

## RESEARCH ARTICLE

# Coping with math anxiety and lack of confidence through AI-assisted Learning

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## ABSTRACT

Artificial intelligence (AI) in education transforms the instructional processes and learning competence of students. AI can adapt to the individual learning needs of students. By analyzing students' progress, performance, and preferences, AI systems can deliver tailored content, recommend additional resources, and provide feedback. The purpose of this study was to develop initial understanding on how AI models help students cope with math anxiety and lack of confidence in engaging with mathematics learning. This exploratory research established the connections between what students feel when using AI and how it benefits them. College students ( $n = 20$ ) enrolled in different math-related programs (i.e., engineering, statistics/mathematics, computer science, education) were purposively sampled for a one-on-one interview. Thematic analysis indicated that students are now turning to AI models as a coping mechanism to alleviate math anxiety and boost their self-assurance. These AI models function as "mentors" and "math companions" that offer step-by-step explanations and personalized support. Their adaptability and personalized approach make mathematics more accessible to students, with the potential to reduce anxiety and enhance the overall learning experience. Moreover, the use of AI models encourages a sense of independence, motivating students to actively engage in self-guided learning. The findings open new questions about using AI models in improving the self-efficacy and confidence of students in mathematics learning. There is also an opportunity to build an AI-assisted learning with a focus on psychological interventions and behavioral interconnections mediating students' academic performance.

**Keywords:** artificial intelligence; coping mechanism; learning difficulties; lack of confidence; math anxiety

## 1. Introduction

Artificial intelligence applications in education have gained significant prominence and received extensive focus in recent years. AI represents a noteworthy advancement in creative and innovative thinking across a range of disciplines, including mathematics education.

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Studies revealed some of the important uses of AI models. The current study indicates various research of AI in different context<sup>[1-7]</sup>. AI has the potential to greatly enhance people's capacities in traversing a world brimmed with ever-advancing technology. Gao<sup>[8]</sup> asserts that the growth and advancement of computer technology have led to the continuous expansion and innovation of AI. This study aimed to assess how students cope with mathematics anxiety and lack of confidence. Specifically, this assessed the psychological factors driven by AI models and how these factors lessen the students' anxiety and lack of confidence.

The AI-based mathematics education focuses on adapting to and prioritizing the development of students' personality within the current educational framework<sup>[9]</sup>. In mathematics education, the incorporation of suitable software to create visualizations and mathematical representations amplifies students' creativity and problem-solving skills<sup>[10,11]</sup>. Integrating AI technologies into educational environments allows computer-based learning systems to fulfill various roles, such as serving as educated tutors, resources, or even tutees, and they can assist in facilitating policy-making processes<sup>[1]</sup>.

AI empowers students to cultivate and augment their mathematical and cognitive abilities during the learning process. Recent studies have demonstrated that AI has a beneficial influence on student achievement, innovative problem-solving abilities, analytical thinking, and learning mindset in many educational environments, ranging from early childhood education to tertiary education<sup>[1,12-15]</sup>. The purpose of technology in higher education is to amplify human cognition and enhance the educational process<sup>[16-18]</sup>. AI facilitates expedited and effortless retrieval of answers for students. Students can effortlessly retrieve all lesson-related material with this cutting-edge intelligent software. In the present day, students demonstrate a greater preference towards independent learning and the desire of new knowledge. The utilization of AI as a potent tool can enable students to engage in further exploration without having to rely on the presence of an instructor.

Both the utilization of AI assistants and AI instructors in the classroom are supplementary options accessible in higher education contexts. The impact of IA on education involves various aspects such as classroom settings, understanding of concepts, utilization of proficient deep learning algorithms, and integration of AI technologies into educational ideologies<sup>[2]</sup>.

Several studies also reported the prominence of math anxiety among students. Research has shown that there is a negative correlation between math anxiety and math achievement because math anxiety can cause students to avoid math altogether and also impede their working memory, which is crucial for solving complex math problems<sup>[5,19]</sup>. Students with elevated levels of mathematics anxiety often exhibit negative thought patterns concerning their self-efficacy. These students may exhibit diminished self-assurance while dealing with numbers and mathematical concepts while engaged in the process of problem-solving<sup>[20]</sup>.

