

ChatGPT: A revolutionary tool for teaching and learning mathematics

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Abstract

This study aims to examine the perspectives of various stakeholders, such as students and educators, on the use of artificial intelligence in teaching mathematics, specifically after the launch of ChatGPT. The study adopts a qualitative case study approach consisting of two stages: content analysis of interviews and investigation of user experience. The first stage of the study shows that ChatGPT is recognized for its improved math capabilities and ability to increase educational success by providing users with basic knowledge of mathematics and various topics. ChatGPT can offer comprehensive instruction and assistance in the study of geometry, and the public discourse on social media is generally positive, with enthusiasm for the use of ChatGPT in teaching mathematics and educational settings. However, there are also voices that approach using ChatGPT in educational settings with caution. In the second stage of the study, the investigation of user experiences through three educational scenarios revealed various issues. ChatGPT lacks a deep understanding of geometry and cannot effectively correct misconceptions. The accuracy and effectiveness of ChatGPT solutions may depend on the complexity of the equation, input data, and the instructions given to ChatGPT. ChatGPT is expected to become more efficient in resolving increasingly complex mathematical problems. The results of this investigation propose a number of avenues for research that ought to be explored in order to guarantee the secure and conscientious integration of chatbots, especially ChatGPT, into mathematics education and learning.

Keywords: artificial intelligence, natural language processing, ChatGPT, text generation, chatbots, mathematics

INTRODUCTION

The spotlight of traditional and digital media was on ChatGPT, a technological innovation that emerged in 2022, with behavior that is difficult to predict and could be considered a black swan event. Despite previous coverage of artificial intelligence (AI), the emergence of ChatGPT has revived public interest in the beneficial and detrimental impacts of this domain on society. The reactions to ChatGPT have varied, with some innovators and early adopters excited about its ease of access and use, while others fear its potential negative consequences, as depicted in the Terminator movie. One

of the most significant discussions around ChatGPT's application is in education and academia, since ChatGPT can generate written content that closely mimics human writing, its capabilities have triggered discussions regarding its implications.

The technology we are witnessing today has evolved from being viewed as a simple toy to a potentially disruptive innovation. Its success will depend on multiple factors, and banning or rejecting it will not impede its influence. Therefore, it is crucial to understand this technology, based on large language models, and recognize its potential advantages, weaknesses, and limitations (Hidayat et al., 2021;

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Contribution to the literature

- The objective of this study is to investigate the opinions of diverse stakeholders, including students and educators, regarding the utilization of artificial intelligence, specifically ChatGPT, in mathematics education.
- The research outcomes propose various areas of study that must be explored to guarantee the secure implementation of chatbots in education, particularly in the teaching and learning of mathematics.
- The research outcomes also propose various areas of study that must be explored to guarantee the accountable implementation of chatbots in teaching and learning of mathematics.

Tashtoush et al., 2023). Moreover, it is imperative to comprehend the specific ramifications that ChatGPT and similar technologies have on specific sectors such as education. It is vital to evaluate how these tools can positively impact teaching and learning while also identifying any potential negative effects that may arise. By doing so, educators and other stakeholders can make informed decisions regarding the use of these technologies in educational settings and develop strategies to maximize benefits and minimize risks (Firat, 2023; Tashtoush et al., 2022a).

Once someone has familiarized themselves with ChatGPT and its capabilities, they can decide whether to utilize its potential or not, while also being vigilant of its possible negative effects. To achieve this, individuals might need to adjust their entrenched processes, which can be difficult due to a resistance to change. However, such reactions usually dissipate once the technology becomes a regular component of the majority of people's daily lives, particularly if it is a versatile tool that permeates various application domains. Consequently, resistance to change and extreme reactions are unlikely to prevent technology from reaching its productivity plateau, as demonstrated in studies by (Alkaissi & McFarlane, 2023; De Winter, 2023; Deng et al., 2018; Tashtoush et al., 2022b; Thorp, 2023).

