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PAPER

The Impact of ChatGPT Usage Intensity on Mathematics Anxiety and Problem-Solving Skills among Undergraduate Students

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ABSTRACT

Given the foundational role of mathematics in higher education and the rapid integration of educational technologies, understanding the impact of digital tools on mathematics learning has become increasingly important. This study examined the impact of ChatGPT usage intensity on mathematics anxiety and perceived problem-solving skills among undergraduate students. A quantitative descriptive research design with a cross-sectional approach was employed, involving a sample of 357 undergraduate students. Data were collected using three validated instruments: the adopted Academic Intensity of ChatGPT Use scale, the Abbreviated Math Anxiety Scale, and the Problem-Solving Inventory. The results revealed a significant positive relationship between ChatGPT usage intensity and perceived problem-solving skills, as well as a significant negative relationship between ChatGPT usage intensity and mathematics anxiety. Regression analyses further indicated that ChatGPT usage intensity significantly predicted both mathematics anxiety and problem-solving skills. The findings suggest that ChatGPT use may support mathematics learning by reducing anxiety and enhancing problem-solving skills among undergraduate students, highlighting its potential value for integration into higher education contexts.

KEYWORDS

ChatGPT, mathematics, anxiety, problem-solving skills, generative artificial intelligence

1 INTRODUCTION

With the rapid advancement of artificial intelligence (AI), ChatGPT has become one of the most prominent interactive tools used by students in the learning process, particularly for interacting with content, requesting direct explanations, and solving academic exercises. These tools are increasingly viewed as supportive learning resources that assist students in understanding academic content and overcoming learning challenges [1–5]. Among academic subjects, mathematics represents a

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fundamental and essential field due to its central role in developing logical and analytical thinking, decision-making, and problem-solving skills [6–9]. These skills are directly linked to students' success in higher education and professional life and are widely recognized as core competencies for the development of 21st-century skills [10–13].

International large-scale assessments, particularly the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA), consistently report weaknesses in Jordanian students' performance in mathematics [14]. At the national level, empirical evidence further indicates that many students encounter considerable difficulties in understanding mathematical concepts and demonstrate low levels of mathematics achievement [15–16]. These academic challenges are frequently associated with increased mathematics anxiety, supporting both theoretical and empirical findings that link poor mathematics performance with heightened anxiety toward the subject [17–18]. In addition, mathematics anxiety has been shown to negatively influence students' problem-solving performance, particularly in tasks requiring higher-order cognitive processing [19].

In parallel with these challenges, the rapid adoption of AI–based educational tools, such as ChatGPT, has attracted increasing attention within higher education research. Emerging studies suggest that AI-based tools can support students' learning processes by enhancing knowledge acquisition, skill development, learning efficiency, and psychological well-being [5], [20–21]. Within mathematics education specifically, such tools may offer additional support for students who experience anxiety or difficulty when engaging with complex problem-solving tasks. However, empirical evidence examining how the academic use of ChatGPT relates to mathematics anxiety and problem-solving skills remains limited in the Jordanian higher education context. Accordingly, the study is guided by the following research questions:

RQ1: What are the levels of mathematics anxiety, ChatGPT usage intensity, and problem-solving skills among undergraduate students?
RQ2: Is there a statistically significant correlation between intensity of use of ChatGPT, mathematics anxiety, and perceived problem-solving skills?
RQ3: Does ChatGPT usage intensity significantly predict problem-solving skills among undergraduate students?
RQ4: Does ChatGPT usage intensity significantly predict mathematics anxiety among undergraduate students?

2 LITERATURE REVIEW

2.1 ChatGPT usage in higher education

ChatGPT has been increasingly examined in higher education literature in terms of its academic use and adoption among university students. Several studies have documented the growing reliance on ChatGPT among university students. [22] Reported that students frequently use ChatGPT to support interaction, personalized learning, and understanding complex academic content, benefiting from immediate feedback and easy access to information. Similarly, [23] found that actual use of ChatGPT is strongly associated with behavioral intention, while habitual use plays

a significant role in shaping students' intention to adopt the tool in higher education. [24] Further demonstrated that university students tend to use ChatGPT more frequently than instructors, reflecting higher levels of student engagement with AI-based tools.

At the institutional level, [25] confirmed the widespread use of ChatGPT among Ukrainian university students, with support from instructors to enhance learning and manage educational processes. In the Jordanian context, [26] reported a moderate level of ChatGPT use among undergraduate students. Similar findings were reported by [5], who also identified a moderate level of chatbot-based AI usage among 340 undergraduate students. Overall, these studies indicate that while ChatGPT has become widely adopted in higher education, its academic use is generally characterized by moderate usage intensity. This pattern highlights the importance of examining ChatGPT usage intensity as a key variable when investigating its relationship with students' learning-related and psychological outcomes, such as problem-solving skills and mathematics anxiety.