Limited studies were conducted in the context of how AI models could lessen the anxiety of students in mathematics and how it influences their confidence in solving math problems. This preliminary study explores about the concepts behind these relations and develop connections between them. Further study will be made quantitatively using these concepts. Exploring the narratives from interviews could give initial insights on how AI models help students cope with their difficulties in mathematics.

## **2. Literature review**

### **2.1. Math anxiety and lack of confidence**

Stressful situations and negative emotions, such as anxiety, can have a detrimental impact on one's mathematical performance<sup>[21,22]</sup>. The attentional control theory (ACT), proposed by Eysenck et al.<sup>[23]</sup>, explains how anxiety can interfere with our ability to focus and concentrate on a task, leading to increased distractibility.

Cognitive factors influence mathematical performance, but emotional factors may also play a significant

role in students' performance<sup>[24,25]</sup>. In this context, this study analyzed the impacts of math anxiety to students' performance in mathematics. Ashcraft<sup>[26]</sup> noted that individuals who experience math anxiety tend to resist matters that require them to accomplish mathematical tasks. This avoidance behavior can lead to a lack of competency, the exposure, and practice, eventually resulting in increased anxiety and a decreased level of mathematical preparedness among students<sup>[25]</sup>.

During the COVID-19 pandemic, students manifested high levels of math anxiety because of the decreased motivation in learning<sup>[22,27]</sup>. In their study, Mubeen and Reid<sup>[28]</sup> explored the connection between motivation and various factors like self-concept, self-efficacy, confidence, and self-esteem in a learning environment. It indicated a correlation between motivation and a strong sense of self-efficacy and self-esteem, which have been found to be effective in reducing academic anxiety. Consequently, a decrease in motivation is linked to a decrease in confidence and a rise in academic pressure.

Research has indicated that there is a negative link between math performance and math anxiety, with students experiencing the anxiety showing a lower excellence of math learning<sup>[25,26,29]</sup>. Experiencing anxiety in math-related situations is a common occurrence that can persist from second grade through the end of secondary school<sup>[25]</sup>.

According to the ACT proposed by Eysenck and Calvo<sup>[30]</sup>, it is suggested that anxiety has the potential to reduce attentional control and enhance focus on stimuli related to threats. In a study conducted by Hopko et al.<sup>[31]</sup>, it was found that individuals with math anxiety have difficulty inhibiting task-irrelevant distractors, leading to a depletion of working memory resources. Several studies have confirmed these findings, highlighting the negative impact of math anxiety on the limitation control system and its particular effects on math abilities<sup>[32,33]</sup>.

## **2.2. Perceptions of students in AI models**

Understanding the formation of attitudes towards behavior is crucial. The Theory of Planned Behavior (TPB) defines attitude as an individual's expectation and experience when engaging in a specific behavior<sup>[34-36]</sup>. The theory suggests that viewpoints about the behavior are formed and adapted based on assessment of beliefs and values<sup>[37]</sup>. The usage of a specific technology is often influenced by the users' personal engagement, which is affected by the relevance, significance, and effect that the technology can give<sup>[36-38]</sup>. Thus, when examining technology adoption, researchers often view attitude and behavior as a key factor in influencing users' favorable perception of a particular technology.

In the study of Buabbas et al.<sup>[39]</sup> among medical students, 41% are not confident in using AI after graduating while 40% do not believe they will have deeper understanding of the methods employed to evaluate the effectiveness of healthcare AI after graduating. Furthermore, 41.1% expressed doubts about their preparedness to utilize AI in everyday clinical settings upon completing medical school.

Meanwhile, the attitudes of individuals towards AI are crucial in determining its acceptance<sup>[40]</sup>. An individual's positive mindset towards information technology (IT) can alleviate any anxiety they may have about IT, encouraging them to engage with IT more frequently, and enhance their confidence in using IT to solve problems<sup>[40,41]</sup>. By principle, when a student believes AI could help him/her academically, engagement in its use might follow.

In addition, participants' attitudes towards IT had a significant impact on their emotions, behaviors, and beliefs about IT. This highlights the importance of fostering a positive attitude towards IT among learners. Research has indicated that increased familiarity with IT, including AI, can result in reduced fear and anxiety, facilitating a deeper understanding of AI use<sup>[40,42,43]</sup>. Following this, students who were proficient in AI

demonstrated a greater sense of optimism and passion towards AI-related work compared to their peers<sup>[44]</sup>. This means to address the ethical dilemmas and disputes linked to AI, it is crucial to prioritize the knowledge on AI use, as well as promote awareness and education about ethical decision-making principles.