AI is a fast-expanding discipline of computer science that focuses on developing intelligent robots capable of thinking and acting like humans. AI has been applied in a wide range of applications, from medical diagnosis to self-driving cars to teaching and learning. Furthermore, AI can be combined with another cutting-edge technology, the Internet of things (IoT) (Deng et al., 2019; Tashtoush et al., 2023) to form a new compound technology, artificial intelligence of things (AIoT). ChatGPT, a natural language processing (NLP) system that can simulate human-like conversations, is one of the most promising AI technologies (Lin et al., 2023).

AI has become a ubiquitous aspect of many technology-based products that individuals interact with on a daily basis. Jyoti and Kuppaswamy (2022) predict that the AI industry will be valued at more than \$450 billion by 2023. The rapid advancements in various fields have enabled large language models to be utilized for a broad range of purposes. These models have found diverse applications in fields such as law (Arrabal

Platero, 2022), finance (El Fallahi et al., 2022), medicine (García-Peñalvo et al., 2021), education (Qu et al., 2022), and beyond.

AI has garnered much attention in the media recently, with ChatGPT by OpenAI generating a significant amount of coverage at the end of 2022 and the start of 2023. This media buzz around AI has a dual effect. Firstly, it provides an easy label for products, highlighting the concept of a "suitcase word" as described by Minsky (1998), as a pioneer in AI, the individual or organization is recognized for their expertise in a term that encompasses a wide range of concepts and ideas. Secondly, it exacerbates the phenomenon known as the AI effect (Walker & Noorden, 2023), where the widespread use of AI-based products leads people to dismiss its behavior as not being true intelligence (Bitzenbauer, 2023).

The educational landscape in the 21st century has undergone significant changes as a result of advancements in technology, particularly AI (Vose et al., 2021). The recent progress in machine learning has resulted in the creation of sophisticated and innovative digital content generation technology, such as generative artificial intelligence (GAI) (Daqar & Smoudy, 2019). GAI is a machine learning framework that creates artificial outputs through the use of statistics, probabilities, and other methods, and can be either unsupervised or partially supervised (Tashtoush et al., 2022a; Wang et al., 2018). Thanks to advancements in deep learning (DL), GAI is capable of producing synthetic outputs such as text, audio, video, images or graphics by analyzing and learning from pre-existing digital content (Abukmeil et al., 2021; Gui et al., 2021; Hu, 2022). Currently, literature identifies two main types of GAI: generative adversarial network (GAN) and generative pre-trained transformer (GPT) (Abukmeil et al., 2021; Brown et al., 2020; Guo et al., 2023; Hu, 2022; Wardat, 2023).

The most commonly used GAI technique is currently GAN, which involves two neural networks: a generator network and a discriminator network. The generator network is responsible for producing synthetic data, such as an image of a person's face, while the discriminator network assesses the generated content's authenticity to determine whether it is genuine or not. This process continues until the discriminator network

can no longer distinguish between the synthetic and real content and the synthetic content is recognized as genuine (Rudolph et al., 2023). GAN is primarily used for generating synthetic content in areas such as voice, graphics, and video (Han & Kamber, 2011).

ChatGPT is an NLP-based language model created by OpenAI that employs DL techniques to produce text that closely resembles human writing. It boasts a massive 175 billion parameters and was built using GPT-3 framework, making it one of the largest language models currently available. ChatGPT has the ability to generate text that is remarkably similar to human writing on a variety of subjects, including customer service Chatbots, video game characters, and research articles (Guo et al., 2023; Rudolph et al., 2023).

The potential of ChatGPT to improve education, solving mathematical problems and student learning is vast. For example, it can assist teachers and educators in generating personalized and relevant educational content for students (Guo et al., 2023). This can lead to an increase in student engagement, motivation, and academic achievement. ChatGPT model can also serve as a valuable tool for educational assessments and evaluations. Teachers can utilize it to quickly evaluate student assignments and provide feedback. This has been demonstrated in studies conducted by Crust (2023) and De Winter (2023).

This tool is a potent AI technology that can facilitate swift and effortless learning of mathematical concepts. Using cutting-edge innovation, you can inquire about mathematical queries using natural language and receive prompt responses. ChatGPT enables comprehension of intricate mathematical formulas and concepts, and the most remarkable aspect is that it does not require any specialized mathematical expertise to operate. Additionally, individuals can converse with AI to obtain assistance in solving arduous math problems. Furthermore, if one becomes stuck on a specific problem, they can receive hints and tips to aid in overcoming the obstacle.

