

Evaluating Artificial Intelligence Anxiety Among Pre-Service Teachers in University Teacher Education Programs

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Article Info	ABSTRACT
<p>Article history:</p> <p>Received 2024-08-29 Revised 2024-09-23 Accepted 2024-10-23</p> <hr/> <p>Keywords:</p> <p>AI Anxiety Gender Mathematics, Science and Technology Education Undergraduates</p>	<p>Adopting artificial intelligence (AI) in education for various purposes has become prominent and has raised many user concerns. The concerns, apprehension, or fear that comes with the use of AI are referred to as Artificial Intelligence Anxiety (AI anxiety). Undergraduates are the most frequent users of AI in higher education. This study assessed AI anxiety among pre-service teachers. A survey conducted online was used for data collection. A sample of 1067 pre-service teachers in mathematics, science, and technology teacher education programs were purposefully selected for the study. A questionnaire was used to collect data regarding the pre-service teachers' AI-Anxiety in six dimensions: technology intimidation, societal impact, job displacement, technological dependence, technological dread, and ethical concerns. The instrument was hosted online through Google Forms, and the data gathered was analyzed descriptively (percentage, mean, and standard deviation) and inferentially (ANOVA and regression analysis). This study reveals a moderate level of AI anxiety among pre-service teachers. Levels of AI anxiety vary across the six dimensions, with five found to be high while only one was found to be at moderate level. It also found significant variations in the level of AI anxiety among pre-service teachers based on their area of speciality. Also, the study identified no significant influences of demographic characteristics on the level of AI anxiety among pre-service teachers, emphasizing gender. Thus, educators and institutions should urgently embark on AI literacy to improve the ethical use of AI technologies among pre-service teachers and ameliorate AI anxiety.</p> <p><i>This is an open-access article under the CC BY-SA license.</i></p> <div></div>
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1. INTRODUCTION

Artificial intelligence (AI) is now becoming a necessary part of many facets of everyday life, having gained popularity swiftly in recent years. The dependence on AI technologies varies from person to person, depending on the task expected to be completed.

In the school setting, AI is used to carry out various academic tasks related to teaching, learning, and administrative tasks [1]. Data analytics, adaptive assessments, intelligent content creation, and personalized learning experiences are all aspects of AI that could revolutionize classroom instruction [2], [3]. This emphasizes the usefulness of AI in meeting educational goals when used by teachers or students. For its many essential roles in the teaching-learning process and its components, AI can potentially impact what students do now and in the future [4].

Educators and students struggle to achieve many contemporary goals for improving teaching or learning [5]. Educators and students look for safe, efficient, and scalable technologically advanced methods to solve various issues relating to teaching and learning [6]. Students and educators are curious about the potential benefits of daily technological breakthroughs. Like everyone else, undergraduates use AI-powered services such as voice assistants, grammar and sentence completion tools, and phone-based automated information search [7]. Though AI offers many benefits, people still worry about its potential psychological effects on the users or potential users. The invention and use of AI have given rise to new problems because new technology often comes with new challenges. Most of these challenges are characterized by worries – worry about losing jobs, openness and privacy, biases in algorithms, increasing socioeconomic disparities, and unethical behaviour [8], [9]. This worry about AI explains the term ‘Artificial Intelligence Anxiety’ (AI-Anxiety). Anxiety refers to the fear of impending harm joined with a sense of dysphoria or physical manifestations of stress [10] and is characterized by concerns, tense muscles or fidgeting, and signs of autonomic overactivity like confusion or profuse perspiration [11]. According to Wang et al. [12], AI anxiety describes a person's predisposition to feel uncomfortable, anxious, or nervous about AI's present or future usage. AI anxiety is an individual's apprehension or fear of using AI.

As AI technologies are being made available to the public, many pre-service teachers in university teacher education programs actively use them [13]. They are looking at how AI may make writing or completing tasks easier and how they locate, choose, and modify content required from them [14]. Despite the usefulness of AI tools, undergraduates, particularly those in teacher education programs, tend to worry about their effects in many ways [9], [15], [16]. Pre-service teachers are critical to the future advancement of the education sector, especially at the primary and secondary levels. As AI tools provide personalized learning opportunities for students, they also come with concerns and different behaviours for academics and pre-service teachers [17], [18]. These behaviours reveal students' apprehensiveness and, in the long run, influence their usage of AI tools [19].

