

DOI: 10.5281/zenodo.19474933

STRUCTURAL MODEL OF ARTIFICIAL INTELLIGENCE USE, ACADEMIC MOTIVATION, AND ACADEMIC ENGAGEMENT IN UNIVERSITY STUDENTS

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Received: 24/10/2025

Accepted: 09/01/2026

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ABSTRACT

The aim of this study was to analyze a structural model relating artificial intelligence use, academic motivation, and academic engagement among university students, in order to determine the direct and indirect relationships among these variables in the context of higher education. The theoretical framework is grounded in self-determination theory, the threedimensional model of academic engagement, and contemporary perspectives on artificial intelligence within digital culture, which emphasize its role not only as a technological tool but also as a transformative element in educational and social practices. The research followed a quantitative approach with a non-experimental, cross-sectional, and explanatory design. The sample consisted of university students who use generative artificial intelligence tools for academic purposes. Data were collected through a structured questionnaire assessing artificial intelligence use, academic motivation, and academic engagement, and were analyzed using Structural Equation Modeling (SEM). The results showed that artificial intelligence use positively influences both academic motivation and academic engagement, with academic motivation acting as a partial mediator in this relationship. These findings suggest that the pedagogical integration of artificial intelligence contributes not only to learning processes but also to the configuration of digital culture in higher education, influencing how students interact with knowledge and develop academic involvement. The originality of the study lies in the empirical validation of a structural model that integrates technological, psychoeducational, and sociocultural dimensions to explain student engagement.

KEYWORDS: artificial intelligence, academic motivation, academic engagement, higher education, structural equation modeling.

1. INTRODUCTION

The incorporation of generative artificial intelligence (AI) into higher education has accelerated significantly following the public emergence of tools such as ChatGPT, developed by OpenAI. This technological advancement has begun to transform traditional dynamics of university learning, enabling students to generate academic texts, solve complex problems, and access personalized explanations in real time. Recent studies have examined the impact of generative AI on educational processes, highlighting both pedagogical opportunities and challenges related to critical thinking, academic integrity, and student autonomy (Kasneci et al., 2023; Lo, 2023). In this context, the use of AI-based tools is rapidly expanding in university environments, raising new questions about their influence on psychological variables associated with learning.

At the international level, organizations such as UNESCO have emphasized that artificial intelligence can significantly contribute to the personalization of learning, improve access to knowledge, and support more flexible and inclusive educational processes (UNESCO, 2023). However, there is also a recognized need for rigorous empirical research examining the effects of these technologies on key psychoeducational dimensions. In this regard, Cotton et al. (2024) argue that the use of generative AI tools in higher education raises important concerns about learning quality and the role of students in knowledge construction. Similarly, Dwivedi et al. (2023) highlight that the growing adoption of artificial intelligence in educational contexts requires robust theoretical frameworks and analytical models to better understand its influence on students' cognitive, motivational, and behavioral processes.

Among the psychological variables associated with university learning, academic motivation is one of the most relevant factors in explaining academic performance, persistence, and engagement in learning activities. From the perspective of contemporary educational psychology, academic motivation is closely linked to self-regulated learning processes, perceived competence, and autonomy. In technology-mediated learning environments, several studies suggest that digital tools can enhance intrinsic motivation when they promote interactive and adaptive learning experiences (Tlili et al., 2023; Lim et al., 2023). However, it has also been argued that an overly instrumental use of artificial intelligence may lead to technological dependency or reduce students' cognitive effort if it replaces

processes of analysis and critical reflection (Chan & Hu, 2023). These findings highlight the need to empirically examine the relationship between artificial intelligence use and motivational processes in higher education.

On the other hand, academic engagement has become a key construct for understanding students' level of involvement in learning. It is defined as a positive psychological state related to study, characterized by vigor, dedication, and absorption. Recent research has shown that academic engagement is significantly associated with academic performance, satisfaction with the university experience, and student retention (Carmona-Halty, Schaufeli, & Salanova, 2019; Bedenlier et al., 2023). In digitally transformed educational environments, advanced educational technologies are considered capable of enhancing engagement when they facilitate active, collaborative, and meaningful learning experiences (Zawacki-Richter et al., 2023). In this sense, it is relevant to analyze how the use of artificial intelligence tools relates to students' levels of academic engagement.