2.2 Mathematics anxiety in the context of ChatGPT use

Mathematics anxiety has been widely documented in the literature as a common experience among students across different educational stages. Previous studies indicate that students' levels of mathematics anxiety often range from moderate to high, depending on contextual and disciplinary factors. For example, [27] and [28] reported moderate levels of mathematics anxiety among students, a finding that was also observed among engineering students at UniMap University in [29]. In contrast, [30] found that undergraduate mathematics majors experienced relatively high levels of anxiety. Other studies have consistently reported moderate mathematics anxiety among university students in different contexts, including Malaysian students [31] and non-mathematics majors enrolled in mathematics courses in the Philippines [32], where anxiety was often associated with fear of grades. Similarly, [33] linked moderate mathematics anxiety to fear of failure and academic stress. At the school level, [34] showed that most secondary school students exhibited moderate anxiety, with a smaller proportion experiencing high levels.

Recent research has demonstrated a clear relationship between the use of AI tools in mathematics learning and students' levels of mathematics anxiety. A systematic review by [35] concluded that technology-based instructional approaches enhance students' attitudes toward mathematics, reduce anxiety, and support the development of problem-solving skills and confidence. In higher education contexts, [26] reported that higher levels of ChatGPT use were associated with reduced academic stress among university students, highlighting the supportive role of AI in students' mental well-being. Similarly, [36] found that integrating conversational agents into mathematics instruction significantly reduced students' anxiety by promoting interaction and experiential learning.

Other studies have reported more differentiated findings [37], showed that ChatGPT use significantly improved self-regulated learning skills in mathematics, although no significant differences were observed in mathematics anxiety, suggesting that anxiety reduction may depend on instructional design. In contrast, [38] demonstrated that an AI chatbot designed with data support, fine-tuning, and prompt engineering provided emotional support that contributed to reducing mathematics anxiety. Likewise, [39] found that the use of ChatGPT among 11th-grade students significantly

reduced mathematics anxiety and improved performance in algebra word-problem tasks. At earlier educational levels, [40] showed that AI-enhanced learning reduced anxiety by increasing students' interest, self-efficacy, and academic engagement. Additionally, [41] reported that students with higher levels of mathematics anxiety were more likely to rely on AI tools for solving mathematical problems, indicating a positive association between anxiety levels and AI use.

Beyond correlational evidence, some studies provide indirect support for a predictive role of ChatGPT-related factors in reducing anxiety. [42] showed that self-efficacy and motivation significantly enhanced student performance in blended learning environments, with the effect of self-efficacy moderated by ChatGPT use. Similarly, [43] reported that students' algebra performance was positively associated with the use of ChatGPT to enhance algebra-related confidence. In addition [44], found that positive attitudes toward ChatGPT were linked to increased motivation, engagement, and confidence in mathematics, suggesting the potential of ChatGPT to contribute to reduced mathematics anxiety when integrated effectively into learning environments. However, limited research has examined ChatGPT usage intensity as a predictor of mathematics anxiety, underscoring the contribution of the present study.

2.3 Problem-solving skills in the context of ChatGPT use

Problem-solving skills are considered fundamental in higher education, and existing literature suggests that most university students demonstrate moderate to high proficiency in these skills. For example, [45] reported that students in higher education institutions in India exhibited average to high levels of problem-solving and decision-making skills. Recent research has increasingly examined the role of ChatGPT in supporting problem-solving skills across different learning contexts. [46] Reported that engaging with ChatGPT contributed to improving students' solution quality, level of detail, and originality, while simultaneously strengthening their confidence in handling complex problem-solving tasks. Similarly, [47] reported that interaction with ChatGPT enhanced students' critical thinking and learning styles, which were positively associated with problem-solving performance. [48] Demonstrated that ChatGPT's performance in solving intuitive verbal problems was comparable to human performance, indicating its potential to support thinking and problem-solving processes.