Similarly, one behaviour stemming from the use of AI, as identified by Wang et al. [12], is AI anxiety, which was emphasized to influence AI learning motivation negatively. In other words, apprehensiveness from using AI for learning purposes tends to make the learner unwilling to be involved in rigorous learning activities. Specifically, Güven et al. [20] stated that university students exhibited high levels of AI anxiety and emphasized the significance of boosting in-service teachers' readiness in university teacher education programs for AI applications and decreasing their anxiety.

Regarding AI anxiety, Falebita [21] and Banerjee [22] found no gender difference in the level of AI anxiety among pre-service teachers and college teachers, respectively. This could imply that AI anxiety is a problem that has no regard for gender. Similarly, Terzi [23] reveals no significant association between AI anxiety and demographics such as age, gender, and experience. However, McGrath et al. [24] show that significant demographic associations, such as gender, age, and race, existed when they examined the concerns of university teachers about AI. Several studies have examined AI anxiety among a specific group or group of individuals [9], [15], [16], [25] without necessarily looking into variations in the level of AI anxiety across some groups of students.

Many future educators may feel overwhelmed or apprehensive about incorporating AI technologies into their teaching practices, potentially hindering their preparedness and effectiveness in modern classrooms. This anxiety can stem from a lack of familiarity with AI tools, fear of job displacement, or uncertainty about their role in an increasingly automated educational situation. Understanding the extent and nature of AI anxiety among pre-service teachers in university teacher education is crucial for developing targeted interventions and training programs that empower pre-service teachers to embrace AI as a valuable resource in their future careers. Among the pre-service teachers, there could be variation in the level of their AI anxiety based on the area of specialization. It is not impossible to have pre-service teachers with specialities in a particular field who are more inclined to use technological tools than those in other fields.

Anxiety and stress are closely related, with one often leading to the other. Technostress describes technology's adverse emotional and physiological effects, particularly on digital devices and online platforms [26]. Proposed by Brod [27], this theory identifies factors such as work-life imbalance, technological incompetence, time pressure, and information overload as contributors to stress and anxiety in AI. As AI systems evolve rapidly, users may experience information overload and fear of falling behind [28]. Additionally, reliance on AI for decision-making can foster anxiety about job security [8]. The pressure to complete multiple AI tasks in teacher education programs for university students can significantly impair cognitive functions like attention and memory [28].

AI anxiety among pre-service teachers is characterized by fears about technology intimidation, job displacement, and ethical concerns, which can impede their confidence and readiness to integrate artificial intelligence into their future classrooms effectively [29]. Mixed results have been found in recent research that has examined pre-service teachers' anxiety and attitudes toward AI. While some studies [21], [30] show significant levels of anxiety related to AI, other studies [25] find anxiety levels below moderate levels in specific dimensions. However, for the dimensions of anxiety about AI replacing jobs and causing sociotechnical issues, Eyüp and Kayhan [25] found the anxiety level to be above moderate. While inconsistent across research, among demographic characteristics, gender variations in AI anxiety have been noted [25], [31]. Although AI anxiety was not considered the primary factor in the adoption of AI tools, rather perceived utility and ease of use affect AI adoption [31], [32]. Pre-service teachers acknowledge that AI has the potential to enhance education via personalized learning and better lesson planning, even in the face of anxiety [21], [33].

However, when the interdisciplinary difference in the level of AI anxiety across these groups of undergraduates in teacher education programs is identified, it will inform the interventions and support mechanisms for helping the group. Also, the revelation can help educators and policymakers develop and implement strategies to address the apprehensions and foster a more positive attitude towards adopting AI technologies, empowering the marginalized and addressing potential bias in adopting AI technologies. Therefore, this study examines AI anxiety among pre-service teachers in university teacher education programs. The study specifically investigates the levels of AI anxiety among Mathematics, Science, and Technology pre-service teachers. A comparison of the AI anxiety levels among pre-service mathematics, science, and technology teachers was also explored. In addition, the influence of demographic characteristics (gender, age, and course of study) on the AI anxiety of Pre-service teachers was examined. To achieve the objectives of this study, the following research questions and hypotheses were raised:

1. What is the level of AI anxiety among pre-service teachers?
2. What are the dimensions of AI anxiety among pre-service teachers?
3. How do the levels of AI anxiety differ across pre-service teacher subject specializations?

