Research Article

Gender differences on the impact of AI self-efficacy on AI anxiety through AI self-competency: A moderated mediation analysis

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Artificial Intelligence (AI) is taking the educational system by storm due to its various implications and endless possibilities. Nevertheless, the teachers, the schools, and most importantly, the students have different perspectives on using AI in their learning experience, especially when gender is involved. In this study, the proponents delve into determining whether gender differences moderate the impact of AI self-efficacy (AISE) on the influence of AI anxiety (AIA) on AI self-competency (AISC). Using a quantitative explanatory research design, the proponents investigated 1,006 students' perspectives regarding AI self-efficacy, AI anxiety, and AI self-competency during the second semester of the academic year 2024-2025. The investigation employed an adapted instrument to determine AI self-efficacy, AI anxiety, and AI self-competency among students. Statistical analysis employed mean and standard deviation and Hayes' Process Macro for the moderation and mediation analysis. In general, the students exhibited a moderate degree of self-efficacy and self-competency in AI, as well as a moderate level of anxiety. Additionally, the investigation revealed that AISE predicts AISC, and AISC is associated with decreased AIA. However, the direct influence of AISE on AIA was insignificant statistically, while the moderated mediation index was also insignificant. In conclusion, gender does not significantly influence how AISC mediates the relationship between AISE and AIA in the study. Based on findings of the study, the paper recommended essential programs and activities to help students prepare for AI integration into their learning experience.

Keywords: AI self-efficacy; AI anxiety; AI self-competency; Gender; Hayes' Process Macro; Moderated-mediation analysis

1. Introduction

In an era where AI technologies are increasingly integrated into various facets of society, understanding how individuals, particularly across different genders, perceive and interact with AI systems has become paramount. In the editorial of Nguyen et al. (2024), they mentioned that the proliferation of AI technologies and chatbots could reshape higher education. They also added that for stakeholders, it is imperative to grasp the fundamentals of AI technologies and understand their impact. In the recent paper of Robert et al. (2024), they emphasized one possible use of AI: providing a tailored education with a fast feedback mechanism and teamwork encouragement in the classroom. A contrasting revelation from another study revealed that the teachers' perceptions

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of AI for social good and confidence might affect the relationships in the proposed research model. Thus, teacher professional programs should include the benefits and risks of AI and good practice sharing (Sanusi et al., 2024). For some study participants, AI socially influences them more than psychologically (Falana et al., 2021).

One significant trend driving this research is the widespread adoption of AI technologies and the corresponding interest in how individuals develop self-efficacy beliefs in using these systems. Ouyang et al. (2022) recognized these as they stipulated the functions of AI applications in online higher education, which include predicting learning status, performance or satisfaction, resource recommendation, automatic assessment, and improvement of learning experience. Hmoud et al. (2024) also reiterated that motivation had more positive characteristics than negative ones in the context of generative AI for students' learning. Conversely, Chiu et al. (2024) also implied that intrinsic motivation and competence to learn about chatbots depended on teacher support and student expertise.

Gender differences in technology adoption and proficiency have long been recognized as essential factors in shaping one's relationship with technology. One paper showed that women perceived knowledge as a key to generating more interest in AI (Armutat et al., 2024). Vo and Nguyen (2024) also believed gender does not impact students' perceptions of generative AI. The current research intended to address a critical issue concerning the disparities in how individuals, especially across genders, experience anxiety related to AI usage. Understanding these discrepancies and their underlying causes is essential for identifying potential barriers hindering effective AI utilization. By investigating how gender influences perceptions of AI self-efficacy, anxiety, and competency, this study aims to uncover insights that could inform the development of strategies to create a more inclusive and supportive AI environment for all individuals, irrespective of gender.

One notable gap in the existing literature that this research seeks to fill is the scarcity of studies explicitly examining the complex interplay between gender differences, AI self-efficacy, AI anxiety, and AI self-competency. One particular paper by Gado et al. (2021) imparted that perceived usefulness and ease of use were most predictive of the students; attitudes toward AI. Additionally, predictors for the intention to use AI included attitude, perceived usefulness, social norms, and knowledge. On the other hand, Strzelecki and ElArabawy (2024) highlighted in their study regarding the moderating impact of gender that it augmented the comprehension of technology acceptance in the context of AI tools as well as provided valuable input for formulating strategies to promote effective incorporation of AI in higher education. However, Elshaer et al. (2024) shared that gender as a moderator failed to demonstrate a significant difference in the impact of effort expectancy and facilitating conditions for AI use. By employing a moderated mediation analysis, this study aims to provide a nuanced understanding of how gender shapes the relationships between these key factors. The findings of this research have the potential to offer valuable implications for educators, policymakers, and developers in designing gender-inclusive AI education programs and developing AI systems that not only mitigate anxiety but also enhance user competency across diverse gender groups.

In the Philippines, several studies have shown promising and desirable perspectives regarding AI use and its influence on students' behavior in higher education institutions. For instance, Agbong-Coates (2024) shared the pivotal role of AI technologies in enhancing personalized learning initiatives. Additionally, most students have positive attitudes towards AI. However, these attitudes do not influence their AI literacy (Reyes et al., 2024). It is also interesting to note that Obenza et al. (2024) indicated a high degree of understanding, knowledge, perception, positive attitude, and firm intention to use generative AI technologies among university students. Conversely, students generally perceived AI positively in enhancing their learning experience, engagement, and critical thinking (Capinding & Dumayas, 2024). Hence, future teachers must demonstrate a good grasp of AI; however, a low level of readiness in the usage and application of AI tools and AI problem-solving still needs to be worked out. (Sabordino et al., 2024). However,

despite these thought-provoking ideas, it is yet to be known whether gender plays a role in the complex interrelationships of AI self-efficacy, AI anxiety, and AI self-competency in the country. Interestingly, no study in the country has yet to explore such a concept, which makes this investigation more fascinating and novel. This premise is why the proponents were prompted to pursue this research endeavor.

