JAAIE : Journal of Applied Artificial Intelligence in Education

Journal of Applied Artificial Intelligence in Education
E-ISSN: 3109-7081
https://journal.lontaradigitech.com/JAAIE

Affective Dynamics and Ethics of AI Use among Higher Education Students: A PLS-SEM Study

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ARTICLE INFO

Keywords:

Affective Engagement;
AI Interaction Quality;
Artificial Intelligence;
Emotional Well-Being;
Ethical Awareness

Article History

Received: Oct 7, 2025
Revised : Dec 26. 2025
Accepted : Jan 5, 2026

ABSTRACT

The use of artificial intelligence (AI) in higher education is increasing rapidly, raising questions about how emotional well-being, AI credibility, and AI interaction quality shape students' affective engagement and ethical awareness. This study employs a quantitative cross-sectional design and analyzes data using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results show that emotional well-being ($\beta = 0.549$, $p < 0.001$) and AI interaction quality ($\beta = 0.420$, $p < 0.001$) significantly affect affective engagement, while AI credibility has no significant effect ($\beta = -0.045$, $p = 0.342$). Affective engagement significantly influences ethical awareness ($\beta = 0.597$, $p < 0.001$) and mediates the effects of emotional well-being and interaction quality. The model explains substantial variance in affective engagement ($R^2 = 0.561$) and moderate variance in ethical awareness ($R^2 = 0.357$). These findings highlight the importance of emotional and interactional factors in fostering ethical awareness and support the need for human-centered and ethically grounded AI integration in education.

To cite this article : Author. (2026). Title. Journal of Applied Artificial Intelligence in Education, 1(2), 86-96.

INTRODUCTION

The development of Artificial Intelligence in Education (AIED) has brought fundamental changes to the global learning system due to its ability to tailor learning experiences to individual needs [1] . This technology promotes a more adaptive and efficient learning process [2]. The OECD (2023) emphasizes that the application of AI must take into account the principles of fairness and ethical responsibility, while UNESCO (2024) stresses the importance of AI literacy based on human values so that technology not only functions as a learning tool but also strengthens character and social empathy. In the Indonesian context, the integration of AIED needs to be directed not only at digital competence but also at shaping students' moral sensitivity and empathy so that its use is sustainable and equitable [3] [4].

Work towards this balance is beginning to take shape through various AIED initiatives in higher education, such as Socrates AI, Pintar Kampus, and Ruang Belajar AI, which help to adapt learning materials [5] [6]. However, despite the increasing use of AI, some students still face challenges in maintaining motivation and trust in AI systems [7] [8]. Thus, emotional aspects and perceptions of AI are important foundations for understanding students' affective engagement [1] [6].

This affective involvement is related to research showing that affective and ethical aspects both play a role in technology-based learning [9]. Studies confirm that emotional well-being and affective engagement increase motivation and learning experiences [10][11], while other studies

emphasize the importance of ethical awareness in the use of AI [9] [12]. These differences in focus indicate the need for research that integrates affective and ethical aspects in order to understand how emotional experiences and interactions with AI contribute to the formation of students' ethical awareness.

These limitations further emphasize the importance of understanding the relationship between affective and ethical aspects. Based on Social Cognitive Theory (Bandura, 1986), emotional experiences influence a person's thinking and ethical judgment processes [13]. This line of thinking is consistent with a research framework that places emotional well-being, AI credibility, and AI interaction quality as factors that shape affective engagement, which in turn influences the development of ethical awareness. Thus, understanding this relationship is important for explaining the formation of students' ethical foundations through their experiences interacting with AI.

Based on this understanding, this study aims to analyze the influence of emotional well-being, AI credibility, and AI interaction quality on students' ethical awareness with affective engagement as a mediating variable. This study also aims to explain the relationship between affective and ethical factors in the use of AI technology and provide a comprehensive overview of the role of affective aspects in shaping students' ethical awareness as a basis for developing learning strategies that support the reflective and responsible use of AI.

Based on these objectives, this study formulates the following research questions:

RQ1 How do emotional well-being, AI credibility, and AI interaction quality affect students' affective engagement in the use of AI technology in higher education?

RQ2 How do emotional well-being, AI credibility, and AI interaction quality affect students' affective engagement in the use of AI technology in higher education?

RQ3 Does affective engagement mediate the influence of emotional well-being, AI credibility, and AI interaction quality on students' ethical awareness?

METHOD

Research Design:

This study used a quantitative approach with a cross-sectional design conducted once in a single data collection period. This design was chosen because it was suitable for analyzing the relationship between variables empirically in accordance with the research objectives [14].