Hypotheses

1. Mathematics, Science, and Technology pre-service teachers do not differ significantly in their level of AI anxiety.
2. Demographic characteristics do not significantly predict AI anxiety among pre-service teachers.

2. METHOD

2.1. Research Design

The design adopted for this quantitative study is a survey design. This enables the gathering of precise and appropriate data, making informed decisions about the sampling techniques, reducing response bias, and optimizing response rates, which invariably improve the validity and quality of the findings [34]. This study aims to collect relevant information that explains AI anxiety among Pre-service teachers in Nigerian universities; therefore, the survey design is fit to collect relevant data. Also, it does not attempt to either add to or subtract from the existing fact or permit the manipulation of variables [35].

2.2. Population, Sample, and Sampling Technique

The target population for this study consisted of all pre-service teachers in university teacher education programs in public universities in southwestern Nigeria. A sample of 1067 MSTE (224 mathematics, 627 science, and 216 technology) pre-service teachers was used for the study. The sample was selected through a purposive sampling technique considering pre-service teachers specializing in mathematics, science (with Biology, Chemistry, and Physics options), and technology. Purposive sampling can be valuable in quantitative studies when it aims to select participants who possess unique characteristics or meet specific

criteria relevant to the research objectives [36]. The sample was selected from the federal and state-owned universities in southwest Nigeria.

2.3. Instrumentation

A questionnaire titled 'Mathematics, Science, and Technology Pre-service Teacher AI-Anxiety Questionnaire (MSTPTAQ)' (*see Appendix 1*), which consists of two sections, was used to collect data regarding the Pre-service teachers' AI-Anxiety. The first section, tagged section A, solicits demographic information of the respondents, such as course of study, current level, age, and gender. Section B consisted of 25 items scale adapted from [34] and used to measure Pre-service teacher's AI-Anxiety levels on a 5-point Likert scale (Strongly Agree = 5; Agree = 4; Neutral = 3; Disagree = 2; Strongly Agree = 1). The scale measures the Pre-service teachers' AI-Anxiety from six (6) dimensions as conceptualized in the study: technology intimidation – perceived inability and lack of confidence (items 1 – 7); societal impact – fear of having impact on the society (item 8 – 10); Job displacement – career and employment concern (item 11 – 14); technological dependence – fear of getting lazy (item 15 – 18); technological dread – fear of being affected in one way or other (item 19 – 22); and ethical concerns – fear of inappropriate usage (item 23 – 25).

The instrument for the study was validated for face and content validity. To ensure the face and content validity, the items were written in clear, simple English that someone who has yet to become an undergraduate could understand. They were meticulously organized to meet the study's aims. To establish the instrument's reliability, it was hosted online to undergraduates outside the geopolitical area of study, and 47 pre-service teachers responded. The data was analyzed using the Cronbach Alpha approach to determine the reliability index. This aids in determining the internal consistency of the instrument, and a reliability coefficient of 0.821 was obtained. The constructs, technology intimidation, societal impact, Job displacement, technological dependence, technological dread, and ethical concerns yielded reliability coefficients of 0.875, 0.851, 0.767, 0.769, 0.762, and 0.761, respectively.

2.4. Ethical Compliance

The consent of the participants was obtained. The participants in the study were assured that their participation was entirely voluntary and that they could withdraw from the study at any moment if they so desired. They were also assured of maintaining confidentiality and that all data collected would be used for research purposes only.

2.5. Administration of Instrument and Data Collection

The instrument was hosted online using a Google form. The link (<https://forms.gle/dt7CeLCF2UfpWPTn6>) generated for responding to the questionnaire was made available to the respondents by the researcher and through the support of research assistants who are lecturers in the MSTE department of the selected universities. The link was posted on the pre-service teacher's WhatsApp group platforms, and they were regularly reminded to complete it. This was made open for two weeks.

2.6. Data Analysis

The data collected from the respondents were coded. Responses on the 25 items of the AI anxiety scale were computed to determine the level of AI anxiety. The computation reveals 43 as the minimum value and 124 as the maximum value, with the range as 81. Four levels of anxiety were considered: Low – normal or no anxiety, Moderate – mild anxiety, High – moderate anxiety, and Very High – severe anxiety (Julian, 2011). The category size was calculated as $20.25 \approx 20$. The computed AI-Anxiety was recomputed into scale: 43 – 63 as low, 64 – 83 as moderate, 84 – 103 as High, and 104 – 124 as Very High.

