2024; Zhou & Peng, 2025). At the same time, the growing reliance on artificial intelligence has raised important questions regarding its broader psychological and behavioral implications for students, particularly in relation to well-being, happiness, and innovative behavior.

Innovative behavior is considered one of the most important indicators of educational and organizational effectiveness because it reflects students' ability to generate, promote, and implement new ideas in response to educational and environmental challenges. Innovative behavior encompasses cognitive flexibility, creativity, idea generation, and the capacity to transform knowledge into practical solutions (Ng & Lucianetti, 2016). In contemporary educational systems, innovative behavior has become increasingly essential due to the complexity of modern learning environments and the accelerating pace of technological change. Artificial intelligence technologies can contribute to innovative behavior by facilitating access to information, encouraging creative exploration, and supporting collaborative learning experiences (Ma et al., 2024; Zhou & Peng, 2025). Recent evidence suggests that the use of artificial intelligence tools enhances students' creative performance and innovative engagement by reducing routine cognitive burdens and allowing learners to focus on higher-order thinking skills (Hosseinzadeh et al., 2025; Rafiq & Ahmad, 2025). Similarly, studies have shown

that educational artificial intelligence positively influences academic creativity and student participation in innovative activities (Asadi Vakil Kandi et al., 2025; Wu & Zhang, 2024). Nevertheless, some scholars argue that excessive reliance on artificial intelligence may weaken independent thinking and reduce authentic creativity if students become passive consumers of algorithm-generated content rather than active creators of knowledge (Luo, 2024; Peng & Wan, 2024). Therefore, the relationship between artificial intelligence use and innovative behavior remains an important area requiring further empirical examination.

Alongside innovative behavior, student well-being has emerged as a major concern in educational research due to its close relationship with academic performance, motivation, engagement, and psychological adjustment. Student well-being refers to a multidimensional construct encompassing psychological, social, and physical dimensions of positive functioning within educational contexts (Zheng et al., 2015). Educational environments characterized by supportive interactions, emotional stability, and meaningful engagement contribute significantly to higher levels of student well-being (Baumann et al., 2014; Everett, 2017). In recent years, the increasing digitalization of educational environments has altered the conditions influencing student well-being. Artificial intelligence technologies may improve well-being by reducing academic stress, facilitating personalized support, and increasing learning flexibility (Chiu et al., 2023; Maunula et al., 2023). AI-based educational systems can provide immediate feedback, adaptive instruction, and individualized guidance, which may enhance students' confidence and satisfaction with learning experiences (Al Shamsi et al., 2022; Long & Magerko, 2020). However, concerns have also been raised regarding the potential negative consequences of artificial intelligence use, including digital fatigue, social isolation, dependency on technology, and emotional distress (Gu et al., 2024; Peng & Wan, 2024). Consequently, understanding how artificial intelligence affects students' well-being requires consideration of both its empowering and potentially harmful dimensions.

One of the critical variables associated with the effective use of artificial intelligence technologies is digital literacy. Digital literacy refers to the knowledge, skills, and competencies required to access, evaluate, utilize, and create digital information effectively and responsibly (Walton, 2016). In the era of artificial intelligence, digital literacy has expanded beyond basic technological competence and now includes the ability to critically understand AI systems,

interpret algorithmic outputs, and engage ethically with digital technologies (Bender, 2024; Ng et al., 2023). Students with higher levels of digital literacy are more capable of using artificial intelligence tools strategically and productively in academic settings (Kazanidis & Pellas, 2024). Furthermore, digital literacy enables students to regulate technology use, manage digital information efficiently, and adapt to rapidly evolving technological environments (Quaicoe & Pata, 2020). Studies have demonstrated that digital literacy contributes positively to academic creativity, learning engagement, and psychological adjustment (Gera et al., 2025; Ibrahim et al., 2024). Research also indicates that digital literacy mediates the relationship between emotional and technological factors and educational outcomes (Ibrahim et al., 2024). Therefore, digital literacy may serve as an important mechanism through which artificial intelligence influences innovative behavior and student well-being.

Theoretical and empirical evidence suggests that students who possess stronger digital literacy skills are better equipped to transform artificial intelligence tools into opportunities for innovation and personal development. AI-based learning environments often require learners to interpret digital information critically, evaluate the reliability of AI-generated content, and apply technological resources creatively to solve academic problems (Long & Magerko, 2020; Ng et al., 2023). Students lacking adequate digital literacy may experience confusion, dependency, or reduced engagement when interacting with artificial intelligence systems. In contrast, digitally literate students are more likely to benefit from AI-enhanced educational opportunities and develop stronger self-regulation, adaptability, and innovative performance (Hosseinzadeh et al., 2025; Kazanidis & Pellas, 2024). Moreover, digital literacy has been associated with higher levels of digital well-being and lower levels of digital stress and addiction (Gera et al., 2025). These findings indicate that digital literacy may function as an essential mediating variable linking artificial intelligence use with students' behavioral and psychological outcomes.