Participant:

The participants in this study were students at Makassar State University who had used AI-based technology, such as ChatGPT, Perplexity, or Gemini, in their academic activities [15]. Participation was voluntary, and all respondents gave their consent before completing the questionnaire [16].

Population/Sampling:

The research population included active UNM students who used AI in the learning process. Purposive sampling was used based on three inclusion criteria: (1) active as a student, (2) having experience using AI for academic purposes, (3) willing to complete all items in the research instrument. The sample size was determined using the rule of thumb in quantitative research, which is a minimum of 5–10 times the number of indicators, so that the sample size used met the PLS-SEM analysis feasibility standard [17].

Ethical Considerations:

This research was conducted in accordance with social research ethics standards and has been approved by the study program/faculty. All participants provided informed consent prior to participation. The confidentiality of the collected data was maintained, and it was used solely for research purposes.

Instrument:

The research instrument consisted of 25 items representing five latent variables, compiled using a 4-point Likert scale [18] [19]. All items were adapted from instruments that had been validated in previous studies. Expert validation was conducted to ensure clarity of language and relevance of constructs.

Table 1. Research Instrument

Variable	Item	Statement	References
AI Credibility	AI-C1	I believe that the information provided by AI (Artificial Intelligence) is accurate, relevant, and academically accountable.	[11]
	AI-C2	I believe that AI has sufficient capabilities to assist the learning process with relevant and useful results.	
	AI-C3	I believe that the information generated by AI is objective, unbiased, and impartial.	
	AI-C4	I believe that AI operates with ethical standards and integrity in providing learning information.	
	AI-C5	I believe that the results provided by AI are consistent and transparently verifiable.	
AI Interaction Quality	AI-IQ1	I find that AI provides quick responses and helps me understand the subject matter.	[20]
	AI-IQ2	I feel that interactions with AI are natural and easy to understand.	
	AI-IQ3	AI is able to adjust its communication style to my level of understanding.	
	AI-IQ4	The feedback provided by AI is clear, specific, and useful for improving my learning.	
	AI-IQ5	My interactions with AI encourage active engagement and curiosity about the subject matter.	
	EWB1	I feel calmer and more confident when using AI for independent learning.	
	EWB2	AI helps me reduce anxiety when facing difficult tasks or material.	

Emotional Well-Being	EWB3	I have become more optimistic about my ability to understand material with the help of AI.	[11]
	EWB4	AI users create a more positive learning environment that supports my motivation to learn.	
	EWB5	AI helps me maintain a balance between academic pressure and my emotional state.	
Affective Engagement	AE1	I feel enthusiastic when using AI to explore new ideas or knowledge.	[20]
	AE2	AI makes me more focused and actively participate during the learning process.	
	AE3	I enjoy the learning experience using AI because it feels interactive and interesting.	
	AE4	AI fosters my curiosity about new topics relevant to learning.	
	AE5	I feel positively engaged and have an emotional connection with the AI system during the learning process.	
Ethical Awareness	EA1	I understand the importance of honesty, responsibility, and fairness in the use of AI in an academic environment.	[21]
	EA2	I realize that misuse of AI can damage academic integrity and public trust.	
	EA3	I feel responsible for ensuring that my use of AI does not violate ethical principles and the rights of others.	
	EA4	I always assess whether AI results are fair, transparent, and unbiased.	
	EA5	I am committed to using AI wisely, reflectively, and in accordance with academic values.	

Procedures:

The research procedure began with the development of instruments based on theoretical indicators and previous research findings, followed by expert validation. Once deemed feasible, the questionnaire was distributed online via Google Forms, preceded by informed consent. All responses were checked for completeness and compliance with participant criteria before data screening was conducted.

Data Analysis:

Data analysis includes descriptive analysis and inferential analysis. Descriptive analysis uses Jamovi to describe the characteristics of respondents and the trends of each research variable [22]. Inferential analysis is performed using Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS to test direct and indirect relationships between constructs, including the mediating role of affective engagement [23].

RESULTS AND DISCUSSION

Results

Respondent Demographic Profile

This study involved 78 student respondents with variations in gender, age, semester, field of study, and frequency of AI use for academic purposes. Understanding these demographic characteristics is important to ensure that the interpretation of the research results is carried out in the context of the relevant population.