Considering AI-Anxiety dimensions, Technology intimidation has minimum and maximum values of 7 and 35, respectively, with seven as the category size. The values ranging from 7 to 13, 14 to 20, 21 to 27, and 28 to 35 were categorized as low, moderate, high, and very high, respectively. The minimum, maximum, and range values for society impact are 6, 15, and 9, respectively, while the category size is 2. Therefore, values ranging from 6 to 8, 9 to 10, 11 to 12, and 13 to 15 were categorized as low, moderate, high, and very high, respectively. Also, the minimum, maximum, and range values for job displacement are 4, 20, and 16, respectively, while the category size is 4. Values ranging from 4 to 8, 9 to 12, 13 to 16, and 17 to 20 were therefore categorized as low, moderate, high, and very high, respectively. In addition, for the technology dependence dimension, the minimum, maximum, and range values are 6, 20, and 14, respectively, while the category size is $3.5 \approx 4$. Values ranging from 6 to 9, 10 to 13, 14 to 17 and 18 to 20 were then categorized as low, moderate, high and very high respectively. Moreover, the minimum, maximum, and range values for technological dread are 4, 20, and 16, respectively, while the category size is 4. Values ranging from 4 to 8, 9 to 12, 13 to 16, and 17 to 20 were thus categorized as low, moderate, high, and very high, respectively. Lastly, the minimum, maximum, and range values for ethical concerns are 4, 15, and 11, respectively, while the category size is $2.75 \approx 3$. The values ranging from 4 to 6, 7 to 9, 10 to 12, and 13 to 15 were therefore categorized as low, moderate, high, and very high, respectively. The statistical software used for the computation and data analysis is IBM SPSS Statistics 29. Descriptive analysis was used to answer the research questions, while the hypotheses were tested using inferential statistics.

3. RESULTS AND DISCUSSION

3.1. Results

Table 1 shows that of the pre-service teachers specializing in Mathematics, Science, and Technology, those in science (58.8%) have the highest percentage, which could be attributed to the fact that there are other units such as Biology, chemistry, physics, and agricultural education under it. Students in 100L were the highest (41.2%) respondents to the questionnaire, while those in 400L had the lowest response. Male pre-service teachers had the highest percentage (57.1%) of respondents, while the female was 42.9%. Undergraduates aged 18 – 20 (44.2%) make up the highest number of respondents, while those above 26 (3.0%) make up the lowest percentage. This indicates that most of the pre-service teachers are aged below 24 years.

Table 1. Respondents Characteristics(N=1067)

Characteristic	Level	Frequency(n)	Percentage (%)
Course of Study	Mathematics Education	224	21.0
	Science Education	627	58.8
	Technology Education	216	20.2
Class	100L	440	41.2
	200L	242	22.7
	300L	201	18.8
	400L	184	17.2
Gender	Male	609	57.1
	Female	458	42.9
Age	18 – 20years	472	44.2
	21 – 23years	435	40.8
	24 – 26years	128	12.0
	Above 26years	32	3.0

Research Question 1: What is the level of AI anxiety among Mathematics, Science, and Technology Education (MSTE) undergraduates?

Table 2. Level of AI Anxiety among Pre-service Teachers

Characteristic	Level	Frequency(n)	Percentage (%)	Mean	SD
AI-Anxiety	Low	137	12.8	2.49	0.79
	Moderate	337	31.6		
	High	529	49.6		
	Very High	64	6.0		
Total		1067	100		

From Table 2, 12.8% of the Pre-service teachers have a low level of AI-Anxiety, 31.6% have a moderate level, 49.6% have a high level, and 6.0% have a very high level of AI-Anxiety. The pre-service teachers' AI anxiety level mean and standard deviation are 2.49 and 0.79, respectively. The cut-off points 1.00 to 1.49 as low, 1.50 to 2.49 as moderate, 2.50 to 3.49 as high, and 3.50 to 4.00 as very high indicate moderate AI anxiety among Pre-service teachers. This implies that although at a moderate level, pre-service teachers could be apprehensive about using AI for many reasons.

Research Question 2: What are the dimensions of AI anxiety prevalent among pre-service teachers?