Another important factor influencing students' educational experiences is happiness. Happiness is a positive emotional state characterized by life satisfaction, positive affect, and psychological fulfillment. In educational contexts, happiness contributes significantly to motivation, resilience, engagement, and academic achievement (Laosum, 2023; Torres-Reynoso et al., 2025). Happy students are generally more optimistic, socially engaged, and

psychologically resilient, enabling them to respond more effectively to educational challenges and technological changes. Previous studies have shown that happiness positively influences innovative and creative behaviors because positive emotions broaden cognitive processes and encourage flexible thinking (Ahmadi & Geramian, 2024; Li & Xue, 2023). Furthermore, happiness has been identified as a protective factor against academic stress, anxiety, and maladaptive technology use (Gu et al., 2024). In technologically enriched learning environments, happiness may strengthen students' willingness to experiment with new technologies and participate actively in AI-supported learning activities.

The moderating role of happiness becomes particularly important when considering the psychological impact of artificial intelligence on students. Students who experience higher levels of happiness may perceive artificial intelligence technologies as supportive and empowering tools rather than threatening or stressful systems. Consequently, happiness may strengthen the positive effects of artificial intelligence use on innovative behavior and well-being (Rafiq & Ahmad, 2025). Positive emotional states can increase students' openness to learning, creativity, and engagement with technological innovations (Torres-Reynoso et al., 2025). Additionally, social-cognitive perspectives suggest that emotional well-being enhances self-efficacy, intrinsic motivation, and adaptive learning behaviors, all of which contribute to innovative outcomes (Ng & Lucianetti, 2016). Therefore, happiness may amplify the benefits of artificial intelligence use by facilitating greater engagement, experimentation, and confidence in educational contexts.

The growing integration of artificial intelligence into educational systems after the COVID-19 pandemic has intensified the need to examine the interactions between technological, psychological, and behavioral variables among students. Post-pandemic educational environments have become increasingly dependent on digital technologies, virtual learning platforms, and AI-supported instructional systems (Maunula et al., 2023; Ng et al., 2023). As a result, students are now expected not only to possess academic competencies but also to develop advanced digital skills and emotional adaptability to function effectively in technology-driven educational settings. Existing studies have primarily focused on the direct effects of artificial intelligence on academic performance, technology acceptance, or learning efficiency (Al Shamsi et al., 2022; Von Garrel & Mayer, 2023). However, fewer studies have simultaneously

investigated the effects of artificial intelligence use on innovative behavior and student well-being while considering the mediating role of digital literacy and the moderating role of happiness.

Moreover, previous findings regarding the psychological and behavioral outcomes of artificial intelligence use remain inconsistent. Some studies emphasize the positive role of AI technologies in enhancing creativity, engagement, and learning flexibility (Ma et al., 2024; Zhou & Peng, 2025), whereas others highlight concerns related to dependency, reduced critical thinking, emotional exhaustion, and weakened interpersonal relationships (Luo, 2024; Peng & Wan, 2024). These inconsistencies suggest that contextual and individual variables may shape the impact of artificial intelligence on students' outcomes. Digital literacy and happiness appear to be among the most influential variables capable of explaining these differences because they affect how students perceive, interpret, and utilize technological resources.

In addition, the majority of previous studies have focused on university students, while relatively limited attention has been paid to secondary school students who are increasingly exposed to artificial intelligence technologies during critical developmental stages. Adolescence is a particularly sensitive period characterized by rapid cognitive, emotional, and social changes, making students more vulnerable to both the opportunities and risks associated with digital technologies (Ma et al., 2025). Understanding how artificial intelligence affects adolescents' innovative behavior and well-being is therefore essential for designing effective educational strategies and technological interventions.

Given the increasing importance of artificial intelligence in educational systems, the significance of digital literacy for effective technology use, and the influential role of happiness in students' behavioral and psychological adjustment, examining the interrelationships among these variables appears highly necessary. Therefore, the present study aimed to investigate the effect of artificial intelligence use on students' innovative behavior and well-being with the mediating role of digital literacy and the moderating role of happiness.