### **2.3. AI-assisted learning and student's achievement**

AI in education provides enormous opportunities for personalizing educational experiences and making education available to people all around the world. It includes AI-powered educational systems, intelligent agents, self-scoring and evaluation, and learner support<sup>[45]</sup>. Chatbots encourage collaborative learning by facilitating learner-to-learner and educator interactions<sup>[45,46]</sup>. A need for self-directed, specifically designed, and flexible learning is growing, while interest in AI for the education system is developing because of recent technological breakthroughs<sup>[47]</sup>.

Personalized learning is challenging and expensive in traditional learning settings; however, advances in AI are assisting in the realization of this ambition<sup>[45,48]</sup>. As technology advances, improved adaptive technologies become accessible. The system gathers information on learners' prior knowledge and academic performance in order to predict and enhance their learning paths<sup>[45]</sup>. This personalized approach is highly effective in addressing the disparities in socioeconomic status and meeting the needs of students<sup>[49]</sup>.

Using AI-powered chatbots in educational activities has proven to be an effective method for increasing student engagement and optimizing learning procedures. Studies also indicated that the adoption of chatbot technology has the potential to improve student engagement and learning outcomes in higher education<sup>[50-53]</sup>. Similarly, Bozkurt<sup>[54]</sup> and, Sengupta and Chakraborty<sup>[55]</sup> argued that AI tools could enhance student engagement and satisfaction by liberating university faculty from routine tasks, enabling them to concentrate on more advanced skills and mentorship. Similarly, Alotaibi et al.<sup>[56]</sup> discovered that chatbots have the potential to enhance student performance and knowledge retention, hence aligning with the concept of personalized learning.

AI has drastically shaped education from learning to student productivity. Different studies were made about AI use and its effects on student's motivation, productivity, learning, and cognitive capacity. This study, however, delved more into how AI-assisted learning lessens student's math anxiety and lack of confidence. This study analyzed the role of AI in helping students learn the basics of mathematics. This concept relates to motivation, behavior, and perception of students about the efficacy of AI models as pseudo-teachers.

## **3. Methods**

### **3.1. Research design**

This study was a qualitative research that explored the experiences of college students in engaging in mathematics problems. This study sought to determine their anxiety and lack of confidence in mathematics and analyze how they cope with them using AI models. This study explored different characteristics of anxiety and lack of confidence and determine how AI models help them cope. This study was a preliminary study to establish the conceptual connections between anxiety, confidence, and coping mechanism. Established concepts were necessary before conducting large-scale quantitative study.

### **3.2. Participants and sampling technique**

College students ( $n = 20$ ) enrolled in math-related courses were the participants in this study. This study used purposive sampling to sample the participants. The four popular courses (i.e., engineering, statistics/mathematics, computer science, math major in education) were chosen where 5 participants were selected each course. **Table 1** presents the courses selected to be interviewed in this study.

**Table 1.** Demographic profile of the participants.

<b>Demographics</b>	<b><i>n</i></b>
BS engineering	5
BS statistics/mathematics	5
BS computer science	5
BS education (math major)	5
Total	20

### 3.3. Research instrument

This study developed interview guide questions based on the objectives established beforehand. The study seeks information about the experiences of students enrolled in math-related courses, i.e., their feeling about solving math problems, how confident they are, some of their limitations, which reflected the purpose of this study. The research instrument in **Table 2** served as the basis for interview.

**Table 2.** Interview guide questions.

<b>Objective</b>	<b>Interview questions</b>
Determine the coping strategies of college students who use of AI models in learning math.	<ol style="list-style-type: none"> <li>1. How you use AI models in learning important concepts in math?                             <ol style="list-style-type: none"> <li>a. Fundamentals of Math</li> <li>b. Computing</li> <li>c. Application</li> </ol> </li> <li>2. What aspects of math you feel difficult to learn? Are you feel anxious in learning math? Do you feel less/not confident in learning?                             <ol style="list-style-type: none"> <li>a. Fundamentals of Math</li> <li>b. Computing</li> <li>c. Application</li> </ol> </li> <li>3. How are you adapting in the difficulties you experience in learning math? How you use AI models to assist you in learning?</li> <li>4. Why do you think it is effective to use AI models in learning math?</li> <li>5. How could it help students feel less anxious and be confident?</li> </ol>

### 3.4. Data gathering procedure

The researchers seek approval from the Research Ethics Committee before conducting the interview of participants. The procedures to be implemented in this study were closely designed to uphold the academic standards, ethics, and rules governed by the participating university.