Table 3 shows the dimensions of AI anxiety levels among pre-service teachers. The result shows that pre-service teachers' AI anxiety regarding technology intimidation, societal impact, job displacement, technological dependence, technological dread, and ethical concerns had a mean of 2.86, 2.47, 2.80, 2.67, 2.59, and 2.52, respectively, while the standard deviations are 0.84, 1.00, 0.90, 0.78, 0.89, and 0.90, respectively. This shows that pre-service teachers have a high level of technology intimidation, indicating that using AI tools makes them apprehensive about technology. This may stem from a lack of guidance on how it could be ethically used, as some academics frown at its usage, especially for academic purposes. Also, a moderate level of societal impact was observed, which could mean that the pre-service teachers do not feel apprehensive about the effect of AI on society.

Moreover, there is a high level of AI anxiety about job displacement, which could be interpreted as pre-service teachers being apprehensive about getting a job after graduating or people losing their jobs when AI takes over. Regarding technology dependence, pre-service teachers have a high level of AI anxiety, which could indicate that they remain apprehensive because people might become lazy. At the same time, they depend on AI to get even simple, logical tasks done. On technology dread, Pre-service teachers have a high level of AI-Anxiety, which indicates that they have a fear of AI affecting them. Regarding ethical concerns, the pre-service teachers have a high level of AI-Anxiety, which is an indication that they fear the inappropriate usage of AI by undergraduates. The order of the dimensions of AI anxiety among pre-service teachers is ranked by prevalence: technology intimidation ranks highest, followed by concerns about job displacement, technological dependence, technological dread, ethical concerns, and, finally, societal impact.

Table 3. AI Anxiety Dimensions Among Pre-service Teachers

Dimension	Level	N	%	M	SD	Remark
Technology Intimidation	Low	48	4.5	2.86	0.84	High
	Moderate	314	29.4			
	High	440	41.2			
	Very High	265	24.8			
Societal Impact	Low	210	19.7	2.47	1.00	Moderate
	Moderate	337	31.6			
	High	328	30.7			
	Very High	192	18.0			
Job Displacement	Low	104	9.7	2.80	0.90	High
	Moderate	250	23.4			
	High	473	44.3			
	Very High	240	22.5			
Technological Dependence	Low	72	6.7	2.67	0.78	High
	Moderate	345	32.3			
	High	513	48.1			
	Very High	137	12.8			
Technological Dread	Low	144	13.5	2.59	0.89	High
	Moderate	306	28.7			
	High	464	43.5			
	Very High	153	14.3			
Ethical Concerns	Low	178	16.7	2.52	0.90	High
	Moderate	280	26.2			
	High	489	45.8			
	Very High	120	11.2			

Research Question 3: How do AI anxiety levels differ across pre-service teachers' subject specializations?

Table 4 shows the differences in the level of AI-Anxiety among pre-service teachers. Technology education (11.11%) pre-service teachers have the lowest percentage among those with low levels of AI-Anxiety, while mathematics education (17.86%) pre-service teachers have the highest. Among those with moderate levels of AI-Anxiety, the technology education (55.56%) pre-service teachers had the highest percentage, while mathematics education (17.86%) students had the lowest. For high levels of AI-Anxiety, science

education (55.02%) pre-service teachers had the highest percentage, while technology education (33.33%) had the lowest. Among those with very high levels of AI-Anxiety, mathematics education (14.29%) pre-service teachers had the highest, while technology education (0.00%) had the lowest. The mean of the pre-service teachers' AI anxiety for those specializing in mathematics, science, and technology are 2.54, 2.61, and 2.22, respectively, while their standard deviations are 0.76, 0.94, and 0.63, respectively. This indicates that AI anxiety is high among mathematics and science pre-service teachers and moderate among technology pre-service teachers.

Table 4. Level of AI-Anxiety among Pre-service Teachers

Characteristic	Level	Specialization			Total (%)
		Mathematics (%)	Sciences (%)	Technology (%)	
AI-Anxiety	Low	40 (17.86)	73 (11.64)	24 (11.11)	137 (12.84)
	Moderate	40 (17.86)	177 (28.23)	120 (55.56)	337 (31.58)
	High	112 (50.00)	345 (55.02)	72 (33.33)	529 (49.58)
	Very High	32 (14.29)	32 (5.10)	0 (0.00)	64 (6.00)
	Mean	2.54	2.61	2.22	2.49
	SD	0.76	0.94	0.63	0.79
Total		224	627	216	1067

Hypothesis 1: Mathematics, Science, and Technology pre-service teachers do not differ significantly in their level of AI anxiety