Table 2. Respondent Characteristics

Characteristic	Category	n	%
Gender	Male	36	46.2
	Female	42	53.8
	Total	**78**	**100.0**
Age (years)	18	12	15.4
	19	41	52.6
	20	16	20.5
	21	7	9.0
	22	1	1.3
	23	1	1.3
	Total	**78**	**100.0**
Semester	I	7	9.0
	III	57	73.1
	V	6	7.7
	VII	8	10.3
	Total	**78**	**100.0**
Major	Non-STEM	19	24.4
	STEM	59	75.6
	Total	78	100.0
Frequency of AI Use (Academic)	1-2 times/week	7	9.0
	3-4 times/week	23	29.5
	Rarely	6	7.7
	Daily	42	53.8
	Total	**78**	**100.0**

Table 1 shows that this study involved students with quite diverse backgrounds and a relatively intensive level of AI utilization in academic activities. This condition provides a relevant context for interpreting the results of the subsequent analysis.

Outer Model

Measurement Model

The measurement model was evaluated to assess the quality of the indicators in representing each latent construct used in this study. Figure 2 presents the measurement model that describes the relationship between latent constructs and their indicators based on the PLS-SEM estimation results.

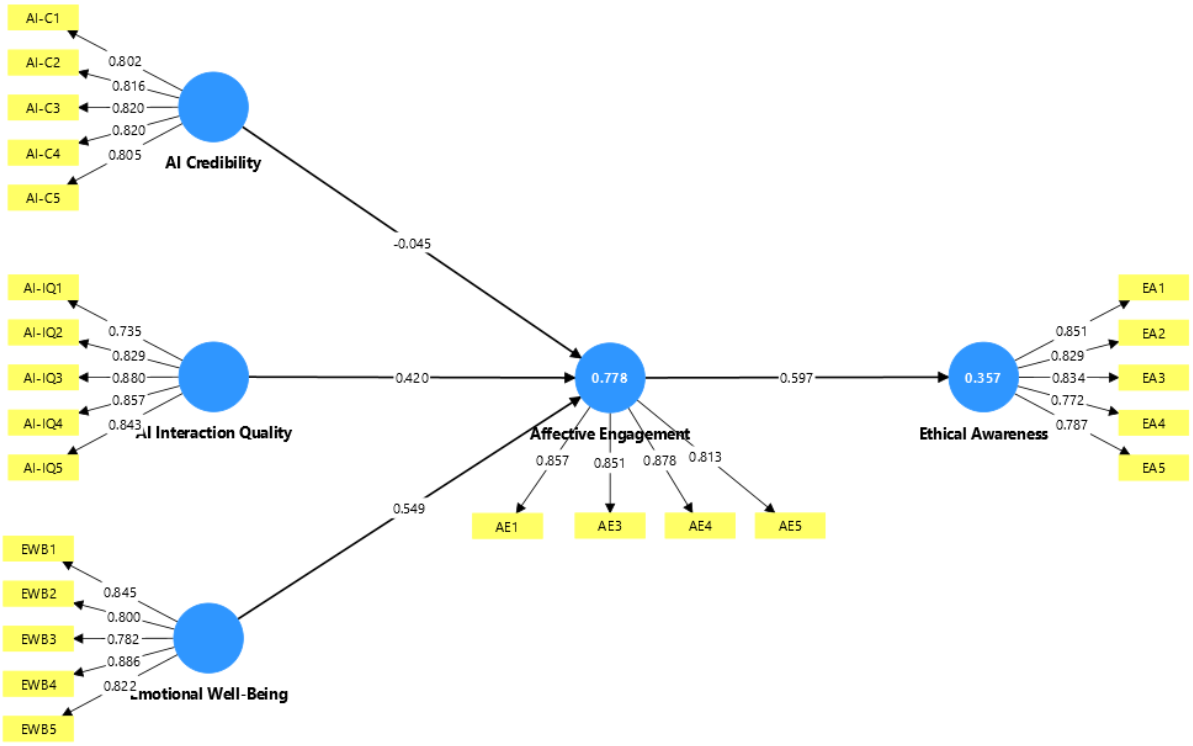

Figure 1. Outer Model

Figure 1 shows that all indicators have adequate loading values for the constructs they measure. Each construct is measured by several indicators with the direction of the relationship corresponding to the conceptual model of the study. This visualization provides an initial overview of the suitability of the indicators before quantitative testing is carried out through statistical reliability and validity measurements.