In mathematics-related contexts, [49] showed that students who actively engaged with ChatGPT employed metacognitive processes such as planning, monitoring, and evaluating, leading to enhanced problem-solving skills, while excessive reliance on the tool without understanding reduced effectiveness. Similarly, [50] found that integrating ChatGPT into programming problem-solving tasks with appropriate metacognitive guidance improved students' understanding of problems and evaluation of solutions. Additional studies have highlighted indirect mechanisms through which ChatGPT may support problem-solving. [51] Reported that ChatGPT use was associated with increased motivation and engagement, which contributed to improved problem-solving and critical thinking. [52] Also indicated that ChatGPT has supportive and predictive capabilities in enhancing mathematical reasoning, particularly in tasks with clear logical structures. Likewise, [53] and [54] showed that integrating ChatGPT into experiential and problem-based learning environments contributed to the development of students' critical thinking and real-world problem-solving competencies.

2.4 Uses and Gratifications Theory

ChatGPT can be conceptualized as both a form of new media and an emerging digital technology. Traditionally, Uses and Gratifications Theory (UGT) has been employed to examine patterns of traditional media use [55–56]. In more recent years, the theory has been extended to internet-based and interactive digital technologies, where its motivational perspective has proven effective in explaining why individuals choose particular media and how they engage with them [57]. Within this framework, UGT assumes that individuals are active users who intentionally select digital media to satisfy specific needs [58]. These needs include cognitive needs, such as learning, understanding, and acquiring information; affective needs, which relate to entertainment, relaxation, and stress reduction; integrative needs, reflecting the enhancement of self-confidence, personal values, and perceived competence; and social-interactive needs, which involve communication, social interaction, and relationship building [59–61]. Together, these need categories provide a coherent theoretical foundation for understanding users' motivations to adopt and engage with contemporary digital technologies, particularly within educational contexts.

In the context of mathematics learning, ChatGPT can be understood as a digital learning tool that fulfills multiple gratifications proposed by UGT. From a cognitive perspective, students may use ChatGPT to obtain explanations, clarify concepts, and support problem-solving processes. From an affective perspective, ChatGPT may help reduce stress and anxiety by providing immediate feedback and a non-judgmental learning environment. Accordingly, the intensity of ChatGPT use reflects the extent to which students rely on the tool to satisfy these cognitive and affective needs, making UGT a suitable theoretical framework for examining the relationships between ChatGPT usage intensity, mathematics anxiety, and problem-solving skills in the current study.

3 RESEARCH METHODOLOGY

The research used a quantitative descriptive research methodology to investigate the relationship between how often university students use ChatGPT for learning mathematics, their math anxiety, and their problem-solving skills. The researches adopted a cross-sectional design (CSD) to assess the research variables at one point in time among a sample of students using a questionnaire.

3.1 Population and research sample

The population of research consisted of undergraduate students enrolled at Middle East University (MEU), which is a private university in Jordan, during the second semester of the scholastic year 2023–2024. The participants were undergraduate students who had completed or enrolled at least one university-level mathematics course (e.g., Probability, Calculus). A purposeful sample was used to select undergraduate students. The criteria for selecting the research participants were as follows: they have studied or enrolled in at least one mathematics course (ie. Probability, calculus), and b) they were enrolled in the second semester of the scholastic year 2025–2024. A total of 357 students participated in the study. The study sample size was calculated in accordance with Thompson's equation [62]. The demographic characteristics of the participants are presented in Table 1.

Table 1. Participants demographic characteristics

Variables		F	P
Gender	Male	165	46.2
	Female	192	53.8
Academic level	1st year	213	59.7
	2nd year	80	22.4
	3rd year	38	10.6
	4th year or more	26	7.3
Technological level	Beginner	65	18.2
	Intermediate	228	63.9
	Advanced	64	17.9
GPA	Excellent	81	22.7
	Very good	105	29.4
	Good	102	28.6
	Poor or less	69	19.3
Total		357	100

4 LITERATURE REVIEW

The researcher used three main valid and reliable tools to collect data regarding the research participants' intensity of use of ChatGPT, their math anxiety and problem-solving skills levels. The tools were reviewed by eight experts specialized in the fields of educational technology, psychological and educational counseling, measurement and evaluation, educational psychology, and English language to make sure they were clear and valid. Also, tools were administered on a pilot sample of 45 undergraduate students from the research population and outside research sample to ensure their reliability and validity. Cronbach's alpha (α) was used to test the reliability in terms of internal consistency, and all tools showed acceptable results (i.e., above 0.70) [63]. Moreover, Pearson correlation coefficients (r) were extracted to confirm the construct validity of the tools, and all tools showed an appropriate item–total relationships.

Abbreviated Math Anxiety Scale (AMAS): The researcher used the AMAS developed by [64] to assess the participant's math anxiety's level. The AMAS is consisted of 9-items that measures anxiety in response to various math-related situations. Participants perceived anxiety in each situation was measured using a five-point Likert scale, anchored from "low anxiety" (1) to "high anxiety" (5). The range of total scores range from 9 to 45, the higher scores indicate grater level of math anxiety. An example item from the AMAS is:" Listening to another student explain a math formula."