This study explores how gender moderates the mediated role of AI self-efficacy on the relationship of AI anxiety with AI-self-competency. This investigation will shed light on potential disparities that could impact how individuals, based on gender, engage with and benefit from AI technologies. Moreover, to understand the underlying mediating role of AI self-efficacy in the influence of AI anxiety on AI-self-competency among students in higher education institutions.

This research is poised to advance our understanding of how gender nuances impact individuals' experiences and attitudes towards AI. By uncovering the underlying mechanisms through which gender influences perceptions of AI proficiency and anxiety, this study aims to create more informed interventions and strategies that promote a more equitable and empowering AI landscape for all individuals, regardless of gender.

2. Literature Review

2.1. AI Self-Efficacy among Students

The literature on the impact of Artificial Intelligence in Higher Education Institutions [HEIs] reveals a complex web of interconnected concepts that influence students' self-efficacy, attitudes towards AI, and overall learning outcomes. Wang et al. (2023) highlight how HEIs' AI capabilities directly affect students' self-efficacy and creativity, suggesting that a technologically advanced learning environment can empower students to engage more effectively with AI tools. This context sets the stage for Bewersdorff et al. (2024), who emphasize the importance of positive attitudes towards AI and AI literacy in fostering students' interest and self-efficacy in AI. This finding indicates that a supportive mindset and foundational knowledge are crucial for effective AI integration in education.

Falebita and Kok (2024) further delve into the relationship between undergraduates' technological self-efficacy and their utilization and perception of AI tools, underscoring the significance of students' confidence in navigating AI technologies for successful integration. Building on this, Kim and Kim (2024) highlight how self-efficacy in AI learning can act as a buffer against work overload, showcasing the protective role self-belief plays in mitigating adverse effects on psychological well-being in demanding academic environments.

Chou et al. (2023) and Kwak et al. (2023) shed light on the factors influencing students' acceptance and attitudes toward AI, emphasizing the interplay of performance expectations, effort expectancies, and self-efficacy in shaping perceptions of AI usability and usefulness. Sun et al. (2023) contribute to this discussion by showcasing how targeted professional development programs can enhance teachers' AI teaching self-efficacy. This idea highlights the importance of equipping educators with the confidence and skills necessary for effective AI integration in teaching practices.

The articles by Chen et al. (2024a), Liang et al. (2023), and Arguson et al. (2023) also collectively highlight the extent of the relationship between AI self-efficacy, anxiety, attitudes towards AI, and actual usage of AI tools, underscoring the pivotal role self-belief plays in shaping learners' interactions with AI technologies and their intentions to utilize them. Together, these findings paint a comprehensive picture of how self-efficacy, attitudes, and educational practices intersect within AI in education, showcasing how these factors influence student engagement, learning experiences, and outcomes in AI-integrated learning environments.

2.2. AI Anxiety of the Students

The discourse surrounding AI anxiety in educational contexts encompasses many interconnected factors that shape individuals' perceptions, attitudes, and intentions toward artificial intelligence

technologies. Researchers such as Li and Huang (2024) have delved into the nuanced dimensions of AI anxiety and proposed a comprehensive theory outlining how such anxieties are acquired, providing a foundational understanding of the complex interplay between fear and technology adoption. This foundational knowledge sets the stage for subsequent studies, such as Kaya et al. (2022), who have shed light on the roles of personality traits, demographic factors, and AI learning anxiety in influencing attitudes towards AI, highlighting the intricate relationship between individual characteristics and perceptions of AI technologies.

Hopcan et al. (2024) have underscored the broader societal concerns surrounding AI, with individuals expressing anxiety about learning AI and its potential impacts on employment and social dynamics, emphasizing the need for a holistic approach to addressing AI-related fears. Conversely, Kenku and Uzoigwe (2024) found that ethical climate does not significantly predict AI anxiety among participants, suggesting that ethical considerations alone may not be the primary drivers of anxiety toward AI in educational settings.

The studies by Banerjee and Banerjee (2023), Bulut et al. (2024), and Guven et al. (2024) collectively highlight the prevalence of AI anxiety among participants and its implications for the practical application of AI technologies in education. While Banerjee and Banerjee emphasize the critical role of addressing AI anxiety for optimal technology integration, Bulut et al. (2024) and Guven et al. (2024) shed light on the varying relationships between age, readiness, and anxiety levels, underscoring the need for tailored approaches to alleviate fears and enhance technology acceptance.

Elinzano et al. (2024) highlight the impact of perceived trust and technological anxiety on individuals' intentions to use AI technologies, expanding the discussion beyond AI anxiety alone to encompass broader psychological and environmental factors influencing technology adoption. Finally, the study by Fatima et al. (2020) underscores the vulnerability of students to unethical behaviors such as plagiarism, indicating the intricate relationship between psychological factors like pressure and self-efficacy on ethical decision-making in educational contexts. Collectively, these studies paint a comprehensive picture of the multifaceted nature of AI anxiety and its far-reaching implications on technology adoption, ethical behavior, and societal perceptions of artificial intelligence in education.