Table 3. Reliability and Validity Results

Construct	Items	Loading	Cronbach's Alpha	CR (rho_a)	CR (rho_c)	AVE
Affective Engagement	AE1	0.857	0.872	0.907	0.907	0.660
	AE3	0.851				
	AE4	0.878				
	AE5	0.813				
AI Credibility	AI-C1	0.802	0.887	0.917	0.917	0.689
	AI-C2	0.816				
	AI-C3	0.820				
	AI-C4	0.820				
	AI-C5	0.805				
AI Interaction Quality	AI-IQ1	0.735	0.872	0.913	0.918	0.723
	AI-IQ2	0.829				
	AI-IQ3	0.880				
	AI-IQ4	0.857				
	AI-IQ5	0.843				

Ethical	EA1	0.851	0.885	0.916	0.916	0.685
	EA2	0.829				
	EA3	0.834				
	EA4	0.772				
	EA5	0.787				
Emotional Well-Being	EWB1	0.845	0.873	0.908	0.908	0.664
	EWB2	0.800				
	EWB3	0.782				
	EWB4	0.886				
	EWB5	0.822				

The results in Table 3 show that all constructs meet the criteria for reliability and convergent validity. Cronbach's Alpha, rho_A, and Composite Reliability have values above 0.70, indicating good internal consistency. In addition, all AVE values are above 0.50, indicating that the constructs are able to adequately explain the variance of the indicators. Thus, the measurement model is deemed feasible to proceed to the structural model evaluation stage.

Table 4. Discriminant Validity (Fornell-Larcker)

Construct	AI Credibility	AI Interaction Quality	Affective Engagement	Emotional Well-Being	Ethical Awareness
AI Credibility	0.813				
AI Interaction Quality	0.712	0.830			
Affective Engagement	0.692	0.823	0.850		
Emotional Well-Being	0.799	0.793	0.846	0.828	
Ethical Awareness	0.543	0.670	0.597	0.489	0.815

The results in Table 4 indicate that all constructs in the model have met the criteria for discriminant validity, as shown by the Average Variance Extracted (AVE) square root value for each construct being higher than the correlation between other constructs. These findings confirm that each latent variable has adequate discriminatory power and represents the construct measured accurately and independently.

Inner Model

Inner model analysis was conducted to evaluate the relationship between latent constructs by testing path coefficients and statistical significance. This section presents the results of testing direct effects and indirect effects based on the bootstrapping process.

Table 5. Direct Effect Result

Relationship	β	STDEV	T-Statistics	p-Value	Description
Affective Engagement → Ethical Awareness	0.597	0.108	5.519	0.000	Significant
AI Credibility → Affective Engagement	–0.045	0.112	0.406	0.342	Not Significant
AI Interaction Quality → Affective Engagement	0.420	0.103	4.060	0.000	Significant
Emotional Well-Being → Affective Engagement	0.549	0.135	4.056	0.000	Significant

The path testing results in Table 5 show that Affective Engagement has a positive and significant effect on Ethical Awareness. In addition, AI Interaction Quality and Emotional Well-Being are also proven to have a significant positive effect on Affective Engagement. Conversely, AI Credibility does not show a significant effect on Affective Engagement. This pattern indicates that students' affective engagement is more influenced by the quality of the interaction experience and the emotional conditions that arise during AI use than by cognitive assessments related to system credibility.

Table 6. R-Square

Construct	R-Square	R-Square Adjusted
Affective Engagement	0.778	0.769
Ethical Awareness	0.357	0.348

The results of the coefficient of determination test in Table 6 show that the model has a very strong explanatory power for Affective Engagement and a moderate explanatory power for Ethical Awareness. These findings indicate that Emotional Well-Being, AI Interaction Quality, and AI Credibility collectively explain substantial variation in students' affective engagement, while the formation of Ethical Awareness is more indirectly influenced through affective engagement arising from experiences interacting with AI. Overall, these results confirm that the affective pathway is the main mechanism in the model that bridges user experience factors with the formation of students' ethical awareness.

Table 7. Indirect Effect Result

Indirect Relationship	β	STDEV	T-Statistics	p-Value	Description
AI Credibility → Ethical Awareness (via AE)	–0.027	0.070	0.388	0.349	Not significant
AI Interaction Quality → Ethical Awareness (via AE)	0.251	0.086	2.929	0.002	Significant
Emotional Well-Being → Ethical Awareness (via AE)	0.328	0.096	3.414	0.000	Significant

The results of the test in Table 7 show that Affective Engagement significantly mediates the influence of AI Interaction Quality and Emotional Well-Being on Ethical Awareness. This finding confirms that interaction quality and emotional conditions do not directly shape ethical awareness, but rather work through the process of affective engagement that arises during AI use. Conversely, no mediating effect was found in the relationship involving AI Credibility, consistent with the direct test results showing that credibility is not strong enough to generate the affective engagement necessary for the formation of ethical awareness.