## 2 Methods and Materials

In terms of nature, the present study was descriptive and survey-based, and in terms of purpose, it was applied research. The statistical population consisted of all male and female lower and upper secondary school students in the city

of Langarud during the 2025–2026 academic year. Based on the Krejcie and Morgan table, the sample size was determined to be 367 participants. In order to examine and compare the role of respondents' demographic characteristics, stratified random sampling was employed. Data collection was conducted using both library-based and field methods.

The research instruments included the Students' Innovative Behavior Questionnaire developed by Ng and Lucianetti (2016), consisting of 3 dimensions and 9 items scored on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5); the Student Well-Being Questionnaire developed by Zheng et al. (2015), consisting of 3 dimensions and 18 items scored on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5); the Artificial Intelligence Use Questionnaire developed by Long and Magerko (2020), consisting of 4 dimensions and 20 items scored on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5); the Digital Literacy Questionnaire developed by Ibrahim et al. (2024), consisting of 10 items scored on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5); and the Happiness Questionnaire developed by Hills and Argyle (2002), consisting of 14 items scored on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). In the present study, the validity of the instruments was confirmed through expert judgment by professors and specialists in the field of management. Prior to the main implementation, the reliability of the questionnaires was examined using a pilot sample of 30 participants, and Cronbach's alpha coefficients for the innovative behavior, well-being, artificial intelligence use, digital literacy, and happiness questionnaires were all greater than 0.70, indicating satisfactory reliability.

The collected data were first analyzed descriptively using means and standard deviations. Subsequently, the Kolmogorov–Smirnov test was employed to examine the normality of data distribution. Finally, to test the research hypothesis and investigate the effects of independent and mediating variables on the dependent variable, structural equation modeling (SEM) was conducted using SmartPLS statistical software.

## 3 Findings and Results

In the present study, the sample consisted of 367 participants. Regarding gender distribution, 51.50% of the participants were female and 48.50% were male. In terms of

age, the majority of participants (37.60%) were 15 and 16 years old, whereas the smallest proportion (26.43%) were 17 and 18 years old. With respect to educational grade level, most participants (35.70%) were in the ninth and tenth grades, while the smallest proportion (30.97%) were in the eleventh and twelfth grades. This demographic distribution indicates that the sample possessed an appropriate diversity

in terms of gender, age, and educational level, and that the groups were reasonably homogeneous with respect to demographic characteristics, thereby enhancing the validity of the research findings.

Table 1 presents the mean and standard deviation scores for the variables of innovative behavior, well-being, artificial intelligence use, digital literacy, and happiness.

**Table 1**

*Descriptive Findings of the Research Variables*

Research Variables	Mean	Standard Deviation
Artificial Intelligence Use	3.55	0.652
Innovative Behavior	3.52	0.689
Well-Being	3.43	0.532
Digital Literacy	3.56	0.770
Happiness	3.62	0.797

Table 1 presents the descriptive findings related to the mean and standard deviation of the main research variables. As can be observed, the mean score for artificial intelligence use ( $M = 3.55$ ,  $SD = 0.652$ ) in the studied sample was at a moderate level. Innovative behavior was also reported with a mean of ( $M = 3.52$ ,  $SD = 0.689$ ), well-being with a mean of ( $M = 3.43$ ,  $SD = 0.532$ ), and digital literacy with a mean of ( $M = 3.56$ ,  $SD = 0.770$ ). Finally, the highest mean score belonged to the happiness variable ( $M = 3.62$ ,  $SD = 0.797$ ).

To examine the normality of the distribution of research variable scores, the Kolmogorov–Smirnov test was conducted. The results indicated that the significance level for all research indicators (innovative behavior, well-being, artificial intelligence use, digital literacy, and happiness)

was less than 0.05. Therefore, all research indicators exhibited a non-normal distribution.

In this section, the statistical analysis related to the research hypothesis—namely, that artificial intelligence use affects students' innovative behavior and well-being through the mediating role of digital literacy and the moderating role of happiness—is presented using structural equation modeling with the PLS approach.

Considering that the research variables consisted of several dimensions, the Kaiser–Meyer–Olkin (KMO) index and Bartlett's test were employed to evaluate the adequacy of the data for confirmatory factor analysis. The results of these tests are presented in Table 2.

**Table 2**

*KMO and Bartlett's Test for the Questionnaire Items*

Index	Value	Interpretation
KMO Test	0.659	Acceptable sample adequacy
Bartlett's Test	$\chi^2 = 19494.289$ df = 2628 Sig = 0.001	Significant

As shown, the KMO index value of 0.659 exceeded the minimum acceptable threshold of 0.60, indicating acceptable data adequacy for factor analysis. Furthermore, the significance of Bartlett's test at the level of  $p \leq 0.01$  demonstrated that the correlation matrix among variables was appropriate for confirmatory factor analysis and that the data possessed sufficient capability for factor extraction.