Table 5. ANOVA of AI Anxiety among Pre-service Teachers

Specialization	N	Mean	SD	DF	F-value	Sig.	Remark
Mathematics	224	2.54	0.76	1064	16.299	0.000	Significant
Science	627	2.61	0.94				
Technology	216	2.22	0.63				
Total	1067	2.49	0.79				

Sig. at $p < 0.05$; $MS_{Btw} = 9.937$; $MS_{Within} = 0.610$; F-value is Welch Test of unequal variance; $df1 = 2$; $df2 = 445.863$

A significant difference was found in the level of AI anxiety among the Pre-service teachers, as shown in Table 5. Given that the data's values fall within an acceptable range, the normality assumption based on skewness and kurtosis values of -2 to +2 and -7 to +7, respectively [37], indicates that the data is typically distributed. A test of the group means' homogeneity of variances; however, it reveals significant ($p < 0.05$) differences. Between groups, the mean square ($MS_{btw} = 9.937$) is higher than the mean square within groups ($MS_{with} = 0.610$). Welch's Robust Test of Equality of Means was used considering the homogeneity of variance test, indicating uneven variation in the group means. The Welch's ANOVA test results show that there was a statistically significant difference between the observed mean Pre-service teacher's AI anxiety ($F_{(2, 445.863)} = 16.299$; $p < 0.05$). Hence, the result indicates that Mathematics, Science, and Technology pre-service teachers differ significantly in their level of AI anxiety. This indicates that the course of study significantly influenced university teacher education students' AI anxiety.

Table 6. Tukey Post Hoc Multiple Comparisons Between Pre-service Teachers Specialization and AI Anxiety

(I) Pre-service Teachers	(J) Pre-service Teachers	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Science	Mathematics	.07126	.06078	.470	-.0714	.2139
	Technology	.38492*	.07446	<.001	.2102	.5597
Mathematics	Science	-.07126	.06078	.470	-.2139	.0714
	Technology	.31366*	.06160	<.001	.1691	.4582
Technology	Science	-.38492*	.07446	<.001	-.5597	-.2102
	Mathematics	-.31366*	.06160	<.001	-.4582	-.1691

*. The mean difference is significant at the 0.05 level.

The Tukey Post hoc test of the multiple comparisons result in Table 6 reveals that pre-service teachers in university teacher education programs studying technology education had lower AI anxiety than those in Mathematics and Science Education, while those in mathematics also had it lower than their counterparts in science education but the difference was not significant. This indicates that subject specialization (course of study) between technology and mathematics and as well science had $p < 0.05$ and contributed statistically significantly to mathematics, science, and technology pre-service teachers' AI anxiety.

Hypothesis 2: Demographic characteristics do not significantly predict AI anxiety among pre-service teachers

Table 7. Regression of Association Between Demographic Characteristics and AI-Anxiety Among Pre-service Teachers

Variable	B	SE	t	p	95% CI
Specialization→AI-Anxiety	-1.983	.755	-2.627	.009	-3.464 – -.502
Class→AI-Anxiety	.052	.569	.092	.927	-1.065 – 1.169
Gender→AI-Anxiety	.074	.977	.076	.940	-1.844 – 1.992
Age→AI-Anxiety	-1.157	.825	-1.403	.161	-2.775 – .461
R = .091; R ² = .008; F=2.235; p=.063					

Table 7 shows the result of multiple regression analysis of the association between demographics and AI anxiety among Pre-service teachers. The model examined the relationship between four independent variables (specialization, Class, Gender, and Age) and the dependent variable of AI-Anxiety. While keeping all other variables constant, the regression coefficient for the course of the study was statistically significant ($B = -1.983$; $t = -2.627$; $p = .009$; 95% CI [-3.464, -.502]). A one-unit increase in specialization was linked with a 1.983-point drop in AI anxiety. This implies that a major determinant of students' degrees of AI anxiety might be their course of study. This means that, after adjusting for the other factors in the model, these variables were not substantially correlated with AI-Anxiety. However, the regression coefficients for Class ($B = 0.052$; $t = 0.092$; $p = .927$; 95% CI [-1.065, 1.169]), Gender, ($B = 0.074$; $t = 0.076$; $p = .940$; 95% CI [-1.844, 1.992]), and Age ($B = -1.157$; $t = -1.403$; $p = .161$, 95% CI [-2.775, .461]), were not statistically significant. This suggests that these variables were not significantly related to AI anxiety after controlling for the other variables in the model. In addition, considering the combined effects of the independent

variables (demographics) on AI anxiety, with $R = .091$ and $R^2 = .008$, the model summary statistics show a small overall effect size, indicating that the model explained over 0.8% of the variation in AI-Anxiety. The general model was not statistically significant ($F=2.235$, $p=.063$), and demographic characteristics did not significantly predict AI anxiety.