Despite the growing body of research on artificial intelligence in higher education, recent literature reviews reveal an important limitation. Most studies have focused on analyzing perceptions, attitudes, or levels of acceptance of artificial intelligence among students and teachers. However, there is still a lack of studies that develop explanatory models integrating artificial intelligence use with key psychoeducational variables such as academic motivation and academic engagement. This gap limits the understanding of the direct and indirect effects that artificial intelligence may have on psychological processes associated with university learning.

In this context, the present study aims to analyze a structural model of artificial intelligence use, academic motivation, and academic engagement among university students. Specifically, it seeks to determine whether artificial intelligence use directly and indirectly influences academic engagement, considering the mediating role of academic motivation. Based on this approach, the following research hypotheses are proposed: H1: artificial intelligence use positively influences academic motivation; H2: academic motivation positively influences academic engagement; H3: artificial intelligence use positively influences academic engagement; and H4: academic motivation mediates the relationship between artificial intelligence use and academic engagement.

2. THEORETICAL FRAMEWORK

2.1 *Artificial Intelligence in Higher Education*

Artificial intelligence (AI) has emerged as one of the most influential technologies driving the digital transformation of higher education. In particular, the development of generative AI systems, such as ChatGPT developed by OpenAI, has expanded the possibilities of interaction between students and digital learning support systems, enabling the generation of academic texts, the solution of complex problems, and the provision of personalized explanations through conversational interfaces.

Numerous studies have highlighted the potential of artificial intelligence to enhance teaching and learning processes by providing more personalized and adaptive educational experiences (Kasneji *et al.*, 2023; Lo, 2023). These tools offer immediate feedback, support autonomous learning, and facilitate access to large volumes of academic information.

Within the field of educational research, several scholars have examined the role of artificial intelligence in transforming educational systems. Wayne Holmes argues that AI-based technologies can foster personalized learning and new forms of interaction between students and knowledge. Similarly, Dirk Ifenthaler emphasizes that the integration of artificial intelligence in higher education can strengthen self-regulated learning processes through learning analytics and intelligent systems.

Furthermore, Cukurova (2025) highlights that artificial intelligence can improve learning quality when it is pedagogically integrated in an appropriate manner. However, several challenges have also been identified, particularly regarding learning quality, the development of critical thinking, and academic integrity (Cotton *et al.*, 2024; Dwivedi *et al.*, 2023). In this context, international organizations such as UNESCO indicate that artificial intelligence can expand access to knowledge and strengthen educational systems, while also emphasizing the need for empirical research examining its effects on psychoeducational variables.

In the contemporary context, artificial intelligence should not be understood solely as a technological tool, but also as a central element in the configuration of digital culture. Its increasing integration into everyday life and educational environments is transforming modes of knowledge access, information production, and social interaction (Dwivedi *et al.*, 2023; UNESCO, 2023). From this perspective, artificial intelligence operates within a broader sociotechnical ecosystem that shapes

cultural practices, cognitive habits, and educational processes (Holmes, 2022). Moreover, its social impact raises important challenges related to ethics, student autonomy, and the development of critical thinking, particularly in contexts where its use may mediate or replace traditional learning processes (Zawacki-Richter *et al.*, 2019). Therefore, it is essential to understand artificial intelligence not only from an instrumental perspective, but also as a cultural and social phenomenon that redefines the ways of learning, teaching, and constructing knowledge in higher education.

2.2 *Academic Motivation*

Academic motivation is one of the central constructs in educational psychology due to its strong influence on academic performance, persistence, and students' engagement with learning. It refers to the set of psychological processes that activate, direct, and sustain goal-oriented behaviors related to academic achievement.

One of the most influential theoretical frameworks for understanding motivation is the Self-Determination Theory, developed by Edward L. Deci and Richard M. Ryan, which posits that human motivation is grounded in the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. When these needs are fulfilled, individuals tend to experience higher levels of intrinsic motivation, well-being, and engagement in their activities.

In the educational context, numerous studies have shown that students who perceive greater autonomy and competence in their learning processes tend to develop higher levels of academic motivation (Ryan & Deci, 2020). In this regard, these authors emphasize that educational environments that support student autonomy foster deeper and more sustained forms of motivation.