In this study, factor loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were used to evaluate convergent validity, construct reliability, and the adequacy of the measurement model. The findings related to these indices for each item and construct are presented in Table 3.

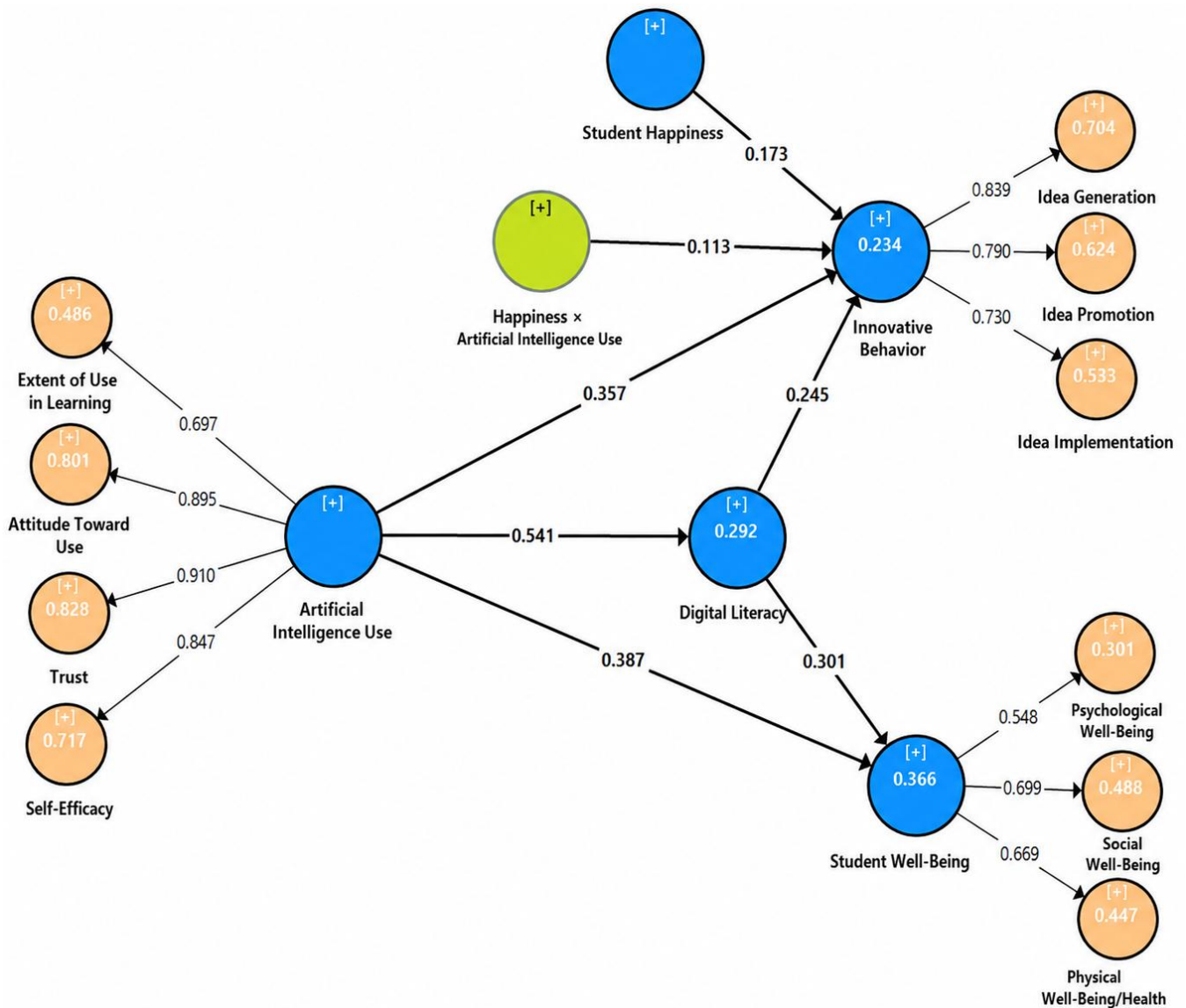
**Table 3**

*Factor Loadings, Significance Statistics, Cronbach's Alpha, Composite Reliability, and AVE for the Questionnaires*