2.3. AI Self-Competency of Students

The literature on artificial intelligence presents a multifaceted understanding of individuals' engagement with AI technologies and the complexities involved in developing comprehensive competencies in this field.

Ghatowar and Neog (2024) conducted a study that revealed no significant variance in AI self-competency engagement among participants, highlighting a linear relationship between AI literacy, AI ethics, AI self-efficacy, and AI self-competency. This result underscores the interconnected nature of various aspects of AI understanding and competency, suggesting that a well-rounded approach encompassing technical knowledge, ethical considerations, and self-belief is crucial for developing robust competencies in AI. Based upon this, Biagini (2024) emphasized in a scoping review that AI literacy extends beyond technical competence to encompass ethical considerations, critical thinking, and socio-emotional skills. This broader perspective on AI literacy underscores the importance of understanding the technical aspects of AI and engaging with its ethical implications and societal impacts, highlighting the need for a holistic approach to AI education. Cubas and Ersdal (2024) also shed light on students' confidence in the practical use of AI tools while noting gaps in theoretical knowledge and understanding of AI's broader societal impacts. This finding underscores the importance of bridging the gap between practical skills and theoretical understanding to ensure that individuals comprehend AI technologies well.

In a literature review, Chen et al. (2024b) highlighted key components essential for educators to enhance their competencies in AI, proposing a framework that emphasizes prompt literacy as a

pathway to greater competence in the field. This framework underscores the significance of continuous learning and adaptation in the rapidly evolving landscape of AI education.

Lastly, Rodrigues-Ruiz et al. (2024) explored how personal characteristics are associated with using AI tools among university students, leading to enhanced self-competence. This study underscores the role of individual traits and characteristics in shaping students' engagement with AI technologies, highlighting the need to consider personal factors in developing effective strategies to enhance competencies in this domain.

Collectively, these studies paint a comprehensive picture of the multifaceted nature of AI literacy, self-competency, and ethical considerations, emphasizing the interconnectedness of technical knowledge, moral awareness, practical skills, and personal characteristics in developing well-rounded competencies in the field of artificial intelligence. This holistic understanding is crucial for individuals, educators, and institutions seeking to navigate the complexities of AI technologies responsibly and effectively.

2.4. AI and Gender Issues

Some studies presented a multifaceted view of gender differences in attitudes toward AI, covering various dimensions such as ethical considerations, educational motivations, usage patterns, acceptance factors, and the predictive role of gender in online learning. Jang et al. (2022) and Ahn et al. (2022) both delve into gender disparities in AI attitudes, with Jang focusing on ethical dimensions like fairness and privacy, while Ahn explores the impact of gender stereotypes on AI recommendation evaluation. Lin et al. (2021) and Stohr et al. (2024) reveal gender gaps in motivation for AI learning and general attitudes towards AI. Lin et al. (2021) highlight male students' higher motivation, and Stohr et al. (2024) showcase males' more positive attitudes and higher usage. Conversely, Xia et al. (2022) report non-significant gender differences in AI learning and challenging assumptions, while Zhang et al. (2023) point out gender disparities in AI acceptance, particularly concerning anxiety and enjoyment. Lastly, Zhang et al. (2023) and Trung et al. (2021) address gender differences in AI acceptance and learning, with Zhang et al. (2023) emphasizing acceptance factors and Trung et al. (2021) highlighting the predictive value of gender in online teaching. These studies provide valuable insights into the complex interplay between gender and attitudes towards AI, highlighting the need for further research to promote gender equity and inclusivity in AI.

2.5. The Current Study

Looking back from the different aspects and perspectives regarding AI and its potential impact to students in the higher education, the paper intended to delve into the unknown to understand the underlying influence of gender into the complex nexus of different interplay of variables. Studies from a variety of countries and reputable authors came out with varying degrees of complexities that AI brought upon to the educational system. The intricate network of AI self-efficacy, AI self-competency, and AI anxiety, with the special participation of gender has made this investigation more intriguing. At the same time, since there were only few accountable papers regarding AI in the country, the current paper can become a fundamental element of future investigation. Reiterating the claim of Wang et al. (2023) wherein the HEIs' capacity to integrate AI tools into their system will empower its students for a better outcome. Preparing the faculty in terms of AI use will help institutions to better equip the educational landscape (Chen et al., 2024b) and raise the level competencies in the field. In this manner, the degree of anxiety that AI has brought may decline slowly but surely amongst the users. This occurrence will then lead to more technologically prepared and adapted students in the future to come.

The study seeks answers to the following research questions in the context of the conceptual framework in Figure 1.

RQ 1) How may the students' artificial intelligence self-efficacy [AISE], artificial intelligence self-competency [AISC], and artificial intelligence anxiety [AIA] be described?

RQ 2) Does AI self-efficacy directly reduce AI anxiety, and does this effect differ between male and female students?

RQ 3) Does AI self-competency mediate the relationship between AI self-efficacy and AI anxiety, and does this mediation effect differ between male and female students?

RQ 4) What is the total effect of AI self-efficacy on AI anxiety for male and female students, and does the strength of the indirect effect via AI self-competency differ between genders?

RQ 5) Does AI self-efficacy significantly predict AI self-competency, and does gender moderate this relationship?