In digital learning environments, educational technologies have been found to influence students' levels of motivation. Recent studies indicate that such tools can enhance perceptions of competence by providing immediate support in completing academic tasks (Lim *et al.*, 2023; Tlili *et al.*, 2023). In addition, Paul A. Kirschner highlights that digital environments can promote self-regulated learning processes when technologies are used strategically by students.

However, some studies warn that excessive reliance on automated technologies may reduce cognitive effort if these tools replace active processes of analysis and critical reflection (Chan & Hu, 2023). Therefore, it is important to empirically examine the

relationship between artificial intelligence use and academic motivation among university students.

2.3 Academic Engagement

Academic engagement has become a key construct for understanding students' level of involvement in their educational process. It is defined as a positive psychological state associated with learning, characterized by high levels of energy, dedication, and concentration in academic activities.

Academic engagement is grounded in the Utrecht Work Engagement Model developed by Wilmar B. Schaufeli and Arnold B. Bakker, which proposes three main dimensions: vigor, dedication, and absorption. Vigor refers to high levels of energy and persistence when facing academic demands; dedication involves enthusiasm, pride, and a sense of significance in study activities; while absorption describes a state of deep concentration during learning.

Several studies have shown that academic engagement is positively related to academic performance, satisfaction with the university experience, and student retention (Schaufeli, 2022). Likewise, Jennifer A. Fredricks highlights that engagement is a fundamental indicator of the degree of student involvement in the learning process.

In digital education environments, recent studies suggest that educational technologies can contribute to strengthening engagement when they promote active and meaningful learning experiences (Bedenlier et al., 2023). In this regard, Alexander Bedenlier notes that interactive digital environments can increase student involvement by enabling new forms of interaction with knowledge.

3. METHOD

The present study was conducted under a quantitative approach, aimed at analyzing relationships between variables through inferential statistical procedures. The research is applied in nature, as it seeks to generate empirical evidence regarding the impact of artificial intelligence use on relevant variables in the university educational process.

The design corresponds to a non-experimental, cross-sectional study, since the variables were observed in their natural context without researcher manipulation and the data were collected at a single point in time. Additionally, the study adopts an explanatory design using structural modeling, with the aim of analyzing the direct and indirect relationships between artificial intelligence use, academic motivation, and academic engagement

among university students. To evaluate these relationships, Structural Equation Modeling (SEM) was employed, a multivariate statistical technique that allows for the simultaneous analysis of the measurement model and the structural model involving latent variables.

The study population consisted of university students enrolled in higher education programs during the data collection period. The sample was selected using non-probabilistic purposive sampling, considering the voluntary participation of students who met the criterion of having used generative artificial intelligence tools for academic purposes. This type of sampling is appropriate when analyzing phenomena associated with specific user groups. The sample size was considered adequate for structural equation modeling, as such models generally require samples larger than 200 participants to ensure stability of estimates and reliability of model parameters.

Data were collected using the survey method through a structured questionnaire administered in digital format. The instrument consisted of three main scales. First, a scale was included to measure artificial intelligence use, aimed at identifying the frequency and ways in which students use generative AI tools in their academic activities, such as information searching, text generation, task support, and problem-solving.

Second, academic motivation was assessed using an adapted version of the Academic Motivation Scale (AMS), an instrument based on Self-Determination Theory that allows the analysis of different levels of motivation toward learning, including intrinsic motivation and various forms of extrinsic motivation. Finally, academic engagement was measured using an adapted version of the Utrecht Work Engagement Scale for Students (UWES-S), a widely used instrument in educational research that evaluates three fundamental dimensions of engagement: vigor, dedication, and absorption, understood as indicators of students' levels of energy, enthusiasm, and concentration in their academic activities.

Responses were recorded using a five-point Likert scale, where higher values indicate higher levels of the construct being measured. The validity and reliability of the instrument were assessed using several statistical procedures. Internal consistency was evaluated through Cronbach's alpha coefficient, while Composite Reliability (CR) and Average Variance Extracted (AVE) were used to assess construct reliability and convergent validity. According to established criteria, CR values above

0.70 and AVE values above 0.50 indicate adequate levels of reliability and convergent validity. Discriminant validity was examined using the Fornell-Larcker criterion, which states that the square root of the AVE of each construct should be greater than the correlations between that construct and the others in the model.