The AMS has demonstrated strong psychometrics properties, including excellent internal consistency, test-retest reliability, and good convergent/divergent validity [64]. In the current research, the researcher also administrated the AMAS to a pilot sample of 45 undergraduate students. The extracted α coefficient reached

(0.93) it indicated a high internal consistency, as well the extracted r between each item and total score rang from 0.420 to 0.810. These results indicate that AMAS is reliable and valid tool [63].

Problem-Solving Inventory (PSI): The researcher used the PSI developed by [65] to assess the participant's personal problem-solving skills' level. The PSI is a widely used tool [66], it consisted of 32-item that distributed over three dimensions: Problem-Solving Confidence (PSC) consisted of 11 items, Approach–Avoidance Style (AAS) consisted of 16 items, and Personal Control (PC) consisted of 5 items. PSI measure participant's perceptions of their problem-solving abilities. Participants rated how much each statement applied to them using a 6-point Likert scale, ranging from "1: strongly disagree to 6: strongly agree". Total scores range from 32 to 192, the higher scores reflect greater problem-solving skills. an example item from the PSI is "Given enough time and effort, I believe I can solve most problems that confront me.".

The PSI has demonstrated internally consistent and stability over time [65] and it has been validated across several countries such as Southeast Asian contexts, Singapore [66], and Birjand, Iran [67]. In the current research, the researcher also administered the PSI to a pilot sample of 45 undergraduate students to examine its reliability and validity within the study context. The psychometrics properties of the PSI scale were extracted and presented in Table 2. The α coefficients for each PSI dimension and for the total scale indicated a strong internal consistency that ensured overall reliability of the PSI. In addition, the extracted r coefficients between each item and the total score of its corresponding subscale ranged from 0.357 to 0.761 confirmed a good internal consistency within each dimension. Furthermore, r coefficients between each subscale score and the total PSI score ranged from 0.325 to 0.719 indicating additional evidence of construct validity [63]. These results confirmed that PSI is reliable and valid tool for measuring personal problem-solving skills in the current research context.

Table 2. Psychometrics properties of the PSI scale

Sub-Scale	r (min – max)		α
	Item-Subscale	Item- Total	
PSC (11 items)	0.423–0.756	0.368–0.701	0.84
AAS (16 itms)	0.357–0.685	0.325–0.628	0.86
PC (5 items)	0.462–0.761	0.428–0.719	0.82
Total PSI (32 items)			0.89

Intensity of ChatGPT Use: The researcher adopted the academic intensity use of Chatbot-based AI (AIUCA) scale that originally developed by [3]. To measure the extent to which students use ChatGPT for educational purposes in mathematics. The adopted version of the AIUCA scale consisted of 9 items, participants rated their intensity use using 5-point Likert scale ranging from "1: strongly disagree to 5: strongly agree". Total score ranges from 9 to 45, the higher total score indicates grater intensity of academic ChatGPT use in mathematic learning. An example item of adopted version of AIUCA item 5: "I feel comfortable using ChatGPT applications for learning mathematics."

The AIUCA has demonstrated strong psychometrics properties as reported by [3]. In the current study, the researcher administrated the adopted version of AIUCA to a pilot sample of 45 undergraduate students. The extracted α coefficient reached (0.94) which indicate a high internal consistency, additionally, the extracted r between each item and the total score rang from 0.359 to 0.799. These results support that adopted AIUCA is reliable and valid tool [63] for assessing the intensity of ChatGPT use in mathematics learning.

4.1 Data collection

The research data were collected during the second semester of the 2025–2026 scholastic year at the third month of the second semester. The research conducted after obtaining the necessary approvals to conduct the study form the administrative board at MEU. The ethical considerations and approval were met and obtained; the IRB approval number (KAT/D/1191) were obtained from the research committee at MEU. then researcher distributed the URL's questionnaires to the research population using E-learning and social media platforms. The questionnaire included three main scales that measured the intensity of ChatGPT use for educational purposes, math anxiety, and personal problem-solving skills. Clear instructions were provided at the beginning of the questionnaire to explain the study's' aims and the possibility of withdrawing the participation of research at any time, the privacy and confidently of data were met during all research processes. The period of data collection process was lasted for three weeks to ensure an adequate response rate.