RQ 6) Does AI self-competency significantly reduce AI anxiety, and does gender moderate this effect?

RQ 7) Does AI self-efficacy directly reduce AI anxiety, and does gender moderate this relationship?

RQ 8) To what extent does gender moderate the mediation effect of AI self-competency in the relationship between AI self-efficacy and AI anxiety?

Figure 1
Conceptual framework
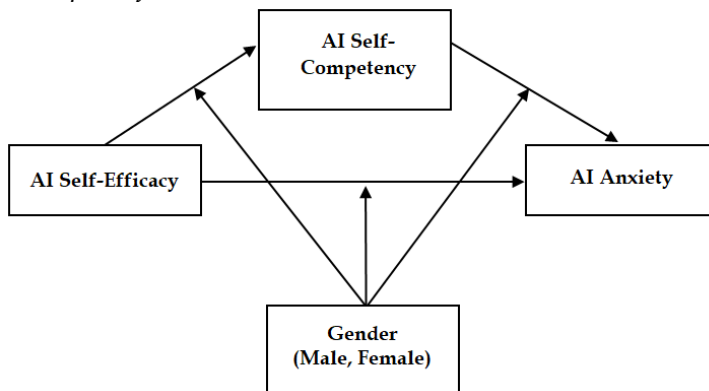
3. Method

3.1. Design

The paper employed a quantitative explanatory design to attain the study's primary purpose. Using such a design and technique is appropriate since this paper intended to investigate the cause-and-effect relationships between variables and establish causal inferences. Explanatory research seeks answer to why questions (Sheppard, 2024). Moreover, the investigation performed a moderation-mediation analysis to understand the underlying moderating role of gender to the mediating effect of AI self-efficacy and the impact of AI anxiety on the AI self-competency of students. Hence the design aligns well with the study's purpose of moderation-mediation study, exploring how and under what conditions one variable influences another mediator or moderator.

3.2. Participants

To generate the necessary data for the study, 1,006 students (567 males and 439 females) from five (5) different colleges in a higher education institution in Olongapo City, Philippines, participated in the online survey from January to February 2024. The proponents used a convenience sampling technique with the online Google form as the primary data-gathering tool. Using such a sampling technique offers several benefits, such as fast and easy data collection, a few rules to consider, and cost-effectiveness.

To be part of the study, a participant must consider the following criteria such as a) being a bona fide student of the institution involved in the study, b) currently enrolled with the academic year, c) must possess a smartphone or gadgets related to learning, and d) have stable internet connection for the online survey. Exclusion criteria for participants include a) students from other

institutions, b) students who are on leave or not enrolled in current academic year, c) no smartphone or gadgets related to learning, and d) no internet connectivity.

3.3. Measures

The paper used two types of measures to achieve the study's objectives. The first measure came from the previous article of Wang et al. (2022) for the study to determine the students' AI anxiety levels. The instrument contained 21 items, and based on the previous article, its reliability coefficient ranges from 0.917 – 0.974, with an overall alpha coefficient of 0.964. This figure exceeded the minimum 0.70 threshold as recommended.

The second instrument was a modification of Carolus et al.'s (2023) previous paper, in which the current research used the AI self-efficacy and AI self-competency constructs of the study. Both constructs have six items, respectively. Based on the previous tool, the internal consistencies for the subscales of AI self-efficacy and AI self-competency were between 0.7 and 0.90, which is within the acceptable range for instrument reliability. Taber (2018) claimed that a rule-of-thumb for the Cronbach alpha should reach 0.70 for an instrument to have an acceptable level of consistency.

3.4. Statistical Analysis

After gathering enough student participants, the proponents subjected them to descriptive and inferential statistical analysis. The study employed mean and standard deviation measurements for the descriptive analysis and Hayes' Process Macro for the inferential analysis. The study used the Statistical Package for Social Sciences 26 software to calculate all the statistics related to the study and answer the research questions posted in the early part.

3.5. Ethical Consideration

Prior to gathering of data, this study imposed strict observance of ethical compliance to protect and adhere to existing study protocols for the participants of the study. During the survey period, the investigators employed informed consent prior to participation emphasizing the study's purpose, procedures, and observed any conflict of interest, privacy and confidentiality, benefits and risks. To protect the participants, they can withdraw anytime during the data gathering, and participation is purely voluntary without any harm or threat to their well-being. The study also observed data privacy protocol to safeguard the gathered data from untoward and unwanted use that may deem harmful to the participants in the future.

4. Results

The research questions posed in the earlier section of the study were the basis for the computation results displayed in the next section starting from Table 1.

Table 1
Students' AI Self-Competency, AI Self-Efficacy, and AI Anxiety

Constructs	SD	Mean
AI Self-Efficacy		
AISE1	0.93	3.07
AISE2	0.93	3.03
AISE3	0.91	3.08
AISE4	0.91	3.02
AISE5	0.91	3.04
AISE6	0.93	3.05
Composite	0.92	3.05