Data analysis was conducted in several stages. First, a descriptive statistical analysis was performed using measures of central tendency and dispersion (mean and standard deviation) to examine the distribution of variables. Subsequently, Pearson correlation analysis was applied to identify preliminary relationships between the study constructs. Finally, Structural Equation Modeling (SEM) was used to simultaneously evaluate the measurement and structural models, as well as to test the proposed conceptual model and research hypotheses.

Model fit was assessed using several goodness-of-fit indices commonly reported in the literature, including the relative chi-square (χ^2/df), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). According to widely accepted criteria, CFI and TLI values above 0.90, as well as RMSEA and SRMR values below 0.08, indicate an adequate fit of the model to the observed data.

Finally, the study adhered to ethical principles applicable to research involving human participants. Participation was voluntary and anonymous, ensuring the confidentiality of the information provided. Prior to completing the questionnaire, participants were informed about the objectives of the study and provided informed consent, guaranteeing that the collected data would be used exclusively for academic purposes.

4. RESULTS AND DISCUSSION

Descriptive analyses showed moderately high levels in the study variables: artificial intelligence use ($M = 3.78$, $SD = 0.82$), academic motivation ($M = 3.65$, $SD = 0.74$), and academic engagement ($M = 3.72$, $SD = 0.69$). The internal consistency of the instruments was adequate (Cronbach's alpha > 0.88).

Table 1. Descriptive statistics and internal consistency

Variable	Mean	SD	Cronbach's Alpha
AI use	3.78	0.82	0.88
Academic motivation	3.65	0.74	0.91
Academic engagement	3.72	0.69	0.93

Pearson correlation analyses indicated positive and significant relationships among all variables: AI

use-motivation ($r = 0.48$, $p < 0.01$), motivation-engagement ($r = 0.62$, $p < 0.01$), and AI use-engagement ($r = 0.41$, $p < 0.01$), supporting the estimation of the structural model.

Table 2. Correlation matrix

Variable	1	2	3
1. AI use	—	0.48**	0.41**
2. Motivation	0.48**	—	0.62**
3. Engagement	0.41**	0.62**	—

Note: $p < 0.01$

Confirmatory factor analysis showed an adequate model fit: $\chi^2/df = 2.31$, CFI = 0.94, TLI = 0.93, RMSEA = 0.056, and SRMR = 0.047. Factor loadings were all significant ($p < 0.001$) and above 0.70, confirming the adequate representation of the items. Composite reliability and average variance extracted exceeded recommended thresholds, and discriminant validity was confirmed using the Fornell-Larcker criterion and HTMT ratio.

Table 3. Reliability and convergent validity

Construct	CR	AVE
AI use	0.93	0.69
Academic motivation	0.91	0.66
Academic engagement	0.94	0.72

The structural equation model (SEM) showed satisfactory fit (CFI = 0.94, TLI = 0.93, RMSEA = 0.058, SRMR = 0.049). AI use positively influenced academic motivation ($\beta = 0.48$, $p < 0.001$), and motivation significantly predicted academic engagement ($\beta = 0.55$, $p < 0.001$). The direct effect of AI use on engagement was smaller ($\beta = 0.19$, $p = 0.012$), indicating that motivation acts as a partial mediator.

Table 4. SEM structural coefficients

Relationship	β	SE	p	Result
AI use → Motivation	0.48	0.06	<.001	Supported
Motivation → Engagement	0.55	0.05	<.001	Supported
AI use → Engagement	0.19	0.07	0.012	Supported

The results of the structural model indicate that artificial intelligence use not only directly influences academic engagement, but that its effect is primarily explained through motivational processes, reinforcing the central role of academic motivation as a mediating mechanism in digitally mediated learning contexts. These findings are consistent with previous studies highlighting the potential of artificial intelligence to enhance autonomous and personalized learning processes (Holmes, 2022; Zawacki-Richter et al., 2019). Beyond a strictly instrumental interpretation, the results can be

understood from a sociotechnical perspective, in which artificial intelligence is configured as a component of digital culture that reshapes how students interact with knowledge (Dwivedi et al., 2023; UNESCO, 2023).