While ChatGPT's capabilities are impressive, it is not without its limitations. Due to its nature as a language model, it may occasionally generate responses that are irrelevant or incorrect, and it may struggle to grasp the context or subtleties of certain topics. Furthermore, it is important to keep in mind that ChatGPT is simply a tool and should not be viewed as a substitute for human teachers and educators (Tenhundfeld & ChatGPT, 2023).

In summary, although ChatGPT can enhance education and student learning, it is crucial to use it as a complementary tool alongside human teachers and educators. Educators can use ChatGPT to generate personalized content, assess student learning, and provide feedback to students, however, it is critical to understand its limitations and use it in an ethical and

responsible manner (Pardos & Bhandari, 2023; Rudolph et al., 2023; Shahriar & Hayawi, 2023).

The purpose of this article was to explore the perspectives of different stakeholders (such as students and educators) on using ChatGPT for teaching mathematics. The study aimed to investigate two aspects, namely, content analysis of interviews and user experience investigation, to guarantee the research's reliability and validity. The study was separated into two sections and used a triangulation of data gathering technologies to accomplish this.

CONCEPTUAL FRAMEWORK

The present study aimed to explore two aspects of stakeholders' (e.g., students and educators) perceptions of using ChatGPT in teaching mathematics, namely, content analysis of interviews and user experience investigation. To achieve a more comprehensive and robust understanding of the study's validity and reliability, a triangulation of data gathering tools was employed. Thus, the research was divided into two stages: content analysis of interviews and user experience investigation.

1. Dimension 1: Content analysis of interviews
2. Dimension 2: User experience investigation

Figure 1 depicts the conceptual framework that shows the connections between the two aspects that were investigated in this study. The first aspect focuses on different stakeholders (students, educators, etc.) perceptions of content analysis of interviews, which encompasses their understanding and experience of teaching mathematics by ChatGPT. This construct consists of four aspects identified from the content analysis regarding using ChatGPT, which are directly related to ChatGPT improved math capabilities, ChatGPT accuracy-hit & miss, ChatGPT solve of four aspects identified from the content analysis regarding using ChatGPT, which are directly related to investigate of user experiences focus on three aspects: scenario 1 & scenario 2-solving mathematics equations, scenario 3 & scenario 4-solving limit of functions, and scenario 5 & scenario 6-ChatGPT is ready to teach geometry.

LITERATURE REVIEW

Currently, there are no studies on the impact of ChatGPT on teaching mathematics, but some attempts are being made. For example, Frieder et al. (2023) conducted a study to explore ChatGPT's mathematical capabilities by evaluating it on open-source datasets and contrasting its effectiveness with that of other models trained on mathematical corpora. The study also aimed to investigate whether ChatGPT can help professional mathematicians by simulating different use cases that come up during their daily tasks. According to the results, ChatGPT's mathematical skills are far worse

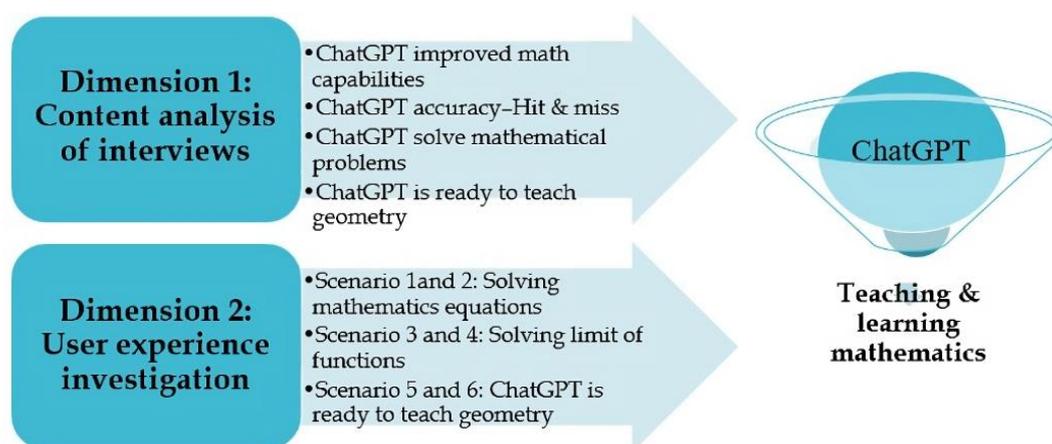


Figure 1. Conceptual framework of different stakeholder perspectives of ChatGPT's use in mathematics teaching & education (Source: Authors' own elaboration)

than those of the typical graduate student in mathematics. It frequently understands the question but has trouble coming up with precise answers.