Table 1 continued

Constructs	SD	Mean
AI Self-Competency		
AISC1	1.02	3.79
AISC2	1.00	3.71
AISC3	1.04	3.52
AISC4	1.04	3.38
AISC5	1.01	3.37
AISC6	0.99	3.38
Composite	1.02	3.53
AI Anxiety		
AIA1	1.00	2.84
AIA2	0.99	2.74
AIA3	0.99	2.74
AIA4	1.00	2.76
AIA5	1.00	2.75
AIA6	1.01	2.69
AIA7	1.01	2.71
AIA8	1.03	2.88
AIA9	1.12	3.47
AIA10	1.12	3.60
AIA11	1.18	3.56
AIA12	1.17	3.64
AIA13	1.14	3.54
AIA14	1.14	3.69
AIA15	1.12	3.78
AIA16	1.09	3.59
AIA17	1.11	3.61
AIA18	1.12	3.47
AIA19	1.12	3.19
AIA20	1.11	3.14
AIA21	1.15	3.05
Composite	1.08	3.21

Note: n = 1006; 1.00-1.79= Not Very Self-Efficient; Not Very Self-Competent; Very Low; 1.80-2.59= Not Self-Efficient; Not Self-Competent; Low; 2.60-3.39= Somewhat Self-Efficient; Somewhat Self-Competent; Moderate; 3.40-4.19= Self-Efficient; Self-Competent; High; 4.20-5.00= Very Self-Efficient; Very Self-Competent; Very High.

Table 1 shows the student-respondents' general perception regarding their AI self-efficacy, AI self-competency, and AI anxiety levels. First is the respondents' AI self-efficacy. They generally have a mediocre degree of perception about their self-efficacy, with a composite mean of 3.05, which falls under "somewhat self-efficient" descriptive interpretation. Regarding AI self-competency, the respondents gave this part a higher composite mean score of 3.53, corresponding to a descriptive interpretation of "self-competency." Lastly, In the case of AI anxiety, the respondents have a moderate level of anxiety regarding AI. The table further reveals a diverse response from the respondents. It gives us an overall glimpse of their perception of this investigation's topics.

Table 2 and Table 3 present the results of a conditional mediation and moderated mediation analysis examining the gender differences in the relationship between AI self-efficacy and AI anxiety through AI self-competency, using Hayes Process Macro Model 59 (Hayes, 2018) with 5000 bootstrapped samples. These tables provide insights into how AI self-efficacy impacts AI anxiety indirectly through AI competency and whether this relationship is moderated by gender at different stages of the mediation process.

Table 2
Conditional Mediation Analysis

Path and moderator	Coefficient	Boot SE	95% CI	
			Boot LLCI	*Boot ULCI*
AISE → AIA (Direct Effect)				
Male	.1022	.0489	.0062	.1981
Female	.0400	.0531	−.0642	.1442
AISE → AISC → AIA (Indirect Effect)				
Male	.1101	.0256	.0646	.1659
Female	.0830	.0380	.0112	.1603
Total Effect				
(Direct + Indirect)				
Male	.2123	-	-	-
Female	.1230	-	-	-

Note. Artificial Intelligence [AI]; AI self-efficacy [AISE]; AI competency [AISC]; and AI anxiety [AIA]; 5000 Bootstrapped samples.

H_{01}: *AI self-efficacy does not directly reduce AI anxiety (AIA), and the effect of AI self-efficacy on AI anxiety does not differ between male and female students.*

Based on Table 2, the direct effect of AI self-efficacy (AISE) on AI anxiety is significant for male students (β = .1022, Boot SE = .0489, 95% CI [.0062, .1981]), indicating that higher AISE leads to a reduction in AI anxiety for males. In contrast, this effect is insignificant for female students (β = .0400, Boot SE = .0531, 95% CI [−.0642, .1442]), suggesting that AISE does not directly impact their anxiety levels. This finding implies that AISE has a more direct influence in reducing anxiety for males compared to females. These findings underscore the importance of AI competency in alleviating AI anxiety across genders, indicating that interventions should focus on building competency while enhancing self-efficacy.

H_{02}: *AI self-competency does not mediate the relationship between AI self-efficacy (AISE) and AI anxiety, and the mediation effect does not differ between male and female students.*

The mediation effect of AI self-competency between AI self-efficacy and AI anxiety is significant for both male (β = .1101, Boot SE = .0256, 95% CI [.0646, .1659]) and female students (β = .0830, Boot SE = .0380, 95% CI [.0112, .1603]). It further indicates that AI competency is crucial in reducing AI anxiety for both genders, with male students showing a slightly more substantial indirect effect than females. This mediation implies that building AI self-competency can alleviate AI anxiety in both groups by enhancing self-efficacy.

H_{03}: *The total effect of AI self-efficacy on AI anxiety does not differ between male and female students, and the strength of the indirect effect via AI self-competency does not differ between genders.*

The total effect, which combines both the direct and indirect effects, shows that AI self-efficacy has a more substantial overall impact on reducing AI anxiety in males (β = .2123) than in females (β = .1230). This difference highlights that while the direct path is weaker for females, the indirect path through AI self-competency still contributes to lowering their anxiety. The results imply that improving AI self-efficacy is more directly effective in reducing AI anxiety in male students than in female students, who may rely more on increasing their AI self-competency to experience anxiety reduction.