Constructs	Indicators	AVE	Composite Reliability	Cronbach's Alpha
Artificial Intelligence Use	Extent of Use in Learning	0.580	0.873	0.819
	Attitude	0.622	0.890	0.842
	Trust	0.586	0.873	0.815
	Self-Efficacy	0.561	0.864	0.803
Innovative Behavior	Idea Generation	0.681	0.865	0.765
	Idea Promotion	0.752	0.901	0.837
	Idea Implementation	0.714	0.882	0.798
Student Well-Being	Psychological Well-Being	0.623	0.908	0.879
	Social Well-Being	0.584	0.894	0.857
	Physical Well-Being/Health	0.500	0.889	0.858
Digital Literacy	—	0.558	0.926	0.911
Happiness	—	0.540	0.942	0.937

**Figure 1**

*Standardized Path Coefficients of the Conceptual Research Model*



The factor loadings obtained from the artificial intelligence use, innovative behavior, student well-being, digital literacy, and happiness questionnaires indicated that none of the items had loadings below 0.50; therefore, no items were removed from the analysis. Moreover, the AVE values for all variables exceeded the acceptable threshold of 0.50. In addition, the square root of the AVE for each factor was greater than its correlations with other factors, confirming discriminant validity. Cronbach's alpha values for all constructs exceeded 0.70, indicating high convergent validity and strong construct reliability for model fitting. The composite reliability (CR) values for all constructs were also greater than 0.70, demonstrating satisfactory composite reliability for the constructs (Table 3).

After confirming the adequacy of the measurement model, the structural model of the study was tested. Figure 1

presents the graphical representation of the conceptual model along with the standardized path coefficients.

To test the significance of path coefficients in the structural model, the bootstrap method and Student's t-statistics were employed. The results demonstrated that all path coefficients were significant at the 0.05 level, as the calculated T-statistic values were greater than 1.96.

The fit of the structural model was evaluated using the key indices of  $R^2$  (coefficient of determination),  $Q^2$  (predictive relevance), and GOF (goodness-of-fit index). These indices respectively indicate the model's ability to explain the variance of endogenous variables, the predictive power of the model, and the overall fit of the model. The results are summarized in Table 4.

**Table 4**

*R<sup>2</sup> Values of the Research Variables*

Row	Variable	R <sup>2</sup>	Q <sup>2</sup>	GOF
1	Innovative Behavior	0.234	0.129	0.358
2	Digital Literacy	0.292	0.148	—
3	Student Well-Being	0.366	0.172	—

Table 4 indicates that the GOF value was 0.358, which exceeds the threshold of 0.30; therefore, the overall fit of the model can be considered appropriate. Furthermore, the  $R^2$  values for the endogenous variables, including innovative behavior (0.234), digital literacy (0.292), and student well-being (0.366), indicate that the model explains a portion of the variance in these constructs. Additionally, the positive  $Q^2$  values for innovative behavior (0.129), digital literacy (0.148), and student well-being (0.172) demonstrate that the model possesses acceptable predictive relevance for the

endogenous constructs. Overall, these indices indicate that the structural model of the study has satisfactory fit and predictive capability.

To examine the hypothesis regarding the effect of artificial intelligence use on students' innovative behavior and well-being through the mediating role of digital literacy and the moderating role of happiness, the bootstrap method was employed. Based on the results presented in Table 5, the significance or non-significance of the indirect effects for the two mediating paths was reported.

**Table 5**

*Bootstrap Results for Examining the Significance of Indirect Effects*

Independent Variable	Mediating Variable	Dependent Variable	Indirect Effect	Bootstrap Upper Bound	Bootstrap Lower Bound	t-Statistic	Standard Error	Significance Level
Artificial Intelligence Use	Digital Literacy	Innovative Behavior	0.137	0.194	0.073	2.359	0.061	0.001
Artificial Intelligence Use	Digital Literacy	Student Well-Being	0.163	0.245	0.109	3.181	0.059	0.001

According to Table 5, the bootstrap results for examining the significance of indirect effects indicate that, in both mediating paths, the significance level was less than 0.05; therefore, the research hypothesis was confirmed. This

means that artificial intelligence use affects students' innovative behavior and well-being through the mediating role of digital literacy. Furthermore, the significance statistic of the moderating effect of the "happiness" variable in the

relationship between “artificial intelligence use” and “innovative behavior” was equal to 2.298, confirming the moderating effect of happiness. The path coefficient value

(0.113) indicates that this effect was positive, meaning that at higher levels of happiness, the impact of artificial intelligence use on innovative behavior becomes stronger.