Permission to conduct the study was formally requested from the principals of the chosen university through an official letter. Upon receiving approval, the authorized letter was then provided to the program advisers in order to facilitate the one-on-one interview.

The research project included one consent letter intended for college students. The letter emphasized the aspects of confidentiality, data usage, publication, and the terms related to data collection. Participants and their parents were required to sign these letters.

The interview process was done via phone call for flexibility and accessibility to participants.

### 3.5. Data analysis

In this research, the primary source of data was the narratives collected from one-on-one interview. These transcriptions were carefully examined and categorized to identify significant themes and recurring experience patterns<sup>[57-60]</sup>. The process employed thematic analysis, which systematically analyzed the data to uncover common ideas and responses.

Caulfield<sup>[61]</sup> outlined the processes involved in thematic analysis which include becoming familiar with the data, coding, generating themes, reviewing themes, defining themes, and writing. In this study, participants' responses were categorized based on shared themes and interpreted through narratives. This approach helped simplify the complexities in their statements and expressions.

After categorizing the responses based on themes, this study interpreted the ideas and experiences of students and relate them to established theories and studies. Such process enabled the researchers to explore the connections between variables and make assumptions about them<sup>[62-64]</sup>. These assumptions will be used for future analysis to be done in large-scale studies.

## **4. Results**

This study determined that some students used AI models to assist them in learning the fundamental concepts of mathematics, computations, and its real-life application. The narratives indicated the opportunity of using AI models in assisting the students in learning different learning areas of mathematics such as solving worded problems and making explanations.

### **4.1. Challenges in learning math**

Students ( $n = 12$ ) feel challenged in understanding the basic concepts of math which affects their confidence as well. Some of the basic concepts involved solving with positive/negative signs, fractions, conversion of units. Some even find it difficult to add or subtract numbers. They feel anxious about the mathematical limitations and them being an ineffective math learner.

“Sometimes, I am challenged about the basic concepts of math like simple addition and subtraction. I feel anxious about making a mistake that also affect my confidence as a student.”

“Sometimes, basic math, like addition or subtraction, used to stress me out. I felt less confident because I worried about making simple mistakes.”

In terms of advanced computing, students ( $n = 17$ ) experienced more challenge in it than of learning simple math concepts. Learning algebra and calculus showed potential patterns of anxiety and lack of confidence associated with complexity and foreignness of the topics discussed to them. This difficulty led to persistent anxiety about the accuracy of their answers, resulting in concerns about receiving low grades.

“This one, even with the aid of AI models I still have a difficult time in understanding some of its concepts and most especially it's steps in computing. That's why sometimes, I feel anxious that my answers are not correct and might get low remarks.”

“I feel anxious when navigating in advanced math like algebra and calculus. They were like foreign language and there were times that I'm not confident at all.”

“When I'm dealing with advanced math, I am worried. It is very confusing to deal with complicated equations and unclear solutions.”

### **4.2. Feelings of using AI models**

Some participants ( $n = 16$ ) acknowledged the usability of AI models in learning the fundamental concepts of mathematics. One participant described the AI models as a “patient teacher” that can help students in learning difficult concepts of mathematics. While using AI models, it is easier for them to learn, and they thought they have someone to rely on when they feel challenged.

“I use AI models like friendly math buddies. They explain basic math concepts in an easy way, solving problems with me. It's like having a patient teacher who's always there to help.”

“For me, AI models can act like a helpful tutor, explaining math basics in a way that’s easy to understand. They can give you examples, solve problems, and answer your questions, making it easier to grasp concepts like addition, subtraction, multiplication, and division.”

“In simple math, I visualize AI models as my friend and math tutor who is there for me to explain the basic concepts. When I saw it doing simple tasks like adding, subtracting, or doing fractions, I feel I have a friend who explains very well.”

Some students ( $n = 10$ ) delved more into the difficult tasks like algebra and calculus. Students described AI models as “mentors” because of their sophisticated strategies in solving complicated problems. These AI models are like “heroes” who assist them in computing and solving math questions. The students feel engaged in chatting with AI models as these provide them solutions, explanations, and detailed learning on complex mathematical computations.