Figure 2 presents a statistical diagram of a moderated mediation model, illustrating how AI self-efficacy influences AI anxiety through AI self-competency, while gender moderates these relationships.
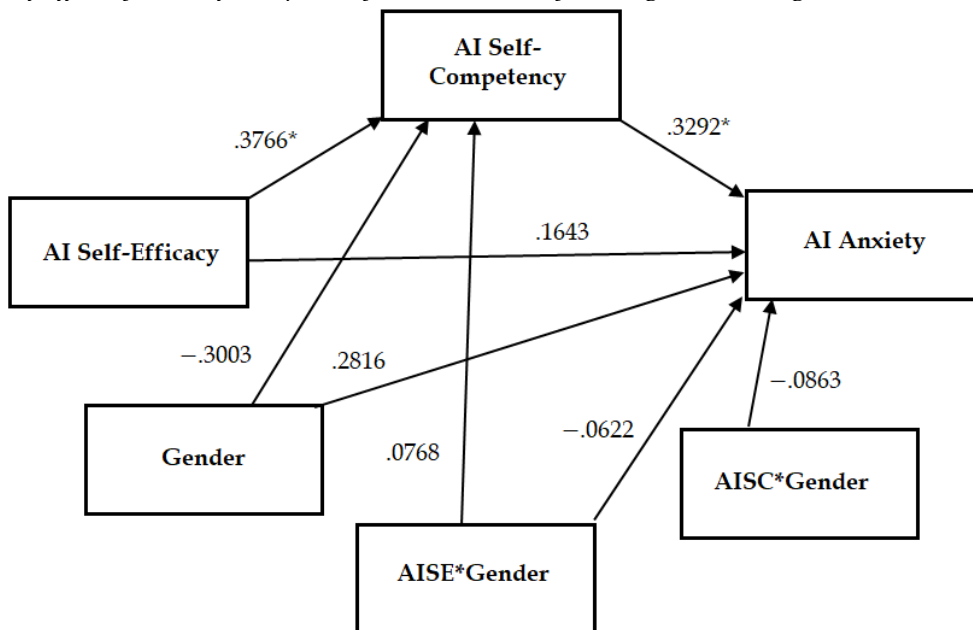
Table 3
Moderated Mediation Analysis Results

			95% CI	
Path	Coefficient	Boot SE	Boot LLCI	Boot ULCI
Indirect Paths				
AISE → AISC	.3766	.1139	.1473	.6019
Gender → AISC	−.3003	.2277	−.7516	.1420
AISE*Gender → AISC	.0768	.0692	−.0598	.2137
AISC → AIA	.3292	.1128	.1146	.5566
AISC*Gender → AIA	−.0863	.0818	−.2502	.0692
Direct Paths				
AISE → AIA	.1643	.1325	−.0955	.4263
Gender → AIA	.2816	.3142	−.3250	.9228
AISE* Gender → AIA	−.0622	.0892	−.2425	.1148
Index of Moderated Mediation (Gender)	−.0271	.0456	−.1156	.0605

Note. Index of Moderated Mediation (Gender) = difference between conditional indirect effects; Artificial Intelligence (AI); AI self-efficacy (AISE); AI self-competency (AISC); AI anxiety (AIA); Indirect paths = These paths are part of the mediation process on how AISE affects AIA through AISC; Direct paths = These paths are direct effects of the independent variable (AISE) and moderator (SEX) on the dependent variable (AIA), controlling for the mediator (AISC); 5000 Bootstrapped samples.

Figure 2
A statistical diagram illustrating a moderated mediation model that explains the relationships between AI self-efficacy, AI self-competency, and AI anxiety, with gender acting as a moderator

H_{04}: *AI self-efficacy does not significantly predict AI self-competency, and gender does not moderate the relationship between AI self-efficacy and AI competency.*

Based on Table 3 and the paths illustrated in Figure 2, AI self-efficacy significantly predicts AI self-competency (β = .3766, Boot SE = .1139, 95% CI [.1473, .6019]). The diagram indicates a positive relationship, demonstrating that AI self-competency among students increases as AI self-efficacy increases. This analysis implies that students who believe they can master AI tend to perform better and are more proficient in AI-related activities.

However, the interaction between AI self-efficacy and gender (AISE * Gender → AISC) is statistically not significant (β = .0768, Boot SE = .0692, 95% CI [−.0598, .2137]). The finding indicates that gender does not significantly moderate the relationship between AI self-efficacy and

AI competency, implying that the effect of AI self-efficacy on AI competency is similar for both male and female students. The lack of a significant interaction suggests that male and female students benefit similarly from increases in AI self-efficacy, and there is no substantial gender-based difference in how self-efficacy translates into AI competency.

H$_{05}$: AI self-competency does not significantly reduce AI anxiety, and gender does not moderate the effect of AI competency on AI anxiety.

As illustrated in Table 3 and Figure 2, AI self-competency significantly reduces AI anxiety (β = .3292, Boot SE = .1128, 95% CI [.1146, .5566]). This result indicates that higher levels of AI self-competency are strongly associated with lower levels of AI anxiety. In other words, as students become more competent and skilled in AI, their anxiety or apprehension towards using AI technology decreases. The finding suggests familiarity and expertise in AI-related tasks contribute to greater confidence and comfort, reducing fear or worry about AI. Developing AI self-competency can alleviate students' anxiety, potentially making them more willing to use AI tools and applications.

However, the interaction effect of gender on this relationship (AISC * Gender → AIA) is not significant (β = −.0863, Boot SE = .0818, 95% CI [−.2502, .0692]). This result suggests that AI self-competency decreases AI anxiety similarly for both male and female students, with no notable differences based on gender. The anxiety-reducing effects of AI competency are experienced equally by male and female students, with both groups benefiting similarly as their AI skills increase.

H$_{06}$: AI self-efficacy does not directly reduce AI anxiety, and gender does not moderate the direct relationship between AI self-efficacy and AI anxiety.