4.2 Data analysis

Data was analyzed using SPSS version 26. First, the descriptive statistics were extracted to explore the average levels of research variables (i.e., intensity use of ChatGPT, math anxiety, and problem-solving skills). Then, one-way ANOVA was conducted to find differences in math anxiety and problem-solving skills between low, moderate, and high ChatGPT users. Finally, simple linear regression was performed to see if ChatGPT usage can predict students' math anxiety and problem-solving skills. All preliminary assumptions for the statistical tests were ensured and met before conducting the main analyses.

5 RESULTS AND SUBMISSION

5.1 Preliminary analysis

Before conducting the main statistical analyses, initial checks were carried out to verify that the data were suitable for regression analysis. These checks focused on examining multicollinearity, normality, linearity, and homoscedasticity.

The assessment of multicollinearity was conducted using VIF and Tolerance measures. For AIUCA, both indices equaled 1.000, remaining well within recommended thresholds and indicating no multicollinearity concerns. The Normal Q–Q plot indicated that the residuals were approximately normally distributed, as they closely followed the diagonal line (see Figure 1).

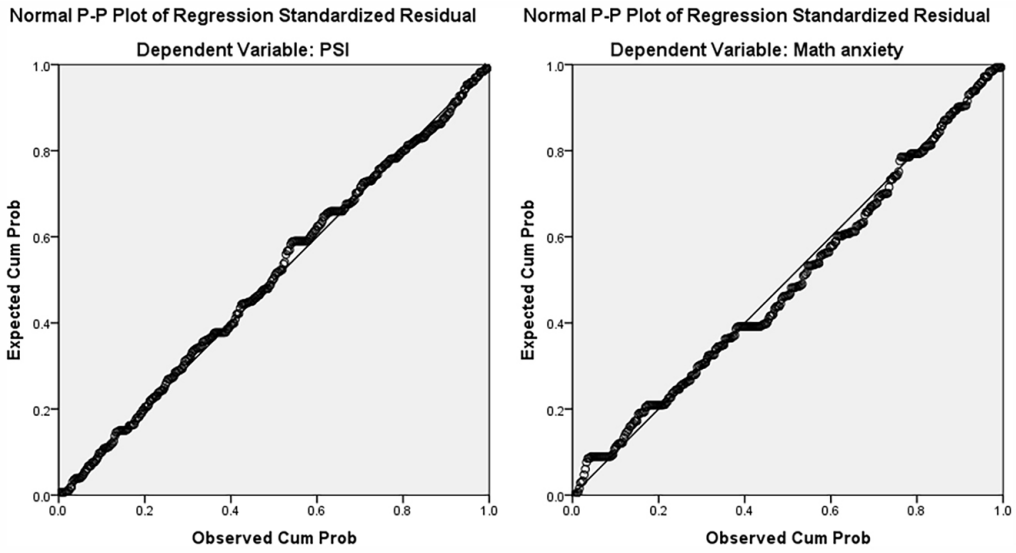

Fig. 1. Normal Q-Q plot of residuals

Visual inspection of scatterplots depicting standardized residuals against standardized predicted values (see Figure 2) revealed a random distribution around the horizontal axis, indicating no violations of linearity or homoscedasticity.

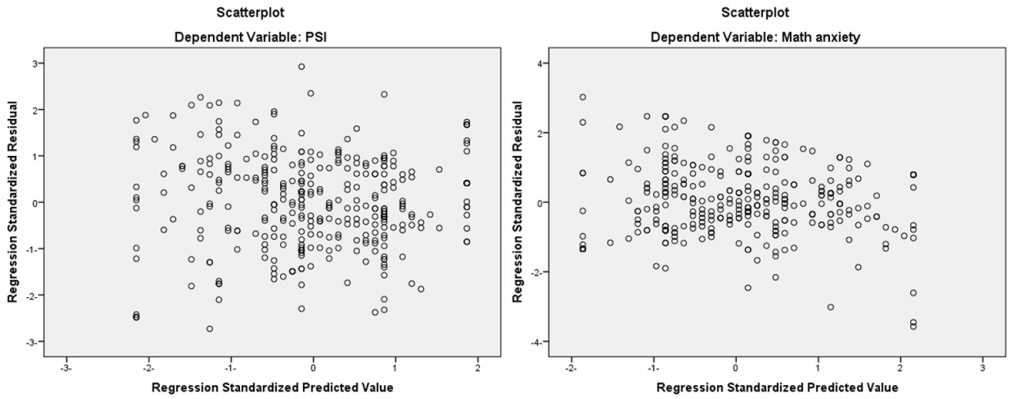

Fig. 2. Scatterplot showing standardized residuals in relation to predicted values

Based on these preliminary checks, the data were considered appropriate for proceeding with the correlation and regression analyses.