“I feel AI models as math hero who is always there to help. I interact with them by asking complex math questions. They serve as math experts who show detailed and step-by-step solutions to help me understand better.”

“When math gets more complicated, like algebra or calculus, AI models become like math mentors. They break down tough problems step by step, making it less overwhelming.”

“AI models show me how math is used in real life, like in science or engineering. It helps me see the practical side of math, which makes it more relatable.”

### **4.3. Adapting and coping with difficulties**

Students ( $n = 20$ ) used AI models to assist them in learning mathematics. They resort in this AI-assisted learning strategy because it is accessible to them. They were practicing with AI models, solving math problems with them while seeking help from other online resources as well. It enabled them to understand the processes on how to do detailed math solutions. They also manifested perseverance in solving math problems while using AI models which opened new questions about how AI models influence students’ persistence.

“To deal with these challenges, I turn to AI models. They act like patient tutors, explaining things clearly and breaking down complex problems. This has boosted my confidence and understanding of math.”

“I am always practicing and be hardworking. You will be accustomed to math when you solve problems. When you make mistakes, it’s okay because it is always part of the game.”

Students ( $n = 13$ ) believed that AI models are effective tool in learning mathematics because it can do detailed explanations and simplify math concepts. They could also adapt to the needs of students and make changes on what aspects the students feel challenged to. This reflect the capacity of AI models to be flexible and be a student-centered algorithm. Such characteristic enabled the AI models to be a special form of learning resource.

“AI models are effective because they offer personalized explanations and simplify complex math. They adapt to my needs, making learning more tailored and understandable, which ultimately boosts my confidence.”

“AI models are effective in learning math because they are like instant tutors. You can ask questions whenever you like. They have special skill in explaining.”

“AI models helps us in do steps and methods on how to solve problems. And it gives ease for those who are seeking them.”

Students ( $n = 10$ ) also noted how AI models help students cope with mathematics anxiety and lack of confidence. When students use AI models it served as a teacher to them, which in turn, makes them feel at ease. The way AI models explain mathematical concepts, solve complex problems, and deal with challenging real-life applications of math help students adapt and cope to their challenges. One student believed that the explanations of AI models are clearer than that of their teacher.

“AI models can reduce anxiety and build confidence by providing clear explanations and step-by-step guidance. They create a supportive learning environment, making math less intimidating and more enjoyable to learn.”

“You’ll feel you have someone to rely on because the explanations of AI are good. You will understand more. Because of that, you will be confident because you feel you know what you are doing.”

“It can help students through boosting their self-esteem and helps them understand that ‘every problem has a solution’. So, it is ok to fail sometimes. Because that just makes you human.”

## 5. Discussion

Students often feel challenged in learning mathematics due to a combination of factors, including the abstract nature of mathematical concepts, varying learning styles, a lack of foundational skills, anxiety, and external pressures. These challenges can create barriers to understanding and succeeding in mathematics. In this study, students revealed that they feel anxious in learning mathematics because increased difficulty and complexity associated with advanced mathematical topics like algebra and calculus.

Learning difficulties involve the challenges that students face when trying to understand formulas, principles, or problem-solving algorithms, despite their best efforts to learn them. **Figure 1** presents the thematic generalization about the challenges of students in learning math, and how these challenges transcend as math anxiety and low confidence.

Challenges in Learning Math	
Difficulty in Basic Math Concepts	It is challenging for students to apply basic mathematical concepts like adding fractions, subtracting numbers.
Complicated solving techniques	Students are anxious in engaging with complex math problems involving algebra and calculus.
Findings reflected that challenges in learning the basic concepts and applying these concepts in learning math are the potential causes of why students feel anxious and have low confidence in the subject. Learning difficulty becomes the driving force of inefficient learning and unproductive cognitive response during math discussions.	