In Table 3 and Figure 2, the direct effect of AI self-efficacy on AI anxiety is non-significant (β = .1643, Boot SE = .1325, 95% CI [−.0955, .4263]). This result suggests that AISE does not directly reduce AI anxiety when controlling AI competency. While students with higher confidence in their AI abilities (AI self-efficacy) may believe they can handle AI-related tasks, this self-assurance alone is insufficient to lower their anxiety about AI once their actual competency is factored in. This analysis implies that reducing AI anxiety is more strongly linked to a student's actual skills and knowledge of AI (their AI self-competency) rather than simply their belief in their ability to use AI effectively.

Moreover, the interaction between AISE and gender (AISE * Gender → AIA) is also not statistically significant (β = −.0622, Boot SE = .0892, 95% CI [−.2425, .1148]). Thus, gender does not moderate the direct relationship between AI self-efficacy and AI anxiety. The effect of AI self-efficacy on AI anxiety is similar for both male and female students, with no significant gender-based differences. The analysis implies that increasing AI self-efficacy alone will not reduce AI anxiety differently for male and female students—both groups are equally affected (or unaffected) by AI self-efficacy when it comes to anxiety about AI.

H$_{07}$: Gender does not moderate the mediation effect of AI competency in the relationship between AI self-efficacy and AI anxiety.

Based on Table 3, the index of moderated mediation (Gender) is non-significant (β = −.0271, 95% CI [−.1156, .0605]). This result indicates that gender does not significantly moderate the mediation effect of AI self-competency on the relationship between AI self-efficacy and AI anxiety. In other words, the indirect effect of AI self-efficacy on AI anxiety through AI self-competency shown in Table 2 is consistent for both males (β=0.1101, 95% CI [0.0646, 0.1659]) and females (β=0.0830, 95% CI [0.0112, 0.1603]) students since they are both significant. Therefore, the process by which AI competency mediates the relationship between AI self-efficacy and AI anxiety operates similarly across genders, suggesting that interventions focusing on enhancing AI self-efficacy and AI self-competency can reduce AI anxiety equally for both male and female students.

5. Discussion

The main objective of this study is to understand and analyze the moderating role of gender in the mediating effect of AI self-efficacy on the influence of AI anxiety on the AI self-competency of students in higher education institutions. The study's analysis revealed some interesting findings. Based on the conceptual model and research questions presented in the earlier part of the study, the investigators share the following important findings.

For the first research question regarding AI self-efficacy, AI self-competency, and AI anxiety, the investigation revealed that students were somewhat self-efficient and self-competent with a moderate degree of AI anxiety. This finding somewhat reflects that the HEI's AI capability affects students' learning performance via creativity and self-efficacy (Wang et al., 2023). Moreover, AI self-efficacy is a factor that affects the behavioral intentions of students (Kwak et al., 2022). On the other hand, a local study by Bulut et al. (2024) and Guven et al. (2024) had a similar moderate degree of AI anxiety among their respondents. Additionally, Kenku and Uzoigwe (2024) showed in their investigation that 15.5% of their participants had high AI anxiety levels.

For the second research question about AI self-efficacy reducing AI anxiety and does it differ between gender, the paper showed that AI self-efficacy has a clear impact on AI anxiety for male students, meaning that higher AISE lowers their anxiety. However, this effect is not significant for female students, indicating that AISE does not directly affect their anxiety levels. A recent study demonstrated the necessity of educational strategies that focus on AI literacy and aim to foster students' attitudes, usage, and interest to effectively promote AI self-efficacy (Bewersdorff et al., 2024). It is also vital to compare the previous work of Falebita and Kok (2024) where they mention that technological self-efficacy raises students' confidence in navigating through AI technologies.

The third research question analyzed the mediation property of AI self-competency to the relationship between AI self-efficacy and AI anxiety and whether it differs between genders. The association between AI self-efficacy and AI anxiety is influenced by AI self-competency for both male and female students. This finding suggests that having AI skills is important in lowering AI anxiety for both genders, with males showing a slightly more substantial connection between AI skills and reduced anxiety compared to females. AI self-efficacy positively predicts AI use through reduced AI self-efficacy and enhanced attitudes toward AI (Chen et al., 2024a). Additionally, Ghatowar and Neog (2024) supports the current findings regarding non-variance in AI self-competency among participants in their previous study.

The fourth research question determined the total effect of AI self-efficacy on the AI anxiety of the respondents and whether the indirect effect (through AI self-competency) differs between genders. When considering both direct and indirect effects, AI self-belief has a more significant impact on decreasing AI anxiety in males than females. This revelation suggests that although the direct impact is weaker for females, enhancing AI self-competency still helps lower their anxiety levels. A previous paper revealed that self-efficacy mediated the association between generative AI interaction and learning achievements among students (Liang et al., 2023). Additionally, Chen et al., (2024a) and Arguson et al., (2023) also shared the extent of association between AI self-efficacy and anxiety, as well as attitudes towards AI, and actual use.

The fifth research question mentions the predictor of AI self-efficacy through AI self-competency and whether gender moderates the association. The analysis found that AI self-efficacy notably predicts AI self-competency, showing a positive connection where students with higher AISE tend to have greater AISC. The result implies that believing in mastering AI leads to better performance and proficiency in AI-related tasks. However, the interaction between AI self-efficacy and gender is non-significant. This finding suggests that gender does not influence how AISE impacts AISC—a recent chapter by Rodriguez-Ruiz et al. (2024) emphasized that certain types of personality correlate with the use and frequency of an individual with AI. In Cubas and Ersdal's (2024) article, they highlighted the students' confidence on the use of AI and noted some gaps on the theoretical knowledge and understanding of AI's impact.