Discussion

The results of the study indicate that Affective Engagement has a significant influence on students' Ethical Awareness. This finding reinforces that ethical awareness in the use of AI is not only shaped by cognitive processes, but also emerges from emotional responses during technological interactions. This aligns with Holmes et al. (2023), who emphasize that emotional engagement plays a central role in moral reasoning within digital learning environments [3].

The next finding confirms that AI Interaction Quality significantly affects Affective Engagement. Responsive, clear, and easy-to-understand interactions create comfort and enhance the positivity of students' learning experiences. This is consistent with Garzón et al. (2025), who state that the quality of human–AI interaction is a key determinant of emotional engagement in AIED contexts [2]. Thus, strong interaction quality fosters a deeper psychological connection between students and AI systems.

Emotional Well-Being is also shown to significantly influence Affective Engagement. Students who perceive emotional support through AI—such as reduced pressure and increased confidence—are more likely to develop positive emotional involvement with technology. This result is reinforced by Masna et al. (2025) and Almufarreh (2024), who noted that positive emotional conditions enhance the intensity of engagement and sustained participation in learning activities [10] [11].

Conversely, AI Credibility did not show a significant effect on Affective Engagement. This pattern likely emerged because students perceive credibility as a baseline technical requirement that AI should inherently possess, thus not strong enough to trigger emotional responses. A similar argument is presented by Pavlou and Gefen (2004), who explain that credibility and trust primarily affect cognitive-based evaluations such as intention to use, rather than emotional attachment [24]. Given students' frequent exposure to AI, credibility becomes a rational judgment rather than an affective trigger, which explains the non-significant path found in this study.

Mediation analysis further shows that Affective Engagement mediates the influence of AI Interaction Quality and Emotional Well-Being on Ethical Awareness. This indicates that positive interaction experiences and supportive emotional conditions shape emotional involvement first, which then fosters ethical reflection. This mechanism aligns with the explanation by Immordino-Yang and Damasio (2007), who argue that emotions serve as a psychological bridge connecting experiential stimuli to moral and ethical judgment processes [25]. The R-square results in this study reinforce the central position of affective engagement as a mediating path linking experience-based factors to ethical awareness.

Theoretically, this study contributes to the AIED literature by integrating affective and ethical dimensions into a unified structural model, expanding understanding of how emotional experiences shape ethical judgment in digital learning. Practically, the findings support the recommendations of OECD (2023) and UNESCO (2024) on the urgency of human-centered AI design and the strengthening of AI ethics literacy in higher education. Methodologically, the high R-square value for Affective Engagement and the moderate value for Ethical Awareness indicate strong predictive strength for affective aspects, although additional variables may be required to enrich the ethical awareness model.

This study has several limitations, including the use of a single institutional sample and a cross-sectional design that restricts generalizability and prevents observation of long-term developmental patterns. Future studies may include longitudinal designs, multi-group PLS analysis, and additional variables such as AI literacy, risk perception, or cultural orientation to produce a more comprehensive conceptual model.

CONCLUSIONS

This study shows that affective engagement plays a central role in shaping students' ethical awareness of the use of Artificial Intelligence (AI) in higher education. The test results indicate that emotional well-being and AI interaction quality have a significant effect on affective engagement, which in turn has an impact on increasing ethical awareness, while AI credibility has not been proven to have a significant emotional effect. These findings show that ethical awareness is built more through emotional experiences and interaction quality than through cognitive evaluation alone. From a theoretical perspective, this study emphasizes the interconnection between affective and ethical dimensions in the study of Artificial Intelligence in Education (AIED), while from a practical perspective, the results emphasize the importance of developing AI that is oriented towards a human-centered approach and the emotional comfort of users. The limitations of this study lie in the use of samples from a single institution and its cross-sectional design, which limits its generalizability and understanding of long-term dynamics. Therefore, further research is recommended to apply a longitudinal design, multi-group PLS analysis, and include variables such as AI literacy, risk perception, and cultural factors to enrich the understanding of the formation of ethical awareness in the sustainable and responsible use of AI.

AKNOWLEDGMENT (IF ANY)

The author would like to express his appreciation to Makassar State University for providing research facilities and to all respondents who took the time to participate in filling out the questionnaire. Thanks are also extended to the supervising lecturers who provided guidance and input during the research process.

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