In this sense, the integration of artificial intelligence tools in higher education not only optimizes access to information but also transforms cognitive practices and learning dynamics, promoting more autonomous, personalized, and interactive learning experiences. However, the observed mediated effect suggests that the impact of artificial intelligence on academic engagement is not automatic, but depends on its capacity to activate deeper motivational processes. This aligns with recent approaches emphasizing the need for a critical pedagogical integration of artificial intelligence to avoid technological dependency or a potential reduction in cognitive effort (Dwivedi et al., 2023).

From a theoretical perspective, the results support Self-Determination Theory (Ryan & Deci, 2020), showing that artificial intelligence can facilitate the satisfaction of basic psychological needs—autonomy, competence, and relatedness—thereby strengthening motivation and engagement. Furthermore, the study confirms the relevance of the academic engagement model (Schaufeli, 2022), demonstrating that student engagement depends not only on technological availability but also on the motivational impact generated.

From an applied perspective, the findings suggest that higher education institutions should integrate artificial intelligence within pedagogical strategies that promote active learning, critical reflection, and students' holistic development, in line with UNESCO (2023) recommendations on the ethical and educational use of artificial intelligence.

Among the limitations, the cross-sectional design prevents the establishment of definitive causal relationships. Future research could employ longitudinal designs, incorporate variables such as self-efficacy, self-regulation, and digital literacy, and conduct multigroup analyses based on gender, academic discipline, or experience with artificial intelligence.

Overall, this study provides empirical validation of a structural model integrating technological and psychoeducational variables, confirming that artificial intelligence use positively influences academic engagement primarily through motivation, offering a useful explanatory framework for pedagogical decision-making and future research in higher education.

5. CONCLUSIONS

The present study aimed to analyze a structural model linking artificial intelligence use, academic motivation, and academic engagement among university students. The results allow us to conclude that the proposed model presents adequate fit indices and significantly explains the behavior of academic engagement, confirming the relevance of the structural approach adopted.

Regarding the general hypothesis, the findings show that artificial intelligence use significantly influences academic engagement, both directly and indirectly through academic motivation. This result confirms that AI-based technologies can contribute to student engagement when they are integrated into learning processes as cognitive and academic support tools.

Furthermore, the specific hypotheses were empirically confirmed. First, it was found that artificial intelligence use exerts a positive effect on academic motivation, suggesting that these tools can enhance students' perceptions of competence, autonomy, and the usefulness of learning. Second, academic motivation was shown to be a significant predictor of academic engagement, confirming its central role in students' involvement in learning activities. Finally, academic motivation was found to act as a partial mediating variable in the relationship between artificial intelligence use and engagement, indicating that the impact of these technologies on academic engagement is primarily explained through motivational processes.

In this regard, the results suggest that the educational effect of artificial intelligence does not depend solely on its technological availability, but rather on its capacity to stimulate motivational processes that foster student participation, interest, and dedication to learning. Academic motivation thus emerges as the central explanatory mechanism of the model, acting as the psychological bridge connecting the use of technological tools with the development of academic engagement.

From a theoretical perspective, this study contributes to expanding the understanding of the role of artificial intelligence in higher education by integrating technological and psychoeducational approaches within an explanatory structural model. In particular, the findings allow the articulation of elements from the Technology Acceptance Model, Self-Determination Theory, and the three-dimensional model of academic engagement, providing empirical evidence that supports the interaction between technological, motivational, and behavioral factors in university learning processes.

From a practical perspective, the findings suggest that the implementation of artificial intelligence tools in higher education should be oriented toward pedagogical strategies that promote autonomy, self-regulation, and active learning. In this sense, higher education institutions have the responsibility to design policies and educational practices that encourage the ethical, critical, and formative use of artificial intelligence, ensuring that these technologies effectively contribute to strengthening students' academic engagement.

In summary, the study demonstrates that artificial intelligence can become a relevant pedagogical resource in higher education when its integration is linked to the strengthening of academic motivation. The validated structural model provides an explanatory framework for understanding how emerging technologies can influence student engagement, offering empirical evidence to the contemporary debate on the role of artificial intelligence in university educational processes.

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