RQ1: What are the levels of mathematics anxiety, ChatGPT usage intensity, and problem-solving skills among undergraduate students?

Descriptive statistics were calculated to determine the levels of ChatGPT usage intensity, mathematics anxiety, and perceived problem-solving skills among undergraduate students.

Regarding perceived problem-solving skills, the results indicated that undergraduate students reported a moderate level (M = 3.76). Item-level analysis, as presented in Table 3, showed that most items were rated at a moderate level, with one item reaching a high level (Item 6, M = 4.39). The highest-rated item was "After I have tried to solve a problem with a certain course of action, I take time and compare the actual

outcome to what I thought should have happened," indicating students' tendency to evaluate their problem-solving outcomes.

Table 3. Descriptive statistics of the PSI

#	SD	M	Level	#	SD	M	Level
1	1.17	4.14	Moderate	17	1.30	4.03	Moderate
2	1.20	3.99	Moderate	18	1.36	3.34	Moderate
3	1.33	3.22	Moderate	19	1.34	3.50	Moderate
4	1.20	4.11	Moderate	20	1.32	3.89	Moderate
5	1.28	4.11	Moderate	21	1.30	3.23	Moderate
6	1.21	4.39	High	22	1.24	3.87	Moderate
7	1.22	4.21	Moderate	23	1.29	4.08	Moderate
8	1.20	4.15	Moderate	24	1.34	3.59	Moderate
9	1.27	3.90	Moderate	25	1.19	3.80	Moderate
10	1.32	3.53	Moderate	26	1.37	3.57	Moderate
11	1.23	4.24	Moderate	27	1.28	3.94	Moderate
12	1.42	3.64	Moderate	28	1.34	3.65	Moderate
13	1.51	3.74	Moderate	29	1.43	3.56	Moderate
14	1.42	3.64	Moderate	30	1.37	3.67	Moderate
15	1.27	4.02	Moderate	31	1.38	3.61	Moderate
16	1.35	3.77	Moderate	32	1.40	3.76	Moderate
Total					0.62	3.76	Moderate

With respect to mathematics anxiety, the results revealed a moderate level among undergraduate students (M = 3.14). Item-level analysis, presented in Table 4, showed that all items were rated at a moderate level. The highest mean score was recorded for Item 1 (M = 3.38), which refers to "Having to use the tables in the back of a math book," whereas the lowest mean score was observed for Item 8 (M = 2.92), which refers to "Being given a 'pop' quiz in math class."

Table 4. Descriptive statistics of the MAS

#	SD	M	Level	#	SD	M	Level
1	1.19	3.38	Moderate	5	1.18	3.30	Moderate
2	1.27	2.96	Moderate	6	1.17	3.33	Moderate
3	1.19	3.19	Moderate	7	1.23	3.02	Moderate
4	1.27	3.07	Moderate	8	1.23	2.92	Moderate
Total	1.00	3.14	Moderate	9	1.22	3.13	Moderate

Regarding ChatGPT usage intensity for learning mathematics, the findings indicated a moderate level (M = 3.18). As shown in Table 5, all items were rated at a moderate level. The highest mean score was observed for Item 7 (M = 3.45), which states, "I am proud to use chatbot-based AI applications for learning mathematics,"

while the lowest mean score was recorded for Item 8 (M = 2.80), which refers to ChatGPT use as part of daily academic activities.

Table 5. Descriptive statistics of the AICUC

#	SD	M	Level	#	SD	M	Level
1	1.22	3.38	Moderate	5	1.28	3.15	Moderate
2	1.28	2.88	Moderate	6	1.38	3.43	Moderate
3	1.37	3.44	Moderate	7	1.35	3.45	Moderate
4	1.29	2.82	Moderate	8	1.34	2.80	Moderate
Total	1.05	3.18	Moderate	9	1.35	3.27	Moderate

The findings of the first research question indicate that undergraduate students reported moderate levels of ChatGPT usage intensity, mathematics anxiety, and perceived problem-solving skills. This finding is consistent with several previous studies that reported similar moderate levels for each variable. The moderate level of perceived problem-solving skills indicates that students generally view themselves as capable of approaching and managing problem-solving situations and evaluating their problem-solving processes. This result is consistent with [45], who found that university students demonstrated average to high levels of problem-solving skills.