The sixth research question relates to AI anxiety reduction through AI self-competency and whether gender moderates the effect. The study showed that AI self-competency significantly lowers AI anxiety, indicating that their anxiety about using AI technology decreases as students become more skilled in AI. This finding suggests that proficiency in AI tasks boosts confidence and comfort, reducing fear about AI. Nevertheless, the effect of gender interaction on this link is not significant. This premise means that AI self-competency reduces AI anxiety similarly for male and female students, without significant gender-based differences. In a related article by Cubas and Ersdal (2024), students tend to be confident in the practical use of AI tools and know its various implications. However, they settle for self-learning due to the gap in the theoretical knowledge and understanding of AI's broader societal impacts. Moreso, there were also broader societal concerns regarding AI with individuals experiencing anxiety about learning it and its impact to employment and social dynamics led to the need of a more holistic approach to address AI-related fears (Hopcan et al., 2024).

The seventh research question tackles the idea that AI self-efficacy reduces AI anxiety and whether gender moderates the relationship. Based on the computation of the study, the direct impact of AI self-efficacy on AI anxiety is not statistically significant. This result means that believing in one's AI abilities does not directly lower AI anxiety when considering AI competency. Similarly, the interaction between AISE and gender also is not statistically significant. This finding indicates that gender does not affect how AISE influences AI anxiety. In a recent book chapter, conscientiousness negatively correlated with the use of AI to do academic tasks and to create fake content (Rodriguez-Ruiz et al., 2024). Personality traits, demographic factors, and AI learning anxiety can also influence the attitudes towards AI of individuals which emphasizes the intricate associations between individual characteristics and perception of AI technologies (Kaya et al., 2022).

Moreover, the last research question covered the extent of gender moderation in the mediation effect of AI self-competency in the association between AI self-efficacy and AI anxiety. The study revealed that the moderated mediation index involving gender is not significant, indicating that gender does not significantly influence how AI self-competency mediates the link between AI self-efficacy and AI anxiety. This analysis means that the indirect impact of AISE on AIA through AISC remains consistent for both male and female students, as both are significant. Consequently, the process where AI competency mediates the connection between AISE and AIA operates similarly for both genders. This premise suggests that interventions to boost AISE and AISC can reduce AI anxiety for male and female students equally. However, Lin et al. (2021) also established the gender differences in the motivation to learn AI. Jang et al. (2022) also established a significant gender difference in AI ethics among undergraduate students. On the other hand, Strzelecki and ElArabawy (2024) highlighted in their study about the moderating impact of gender that it augmented the comprehension of technology acceptance in the context of AI tools as well as provided valuable input for formulating strategies to promote effective incorporation of AI in higher education. However, Elshaer et al. (2024) also shared that gender as a moderator failed to demonstrate a significant difference in the impact of effort expectancy and facilitating conditions for AI use.

6. Conclusion

Based on the preceding results and discussion of the study, the proponents conclude that the investigation revealed that participants exhibited a moderate level of self-efficacy and self-competence in AI, alongside a moderate level of anxiety. Moreover, for male students, AI self-efficacy was found to have a significant impact on AI anxiety, with higher AISE levels correlating with reduced anxiety. Conversely, this relationship was not significant for female students, suggesting that AISE does not directly influence their anxiety levels. The association between AI self-efficacy and AI anxiety was determined to be mediated by AI self-competency for both genders. Additionally, it was observed that AI self-belief played a more substantial role in

diminishing AI anxiety among males than females when considering both direct and indirect effects. Furthermore, the study indicated that AISE statistically predicts AI self-competency, with a positive correlation observed between higher AISE and greater AISC among students. Notably, enhanced AI self-competency was linked to reduced AI anxiety, suggesting that their anxiety levels decrease as students become more proficient in AI. The direct impact of AISE on AIA was found to be statistically insignificant. At the same time, the moderated mediation index involving gender was also deemed insignificant, signifying that gender does not significantly influence how AISC mediates the relationship between AISE and AIA.

7. Recommendations

Based on the conclusions drawn from the study, several recommendations were provided to enhance AI self-efficacy and mitigate AI-related anxiety among students. First, tailored support programs should be developed to improve AI self-efficacy and self-competency, particularly for female students, as no direct correlation between self-efficacy and anxiety was observed in this group. These programs could include mentoring, workshops, and hands-on AI skill-building activities. Given the differential impact of AI self-belief on anxiety between male and female students, interventions should address gender-specific needs and concerns. Encouraging students to engage in practical AI skill development can enhance their self-competency and potentially reduce anxiety associated with AI technologies. Additionally, fostering positive self-beliefs and confidence in AI use, especially among male students, can help alleviate anxiety and improve overall self-efficacy in AI-related tasks. Regular assessments should be implemented to monitor changes in AI self-efficacy and anxiety levels, providing constructive feedback and support to help students manage these fluctuations. Educational initiatives and interventions should be gender-sensitive and inclusive, addressing the unique challenges faced by both male and female students. Finally, further research is needed to explore additional factors, such as cultural differences or prior experiences with AI technologies, to develop more comprehensive interventions and support strategies.

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