**Table 6**

*Results of Structural Model Evaluation for Testing the Research Hypotheses*

Row	Path	Path Coefficient ( $\beta$ )	t-value	Test Result
1	Artificial Intelligence Use $\rightarrow$ Innovative Behavior	0.357	6.165	Confirmed
2	Artificial Intelligence Use $\rightarrow$ Digital Literacy	0.541	14.222	Confirmed
3	Artificial Intelligence Use $\rightarrow$ Student Well-Being	0.387	6.984	Confirmed
4	Digital Literacy $\rightarrow$ Innovative Behavior	0.245	4.786	Confirmed
5	Digital Literacy $\rightarrow$ Student Well-Being	0.301	5.339	Confirmed
6	Happiness $\times$ Artificial Intelligence Use $\rightarrow$ Innovative Behavior	0.113	2.298	Confirmed

According to Table 6, the results of the structural model evaluation demonstrate that all relationships among the research variables were significant at the 95% confidence level. Specifically, artificial intelligence use had a direct and positive effect on innovative behavior ( $t = 6.165$ ), student well-being ( $t = 6.984$ ), and digital literacy ( $t = 14.222$ ). Furthermore, digital literacy had a positive and significant effect on innovative behavior ( $t = 4.786$ ) and student well-being ( $t = 5.339$ ). In addition, the moderating effect of the “happiness” variable on the relationship between “artificial intelligence use” and “innovative behavior” was also significant ( $t = 2.298$ ), indicating the existence of a positive moderating effect of happiness. The path coefficients further indicated that artificial intelligence use positively affected innovative behavior ( $\beta = 0.357$ ), student well-being ( $\beta = 0.387$ ), and digital literacy ( $\beta = 0.541$ ), while digital literacy positively affected innovative behavior ( $\beta = 0.245$ ) and student well-being ( $\beta = 0.301$ ). The moderating effect of happiness ( $\beta = 0.113$ ) indicates the strengthening of the relationship between artificial intelligence use and innovative behavior at higher levels of happiness. Therefore, all research hypotheses were confirmed.

#### 4 Discussion

The findings of the present study demonstrated that artificial intelligence use had a significant and positive effect on students’ innovative behavior. This finding indicates that greater engagement with artificial intelligence technologies contributes to higher levels of idea generation, idea promotion, and idea implementation among students. The obtained result is consistent with previous studies emphasizing the positive role of artificial intelligence technologies in enhancing creativity, innovative engagement, and flexible thinking among learners (Ma et al.,

2024; Rafiq & Ahmad, 2025; Zhou & Peng, 2025). Similarly, Hosseinzadeh et al. reported that AI-based education positively affects students’ academic creativity and cognitive innovation (Hosseinzadeh et al., 2025). The findings are also aligned with the theoretical assumptions of social-cognitive theory proposed by Ng and Lucianetti, which emphasize that technological environments enhancing self-efficacy and cognitive flexibility can strengthen innovative behavior (Ng & Lucianetti, 2016). Artificial intelligence technologies provide students with rapid access to information, adaptive feedback, and interactive educational experiences, all of which facilitate experimentation, problem-solving, and creative exploration. Furthermore, AI-supported systems reduce repetitive cognitive burdens and allow students to devote greater cognitive resources to innovation-oriented activities. In contemporary educational settings, students increasingly rely on intelligent systems for brainstorming, content generation, and idea evaluation, which may explain the strengthening of innovative behavior through AI utilization. Additionally, AI technologies encourage collaborative learning and interdisciplinary thinking, which are important prerequisites for innovation development in educational contexts.

Another important finding of the present study was that artificial intelligence use positively influenced students’ well-being. This result suggests that students who use artificial intelligence technologies more effectively experience higher levels of psychological, social, and physical well-being. This finding is consistent with previous studies indicating that digital and AI-supported educational environments can improve students’ learning satisfaction, emotional adjustment, and educational engagement (Chiu et al., 2023; Maunula et al., 2023). Ma et al. demonstrated that AI usage in college teaching enhances students’

psychological well-being by improving learning adaptability and reducing educational stress (Ma et al., 2024). Moreover, Everett highlighted that technologically enriched learning environments increase students' engagement and emotional satisfaction through personalized educational experiences (Everett, 2017). Artificial intelligence systems may contribute to well-being because they facilitate individualized instruction, immediate feedback, and flexible learning opportunities that accommodate students' academic needs and learning preferences. When students perceive educational technologies as supportive rather than threatening, they are more likely to experience emotional comfort and academic confidence. In addition, AI tools can reduce feelings of uncertainty and academic frustration by simplifying access to educational resources and offering personalized assistance. The present findings also correspond with the conceptualization of well-being proposed by Zheng et al., who emphasized the importance of supportive organizational and educational environments for fostering positive psychological functioning (Zheng et al., 2015). Therefore, artificial intelligence technologies may function as supportive educational resources that strengthen students' emotional adjustment and educational satisfaction.