Similarly, the moderate level of mathematics anxiety suggests that students experience noticeable, yet manageable, anxiety in mathematics-related situations. Comparable moderate levels of mathematics anxiety have been reported among university students in different contexts [27–29], as well as among non-mathematics majors enrolled in mathematics courses [32]. However, some studies have reported higher anxiety levels among specific student groups, such as mathematics majors [30], indicating that anxiety levels may vary by discipline. In addition, the moderate level of ChatGPT usage intensity found in this study is consistent with previous research reporting moderate academic use of chatbot-based AI tools among undergraduate students [3, 26].

RQ2: Is there a statistically significant correlation between intensity of use of ChatGPT, mathematics anxiety, and perceived problem-solving skills?

To assess the interrelationships among the study variables, Pearson's correlation coefficients were employed for ChatGPT usage intensity, mathematics anxiety, and perceived problem-solving skills. The results showed a statistically significant positive correlation between ChatGPT usage intensity and perceived problem-solving skills ($r = .474$, $p < .001$). In contrast, a statistically significant negative correlation was found between ChatGPT usage intensity and mathematics anxiety ($r = -.486$, $p < .001$). These findings indicate that ChatGPT usage intensity is significantly associated with both perceived problem-solving skills and mathematics anxiety among undergraduate students.

The significant correlations observed in this study indicate that students who engage more intensively with ChatGPT for learning mathematics tend to report higher levels of perceived problem-solving skills and lower levels of mathematics anxiety. These findings highlight the dual cognitive and emotional role that ChatGPT may play in supporting mathematics learning, without implying a causal relationship.

From a theoretical perspective, these relationships can be interpreted through the UGT, which posits that individuals actively select digital media to satisfy specific needs. The positive association between ChatGPT usage intensity and perceived problem-solving skills reflects the fulfillment of cognitive needs, such as understanding mathematical concepts, evaluating solutions, and supporting problem-solving processes. Prior research supports this interpretation, as studies have shown that students who use ChatGPT demonstrate improved solution quality, originality, and self-efficacy in problem-solving tasks [46], as well as enhanced critical thinking and metacognitive engagement that contribute to better problem-solving performance [49].

Conversely, the negative association between ChatGPT usage intensity and mathematics anxiety aligns with the fulfillment of affective needs proposed by UGT. The use of ChatGPT may help reduce emotional tension by providing immediate feedback and a non-judgmental learning environment, thereby supporting students in managing anxiety during mathematics-related tasks. This finding is consistent with previous research indicating that AI-based and technology-enhanced learning environments can reduce academic stress and support students' emotional well-being [26, 3]. Overall, these findings suggest that ChatGPT functions as both a cognitive support tool and an affective resource in mathematics learning, helping to explain its significant associations with perceived problem-solving skills and mathematics anxiety among undergraduate students.

RQ3: Does ChatGPT usage intensity significantly predict problem-solving skills among undergraduate students?

A simple linear regression analysis was used to assess the predictive effect of ChatGPT usage intensity on perceived problem-solving skills among undergraduate students. As presented in Table 6, ChatGPT usage intensity explained 22.4% of the variance in perceived problem-solving skills ($R^2 = .224$, Adjusted $R^2 = .222$), indicating a moderate level of explanatory power.

Table 6. Model summary

Model	R	R^2	Adjusted R^2	Std. Error Estimate
1	.474[a]	0.224	0.222	0.54444

Note: [a]Predictors: (constant) and ChatGPT usage intensity.

The analysis of variance results shown in Table 7 indicated that the regression model was statistically significant, $F(1, 355) = 102.725$, $p < .001$, confirming that the model was appropriate for predicting problem-solving skills.

Table 7. ANOVA results

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	30.449	1	30.449	102.725	.000
Residual	105.228	355	0.296		
Total	135.677	356			

Further inspection of the regression coefficients in Table 8 revealed that ChatGPT usage intensity was a significant positive predictor of perceived problem-solving skills ($B = 0.294$, $\beta = 0.474$, $t = 10.135$, $p < .001$). Accordingly, higher levels of ChatGPT

use for learning mathematics were associated with higher levels of perceived problem-solving skills.

Table 8. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Beta	Beta (β)		
(Constant)	2.838	0.096		29.685	0.000
ChatGPT	0.294	0.029	0.474	10.135	0.000

The regression equation can be expressed as follows:

$$\text{Problem-Solving Skills} = 2.838 + 0.294 \times (\text{ChatGPT Usage Intensity})$$

These findings indicate that ChatGPT usage intensity significantly predicts perceived problem-solving skills among undergraduate students. Unlike the correlational results, this finding suggests that increased engagement with ChatGPT may contribute to changes in students perceived problem-solving abilities rather than merely co-occurring with them. From a theoretical perspective, this predictive relationship can be interpreted through the UGT, which posits that learners actively select digital media to fulfill cognitive needs such as learning, understanding, and evaluating information. In this context, sustained use of ChatGPT may provide ongoing cognitive support—through explanations, guided reasoning, and opportunities for reflection—that strengthens students' confidence in their problem-solving processes over time.