**Figure 1.** Challenges of students in learning math.

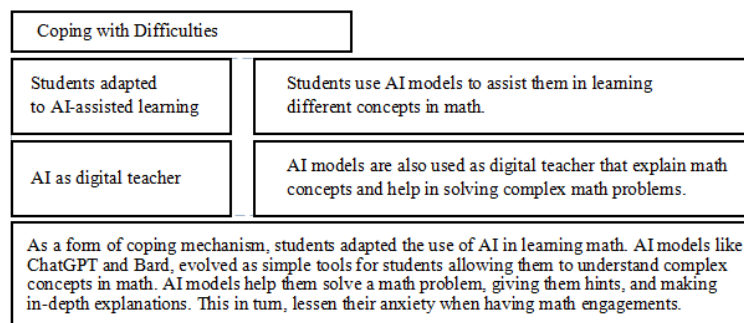
The learning difficulties experienced by students can have a significant impact on their academic achievements. Achieving good learning outcomes necessitates students’ diligent efforts in their studies<sup>[64]</sup>. For college students, they have difficulty in understanding basic concepts in math which led them to be less confident and more anxious about their learning capacity. When a student has low self-efficacy, they tend to perform bad academically<sup>[65-67]</sup>. In fact, extensive research has established a significant correlation between self-efficacy and both college success and psychological well-being<sup>[68]</sup>. A study conducted in Australia revealed that college students who possessed high levels of self-efficacy reported a more positive college adjustment<sup>[69]</sup>. Similarly, in a study among students from India and Iran, it was found that having low levels of self-efficacy can be linked to higher levels of depression, anxiety, and stress<sup>[70]</sup>.



College student in this study noted that mathematics is a “foreign language” to them and is “confusing” to deal with. These simple descriptions reflect how they perceived mathematics as a challenging subject to learn. These perceptions serve as the catalysts for math anxiety and low learning confidence. As the ACT<sup>[23]</sup> posits, anxiety has been found to have a negative impact on attentional control, which is a crucial function of the central executive. Individuals who experience anxiety tend to focus their attention more on stimuli that are related to threats, whether they are internal (worrying thoughts) or external (distracting tasks that are threatening but not relevant to the main task). When a student has bad impressions on mathematics, they focused more on how less capable they are in solving equations than trying their best and/or resist in math engagement. This might be severe when students commit mistakes in simple math like basic operations. Individuals with high levels of anxiety tend to quickly focus their attention on potential threats, unlike those with lower levels of anxiety while they may struggle to shift their attention away from these threatening stimuli<sup>[71,72]</sup>.

For some students who feel challenged in learning mathematics, they cope with it by using AI models. AI-assisted learning become common among students because of the accessibility of AI models like ChatGPT and Bard. Chat models served as their “mentors” and “math buddies” who give them step-by-step procedures on how to solve math problems, explain complex math concepts, and make mathematical representations if needed. In essence, students use AI models because of its potential to ease their difficulties and serve as their coping mechanism for math anxiety and low confidence.

Meanwhile, recent studies have linked AI literacy to a range of other skills, such as effective communication and collaborative abilities in the context of AI<sup>[73–76]</sup>. According to Long and Magerko<sup>[73]</sup>, AI literacy involves the digital skills required to adapt to the changing ways in which AI affects communication, work, and interactions with both humans and machines. College students manifested remarkable inclination in AI use especially in assisting them in learning mathematics. For them, AI models are “patient tutors” as they make complex math topics more understandable and simpler. Furthermore, the adoption of coping skills enhances students’ ability to attend, engage, and persist in the presence of challenges or difficulties, while also fostering a more demanding and resilient self that is capable of learning in a far more efficient manner<sup>[77]</sup>.



**Figure 2.** Coping with learning difficulties.

College students believed that AI models are effective in learning mathematics because they can provide personalized explanations and adapt to individual student needs. In **Figure 2**, students used AI models as a digital teacher that help them solve complex problems in algebra and calculus. This student-centered approach makes learning more tailored and understandable, which can be particularly helpful for students with varying levels of proficiency in math. The adaptability contributes to their effectiveness as learning resources and their ability to make math more approachable. Clear explanations and step-by-step guidance create a supportive learning environment that might reduce anxiety and enhances the overall learning experience.

Not only AI models served as coping mechanisms for math anxiety and low confidence, but it also encourages students to be self-reliant and engage in independent learning. One student noted that using AI models makes him hardworking by practicing how to solve math problems. Independence represents the capacity to proactively act, overcome challenges, possess self-assurance, and function individually without reliance on others<sup>[78,79]</sup>. Independent learning allows students to practice autonomy in utilizing their own learning style, advancing at their individual speed, investigating their personal interests, and cultivating their capabilities through the use of various intelligences that align with their own abilities<sup>[80]</sup>. Similarly, the use of AI also fosters innovative and creative learning among college students making them self-reliant and independent in developing their ideas<sup>[81]</sup>. In the study of Duhaylungsod and Chavez<sup>[81]</sup>, students use AI models to recreate their ideas, e.g., creating topics for research development, stories, etc. This shift towards self-reliance is vital in fostering independent problem-solving skills, self-confidence, and initiative-taking. It suggests that AI models can empower students to take charge of their education and become more proactive in their learning journey.