The results further revealed that artificial intelligence use had a positive effect on students' digital literacy. This finding is theoretically and empirically meaningful because AI technologies inherently require students to engage with digital platforms, evaluate online information, and develop technological competencies. The result is consistent with previous studies emphasizing the close relationship between AI engagement and digital literacy development (Bender, 2024; Kazanidis & Pellas, 2024). Ng et al. argued that interaction with artificial intelligence systems contributes to the development of twenty-first-century digital competencies and technological awareness among learners (Ng et al., 2023). Likewise, Long and Magerko highlighted that AI literacy and digital literacy are closely interconnected because students must understand algorithmic systems, critically interpret AI outputs, and interact effectively with intelligent technologies (Long & Magerko, 2020). Artificial intelligence environments expose students to diverse digital tools, interactive interfaces, and technologically mediated problem-solving processes, thereby enhancing digital competence through repeated engagement. Furthermore, AI-supported educational activities encourage students to become active participants in digital ecosystems rather than passive recipients of information. This process gradually strengthens their digital confidence, technological self-

efficacy, and capacity to navigate complex digital environments. In modern educational systems, digital literacy has become essential not only for academic success but also for psychological adaptation and future employability. Therefore, the positive relationship between AI use and digital literacy reflects the broader transformation of education toward digitally integrated learning environments.

The findings additionally showed that digital literacy positively influenced innovative behavior. This result indicates that students with stronger digital literacy skills are more capable of generating innovative ideas and engaging in creative educational activities. This finding aligns with previous studies demonstrating that digital literacy enhances students' creativity, adaptability, and cognitive flexibility (Kazanidis & Pellas, 2024; Quaicoe & Pata, 2020). Digital literacy enables students to access diverse sources of information, evaluate digital content critically, and utilize technological resources creatively for solving academic problems. Students with higher digital competence are generally more confident in experimenting with new technologies and integrating digital tools into their learning activities, which promotes innovation-oriented behaviors. Moreover, digital literacy enhances students' self-regulation and information management abilities, allowing them to process knowledge more effectively and transform information into innovative outcomes. The present finding is also compatible with the work of Zhou and Peng, who suggested that AI literacy and digital competence strengthen students' creativity and engagement within technology-supported educational environments (Zhou & Peng, 2025). Therefore, digital literacy may serve as an important cognitive and technological foundation underlying innovative behavior in modern educational systems.

The results also demonstrated that digital literacy positively affected students' well-being. This finding suggests that students possessing stronger digital competencies experience greater psychological and social adjustment within educational settings. The finding is consistent with previous research emphasizing the beneficial role of digital literacy in reducing digital stress, strengthening self-regulation, and promoting digital well-being (Gera et al., 2025; Ibrahim et al., 2024). Ibrahim et al. found that digital literacy mediates important psychological processes and contributes to improved emotional adjustment among students (Ibrahim et al., 2024). Digitally literate students are more capable of navigating online environments safely and efficiently, reducing feelings of confusion,

frustration, and technological anxiety. They also possess greater control over their digital behaviors and are more likely to use educational technologies in balanced and productive ways. In contrast, students with limited digital literacy may experience stress, dependency, and cognitive overload when interacting with technological systems. Therefore, digital literacy functions not only as a technological competency but also as a protective psychological resource that facilitates emotional stability and educational satisfaction. In highly digitalized educational systems, students who understand technological environments effectively are more likely to perceive digital learning as empowering and supportive rather than stressful and overwhelming.

Another significant finding of the study concerned the mediating role of digital literacy in the relationship between artificial intelligence use and both innovative behavior and student well-being. This finding indicates that artificial intelligence contributes to positive educational and psychological outcomes partly through improving students' digital literacy competencies. This result is supported by studies suggesting that the benefits of AI technologies are strongly dependent on learners' digital competencies and their ability to interact effectively with intelligent systems (Bender, 2024; Ng et al., 2023). Artificial intelligence alone may not automatically improve innovation or well-being unless students possess the necessary digital skills to use these technologies strategically and critically. The mediating role of digital literacy suggests that students who become more technologically competent through AI engagement are subsequently more capable of benefiting psychologically and behaviorally from digital learning environments. These findings also align with previous studies indicating that digital literacy serves as a central mechanism linking technological experiences with educational adjustment and creativity (Gera et al., 2025; Ibrahim et al., 2024). Consequently, the effectiveness of AI-supported education appears to depend significantly on the extent to which students develop digital literacy competencies alongside technological exposure.