3.2. Discussion

This study focuses on AI anxiety among pre-service teachers in university teacher education programs. Its findings show that there is a moderate level of AI anxiety among Pre-service teachers. This level of anxiety suggests that while the pre-service teachers recognize the potential challenges posed by AI, they are not incapacitated by fear; instead, they seem to be in a state of cautious awareness. This moderate anxiety could stem from a blend of excitement about the innovative possibilities AI brings to teaching and apprehension about its implications for their roles in the classroom. Contrary to this finding, Falebita [21] and Butakor [33] indicate high levels of AI anxiety among pre-service teachers. At the same time, Eyüp and Kayhan [25] report anxiety below moderate levels in specific dimensions and above moderate anxiety about AI replacing jobs and causing sociotechnical issues. This presents an opportunity for educators and institutions to provide targeted support and training, empowering pre-service teachers to navigate their concerns and harness AI as an effective educational tool.

The finding also shows that pre-service teachers' AI anxiety regarding technology intimidation, job displacement, technological dependence, technological dread, and ethical concerns is high, while it is only moderate for societal impact. The order of the dimensions of AI anxiety among pre-service teachers is ranked by prevalence: technology intimidation ranks highest, followed by concerns about job displacement, technological dependence, technological dread, ethical concerns, and, finally, societal impact. This suggests that fear of becoming lazy, being stuck in one way or another, fear of inappropriate usage, and perceived inability and confidence to use AI tools effectively are causing pre-service teachers in university teacher education programs to experience anxiety about using AI. These results complement the general research on AI anxiety among pre-service teachers. As Güven et al. [20] suggest, university students exhibited high levels of AI anxiety across the four dimensions of AI anxiety considered in their study: learning, job change, sociotechnical blindness, and AI configuration. Also, Fu [18] points out that students may have significant reservations about utilizing AI technologies, including being lazy, being locked in one way of thinking, misusing the technology, and perceiving incapacity to utilize it successfully. Wang et al. [12] underlined even more how common AI anxiety is among university students and how it could affect their learning motivation. However, the present research findings provide empirical evidence for these worries, showing that AI anxiety is a significant problem among pre-service teachers in university teacher education programs when considering the six AI anxiety dimensions. This implies that the features of AI anxiety shown in other studies, like fear of laziness, inflexible thinking, misuse, and lack of confidence, may be contributing to the increased degrees of anxiety reported among university students.

According to this study, pre-service teachers' AI anxiety levels in university teacher education programs differ significantly depending on their course of study. Students in

science education programs showed the highest level of AI anxiety, followed by those in mathematics education; technology education students showed a moderate level of AI anxiety. This implies that a student's perceptions and worries about AI might be influenced by the relevance and exposure to AI technology within their academic area. Garrel and Mayer [17] observe that science, mathematics, and engineering students exhibit different behaviours while utilizing AI-based tools, presumably because different technologies are relevant to their academic endeavours. When AI technologies are regarded as immediately relevant and advantageous for a student's course of study, it might help to change personal opinion of the technology and lower anxiety around its application. Students in science-oriented programs, on the other hand, showed more anxiety even if they would see artificial intelligence as less directly relevant to their assignments. Moreover, the moderate level of AI anxiety among technology education students suggests that worry could be lessened by increasing acquaintance and interaction with AI-related technologies and ideas. This emphasizes the need to integrate AI-oriented courses and opportunities for experiential learning into MSTE across various programs.