The study emphasized the strong conceptual link between students' self-efficacy and their mathematics learning engagement. Because low self-efficacy is associated with poor academic performance, educators should work to increase students' confidence and self-perception of their mathematical abilities. Increasing self-efficacy can also promote psychological well-being, including anxiety and stress reduction.

The incorporation of AI models in mathematics instruction appears to be a good technique for assisting students in coping with arithmetic anxiety and boosting their confidence. AI models can be good tutors and math buddies, delivering step-by-step explanations and individualized assistance. Educators should look into using AI models to supplement traditional teaching techniques, resulting in a more inclusive and customized learning environment that caters to students' specific requirements and competence levels. Nevertheless, several studies noted that teachers should adapt the use of student-centered learning strategies, like humanized teaching<sup>[82]</sup> and strategic assessment<sup>[83]</sup>, to engage students in learning and maximize their cognitive potentials.

## **6. Limitations**

While the findings of this study provide valuable insight, numerous limitations should be recognized. First, because it focuses on specific issues linked to math fear and confidence, the study may not represent the whole range of student experiences in mathematics. Broader challenges, such as cultural and socioeconomic variables, may have an impact on students' mathematics experiences and should be investigated more. The study also depends on self-reported data (e.g., I feel..., I think...), which is susceptible to biases such as social desirability bias and students' personal interpretations of their experiences. The combination of self-report data with objective assessments could provide a more comprehensive knowledge of the topics addressed in this study. Lastly, the study did not investigate educators' roles in facilitating the usage of AI models in the classroom. Understanding instructors' perspectives and preparedness to adopt AI technologies could provide a more comprehensive picture of AI-assisted learning in mathematics education.

## **7. Conclusion**

This exploratory study provided conceptual analysis about the difficulties that college students encounter when studying mathematics. Understanding and succeeding in mathematics can be quite challenging due to various factors. These include the abstract nature of mathematical concepts, different learning styles, a lack of core skills, anxiety, and external demands. Particularly, anxiety is a significant factor affecting students' mathematical performance and overall confidence. Students' low self-efficacy and negative perceptions of mathematics can lead to anxiety, further hindering their ability to engage with the subject and perform well

academically.

Remarkably, some students are turning to AI models as a coping mechanism for math anxiety and low confidence. AI-assisted learning, facilitated by models like ChatGPT and Bard, is becoming increasingly popular among students. These AI models serve as “mentors” and “math buddies,” providing step-by-step explanations and personalized assistance. These AI models have the ability to adapt and personalize the learning experiences, making math more accessible for students. This can have a positive impact by reducing anxiety and improving the overall learning experience. In addition, the utilization of AI models promotes a sense of independence and encourages students to actively participate in self-guided learning.

However, the study did not delve into educators’ perspectives and readiness to adopt AI technologies, which could offer valuable insights into the use of AI-assisted learning in mathematics education. In light of these findings, educators should consider the potential of AI models to supplement traditional teaching techniques, creating a more inclusive and customized learning environment that addresses students’ specific needs and competence levels, ultimately enhancing their mathematical self-efficacy and reducing anxiety.

## **Author contributions**

Conceptualization, HVI, MME, MSA, MDD and JVC; methodology, HVI, MME, MSA, MDD & JVC; software, HVI, MSA, MDD & JVC; validation, HVI, MSA, MDD and JVC; formal analysis, HVI, MSA, MDD and JVC; investigation, HVI, MSA, MDD and JVC; resources, HVI, MSA, MDD and JVC; data curation, HVI, MME, MSA, MDD and JVC; writing—original draft preparation, HVI, MME, MSA, MDD and JVC; writing—review and editing, HVI, MME, MSA, MDD and JVC; visualization, HVI, MME, MSA, MDD and JVC; supervision, HVI, MSA, MDD and JVC; project administration, HVI, MSA, MDD and JVC; funding acquisition, HVI, MSA, MDD and JVC. All authors have read and agreed to the published version of the manuscript.

## **Conflict of interest**

The authors declare no conflict of interest.

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