Although direct predictive studies examining ChatGPT use and problem-solving skills remain limited, this result is consistent with prior empirical evidence showing that ChatGPT use is associated with improvements in solution quality, self-efficacy, and metacognitive engagement [46], [49–50]. These studies, while largely correlational or experimental, provide indirect support for the predictive role observed in the current study. Overall, the present finding contributes to the emerging literature by extending existing evidence and suggesting that ChatGPT usage intensity may serve as a meaningful predictor of perceived problem-solving skills in mathematics learning contexts.

RQ4: Does ChatGPT usage intensity significantly predict mathematics anxiety among undergraduate students?

Simple linear regression analysis was used to assess the predictive effect of ChatGPT usage intensity on mathematics anxiety among undergraduates. As shown in Table 9, ChatGPT usage intensity accounted for 23.6% of the variance in mathematics anxiety ($R^2 = .236$, Adjusted $R^2 = .234$), indicating a moderate explanatory power of the regression model.

Table 9. Model summary

Model	R	R^2	Adjusted R^2	Std. Error Estimate
1	.486[a]	0.236	0.234	0.91602

Note: [a]Predictors: (constant) and ChatGPT usage intensity.

The analysis of variance results presented in Table10 showed that the regression model was statistically significant, $F(1, 355) = 109.954$, $p < .001$, confirming the suitability of the model for prediction.

Table 10. AVOVA Results

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	92.261	1	92.261	109.954	.000
Residual	297.876	355	0.839		
Total	390.137	356			

Further examination of the regression coefficients in Table 11 revealed that ChatGPT usage intensity was a significant negative predictor of mathematics anxiety ($B = -0.512$, $\beta = -0.486$, $t = -10.486$, $p < .001$). Accordingly, higher levels of ChatGPT use for learning mathematics were associated with lower levels of mathematics anxiety.

Table 11. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Beta	Beta (β)		
(Constant)	4.787	0.161		29.758	0.000
ChatGPT	–0.512	0.049	–0.486	–10.486	0.000

The regression equation can be expressed as follows:

$$\text{Mathematics Anxiety} = 4.787 - 0.512 \times (\text{ChatGPT Usage Intensity})$$

The results indicate that ChatGPT usage intensity significantly predicts mathematics anxiety among undergraduate students, suggesting that sustained engagement with the tool may influence students' emotional responses toward mathematics. From the perspective of the UGT, this predictive effect reflects the fulfillment of affective needs, such as reducing stress and emotional tension during learning. This finding is supported by previous studies showing that AI-based and technology-enhanced learning environments contribute to lowering students' anxiety and academic stress. For example, [35] reported that technology-supported instruction improves attitudes toward mathematics and reduces anxiety, while [26] found that higher levels of ChatGPT use were associated with reduced academic stress among university students. Similarly, [36] and [39] demonstrated that integrating conversational agents into mathematics instruction led to lower anxiety levels and increased academic confidence. Overall, the findings suggest that ChatGPT may function as an affective support tool that predicts lower levels of mathematics anxiety when used consistently in mathematics learning contexts.

6 CONCLUSION

This study examined the impact of ChatGPT usage intensity on mathematics anxiety and perceived problem-solving skills among undergraduate students. The findings showed that higher levels of ChatGPT use were associated with enhanced perceived problem-solving skills and lower levels of mathematics anxiety. Regression analyses further indicated that ChatGPT usage intensity significantly predicted both outcomes, highlighting its potential role as a supportive tool in mathematics learning. From a theoretical perspective, these findings align with the UGT, suggesting that ChatGPT may satisfy both cognitive and affective needs by supporting

understanding and reducing emotional tension during learning. Based on these findings, it is recommended that educators consider integrating ChatGPT as a supplementary learning tool in mathematics courses to support students' problem-solving skills and reduce anxiety.

Although the study offers valuable insights, certain limitations should be acknowledged. The CSD precludes causal conclusions, and reliance on self-report data may increase the risk of response bias. Moreover, the use of a single-university sample may restrict the broader applicability of the findings. Future research is encouraged to utilize longitudinal or experimental methodologies and to investigate additional constructs, including self-efficacy, to further clarify the observed relationships.

7 AI TOOLS

An AI-based tool (ChatGPT) was used solely for language editing and proofreading. The authors are fully responsible for the content and results of this study.

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