The present study also confirmed the moderating role of happiness in the relationship between artificial intelligence use and innovative behavior. Specifically, the positive effect of artificial intelligence on innovative behavior became stronger at higher levels of happiness. This finding supports theoretical perspectives suggesting that positive emotional states broaden cognitive functioning and facilitate creativity, flexibility, and innovation-oriented thinking. The result is

consistent with previous studies demonstrating positive relationships between happiness and innovative or creative behavior (Ahmadi & Geramian, 2024; Rafiq & Ahmad, 2025). Happy students generally experience greater motivation, psychological resilience, and openness to new experiences, making them more willing to experiment with AI technologies and engage creatively with digital learning tools. Moreover, happiness may reduce fear of failure and technological anxiety, thereby encouraging students to use artificial intelligence more actively and innovatively. Torres-Reynoso et al. emphasized that happiness management and positive emotional experiences strengthen students' engagement and satisfaction within educational environments (Torres-Reynoso et al., 2025). Likewise, Laosum highlighted the importance of happiness in improving students' learning experiences and educational participation (Laosum, 2023). Therefore, happiness appears to function as an emotional catalyst that amplifies the positive educational effects of artificial intelligence technologies.

The findings of the present study can also be interpreted within broader educational and technological transformations occurring in post-pandemic learning environments. The COVID-19 pandemic accelerated the adoption of digital technologies and AI-supported learning systems worldwide, fundamentally altering students' educational experiences (Maunula et al., 2023). As educational systems increasingly integrate intelligent technologies, students' innovative capacities and psychological well-being become closely connected to their ability to adapt to digital environments. Artificial intelligence technologies are no longer supplementary educational tools but are becoming central components of learning ecosystems. Consequently, the ability to use AI effectively, maintain digital well-being, and engage innovatively with technological systems has become increasingly important for students' academic and psychological development. The present study contributes to the existing literature by demonstrating that the effects of artificial intelligence on students are multidimensional and shaped by both technological competencies and emotional factors.

## 5 Conclusion

One of the strengths of the present study is that it simultaneously examined technological, behavioral, cognitive, and emotional variables within a single structural

model. While many previous studies focused exclusively on the direct effects of artificial intelligence use, the current research demonstrated that digital literacy and happiness significantly influence the pathways through which AI affects students' outcomes. These findings suggest that educational policymakers and school administrators should avoid viewing artificial intelligence solely as a technological innovation and instead recognize its broader psychological and behavioral implications. Effective implementation of AI-based educational systems requires simultaneous attention to students' digital competencies, emotional well-being, and creative capacities.

The present study had several limitations that should be considered when interpreting the findings. First, the study employed a cross-sectional design, which limits the ability to infer causal relationships among variables. Second, the data were collected using self-report questionnaires, which may increase the possibility of response bias and social desirability effects. Third, the research sample was limited to secondary school students in the city of Langarud, which may restrict the generalizability of the findings to other educational levels or geographical regions. In addition, the study focused primarily on students' perceptions of artificial intelligence use rather than objective indicators of technology engagement. Finally, cultural, socioeconomic, and educational differences among students were not extensively examined, although these variables may influence digital literacy, happiness, and innovative behavior.

Future research is recommended to employ longitudinal and experimental designs in order to examine the long-term causal effects of artificial intelligence use on students' psychological and behavioral outcomes. Researchers are also encouraged to investigate additional mediating and moderating variables such as academic motivation, self-efficacy, technological anxiety, emotional intelligence, and family support. Comparative studies across different educational levels, cultural contexts, and countries may provide deeper insights into how artificial intelligence influences students under varying educational conditions. Furthermore, future studies could examine specific types of AI technologies separately, such as generative AI systems, intelligent tutoring systems, and educational chatbots, in order to identify their unique effects on student innovation and well-being.

From a practical perspective, educational policymakers and school administrators should design structured programs to improve students' digital literacy alongside the integration

of artificial intelligence technologies into educational systems. Schools should provide training workshops and practical learning opportunities that enable students to use AI tools critically, ethically, and creatively. In addition, educational institutions should implement psychological support and happiness-enhancement programs to strengthen students' emotional well-being and maximize the positive effects of AI-supported learning environments. Teachers should also be trained to integrate artificial intelligence into classroom instruction in ways that encourage innovation, creativity, and collaborative learning rather than passive technological dependence.

### **Authors' Contributions**

All authors have contributed significantly to the research process and the development of the manuscript.

### **Declaration**

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

### **Transparency Statement**

Data are available for research purposes upon reasonable request to the corresponding author.

### **Acknowledgments**

We would like to express our gratitude to all individuals helped us to do the project.

### **Declaration of Interest**

The authors report no conflict of interest.

### **Funding**

According to the authors, this article has no financial support.

### **Ethical Considerations**

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were observed.

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