The study's analysis revealed that among the Pre-service teachers sampled, demographic factors, including age, class, and gender, had no appreciable effect on the level of AI anxiety. This result confirms the body of current research on this subject. For example, Banerjee and Banerjee [22] and Falebita [21] observed no significant gender differences in AI anxiety among pre-service teachers and academics. Terzi's [38] research also showed no significant correlation between demographic factors, including age, gender, and experience with AI anxiety. These consistent results across several educational and professional environments imply that elements beyond essential demographic traits may be more significantly influencing AI anxiety. This suggests that the causes of AI-related fears among professionals and students might be more complicated and varied and may be derived from elements like educational background, exposure to AI technology, and perceived significance of AI to one's work area. However, McGrath et al. [39], who observed significant connections between AI anxiety and demographics, including gender, age, and race, among university teachers, show that their findings contradict the study. This disparity emphasizes the necessity of further study to better grasp the link between demographic elements and AI-related worries across several demographics and academic sectors. The lack of significant demographic influences on AI anxiety observed in this study, and the other literature indicates that educational interventions and support strategies to address AI-related anxieties may need a more holistic and discipline-specific approach rather than relying solely on demographic characteristics. Understanding the many elements influencing AI anxiety helps educational institutions create more focused and successful initiatives to equip students to incorporate AI technology into their future endeavours.

4. CONCLUSION

The findings of this research suggest that pre-service teachers in university teacher education programs show different levels of AI anxiety. While those specializing in technology showed relatively moderate levels of AI anxiety, those in science and mathematics showed a high level of AI anxiety. This result suggests that students'

perceptions and worries about AI technologies might be influenced by the perceived relevance and application of the technologies within their academic area of specialization. Also, the research found that demographic variables, including gender, age, and class, had no significant effect on the pre-service teachers' AI anxiety levels. This implies that the causes of AI anxiety among undergraduates might be more complicated and subtle, maybe derived from elements beyond essential demographic traits. These results have significant implications for policymakers trying to alleviate pre-service teachers' AI anxiety and for educational institutions. Integrating AI literacy initiatives and offering focused instruction on using AI tools effectively within Pre-service teachers' particular academic fields may reduce their anxiety and promote a more favourable view of the technology.

Moreover, career advice and well-being seminars may assist pre-service teachers in overcoming their worries about how AI would affect their future jobs and personal welfare. Also, the research findings on AI anxiety among pre-service teachers have significant implications for higher education institutions and academics. These institutions and professionals are instrumental in helping pre-service teachers in university teacher education programs negotiate the growing incorporation of AI technologies into their academic and career paths. Interventions addressing the unique causes of AI anxiety, like skill-building, ethical training, and cultivating a growth mindset, are beneficial in reducing these worries and supporting the responsible and efficient use of AI tools. Adopting a multifarious strategy that considers university students' particular requirements and concerns across various teacher education programs would help educational institutions equip the next generation of STEM educators to adopt and efficiently use AI technology in their respective domains.

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Appendix 1

Mathematics, Science, and Technology Pre-service Teacher AI-Anxiety Questionnaire (MSTPTAQ)

1. Learning all the specialized functions of an AI technique or product makes me worried
 2. Learning how to utilize AI tools or products effectively makes me worried
 3. Learning to navigate and utilize specific functions of an AI technique or product makes me worried
 4. Understanding the inner workings of an AI technique or product makes me anxious
 5. Interacting with an AI technique or product makes me worried
 6. Enrolling in a course that covers the development of AI techniques and products makes me worried
 7. Reading a manual for an AI technique or product makes me anxious
 8. Feeling unable to keep up with the advancements in AI techniques and products makes me worried
 9. I am concerned that relying on an AI tool may lead to dependency
 10. I am worried that an AI tool may contribute to increased laziness
 11. I fear that an AI technique or product may replace human workers
 12. The idea of artificial intelligence makes me worried about my future career prospects
 13. I have concerns that the widespread use of humanoid robots will result in job displacement
 14. I am afraid that if I start using AI techniques or tools, I might become dependent on them and lose some of my critical thinking skills
 15. I am concerned that AI techniques or tools will replace jobs currently held by people
 16. I am anxious about the potential misuse of AI techniques or tools.
 17. I am worried about various issues that may arise concerning the usage of AI tools.
 18. I fear that an AI tool may malfunction and get out of control
 19. I am apprehensive that AI techniques or products may lead to autonomous robots
 20. I find humanoid AI tools, such as humanoid robots, frightening
 21. Humanoid AI tools, such as humanoid robots, make me feel intimidated
 22. I cannot explain why, but humanoid AI tools, such as humanoid robots, evoke fear in me
 23. I worry about the potential ethical implications of artificial intelligence
 24. The thought of relying heavily on artificial intelligence in the future makes me anxious in my field
 25. I worry about the potential ethical implications of artificial intelligence
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