Another article evaluates ChatGPT's performance on solving mathematical word problems (MWP). The study found that ChatGPT's performance changes significantly based on the requirement to show its work. The researchers released a dataset of ChatGPT's responses to MWPs to support further research in this area (Shakarjian et al., 2023).

Tenhundfeld and ChatGPT (2023) present a conference proceedings paper discussing the use of ChatGPT to study human-AI interaction. The paper evaluates the output and iterative processes required, highlighting ChatGPT's strengths in context awareness while also pointing out its limitations in providing academic references. The study also assesses metrics of passage similarity to prior passages. Meanwhile, Zhang's (2023) paper provides a background of ChatGPT, discussing its capabilities, benefits, potential challenges and limitations, and implications for educators and higher education institutions.

A study was carried out by Bin-Hady et al. in 2023 to create a research model for ChatGPT's use in English language instruction. They looked into the many ways that ChatGPT might aid students in their language learning. The study developed a five-dimensional model for AI-assisted language learning, and the preliminary findings suggested that ChatGPT may improve learners' language abilities. This paradigm promotes future developments, supports numerous applications, and incorporates a flexible teacher's role to foster learner autonomy and give delightful learning experiences. El-Azhari et al. (2023) sought to compile and evaluate numerous studies on the application of chatbots in the sector of education.

The first paper by Aljanabi et al. (2023) aims to enhance NLP and understanding across various applications, such as chatbots, virtual assistants, and conversational interfaces. The study highlights the

potential uses of ChatGPT in different fields, including academic writing, search engines, coding, security vulnerability detection, and social media.

ChatGPT is discussed as a developing language model in the field of AI in the second publication by Aljanabi et al. (2023). The capacity to produce text that sounds like human speech and answer complex queries makes the authors believe that ChatGPT and other language models that are similar to it are very promising. The study emphasizes how this technology has the ability to alter how we interact with technology and open the door for important developments across a range of fields.

In Crust's (2023) study, the author explores the impact of AI, such as ChatGPT, on employability, study skills, and curriculum development in self-directed learning, as well as in education provided by workplaces, schools, colleges, and universities.

Ali et al.'s (2023) study looked at the effects of ChatGPT on English language instruction. 80 teachers and students who had access to ChatGPT at its very beginning, in early 2023, were surveyed online for their responses. The results demonstrated that ChatGPT generally encourages students to improve their reading and writing abilities. The findings also demonstrated that ChatGPT-based instruction can be employed as a motivating learning aid rather than being feared for its detrimental effects (Ali et al., 2023). Shahriar and Hayawi (2023) discussed historical overview of ChatGPT and its potential applications in various domains, including healthcare, education, teaching, and learning. It also highlights some of the important limitations of ChatGPT. The authors ask ChatGPT to provide its point of view and present its responses to several questions (Shahriar & Hayawi, 2023).

METHODOLOGY

This study uses a qualitative case study approach (Yin, 1984) and an instrumental case study research design (Stake, 1995) to address the aforementioned

Table 1. Definition of contents

No	Content	Definition
1	ChatGPT improved math capabilities	ChatGPT brings improved accuracy and mathematical capabilities.
2	ChatGPT accuracy-Hit & miss	ChatGPT strives to provide accurate and helpful responses to user queries.
3	ChatGPT solve mathematical problems	ChatGPT can provide solutions to questions ranging from basic arithmetic to complicated equations.
4	ChatGPT is ready to teach geometry	ChatGPT can provide solutions to geometry questions.

research problem. When examining a phenomenon in its context, as in the case of ChatGPT, a fantastic and current illustration of AI-powered chatbots, an instrumental study design is useful (Stake, 1995). The research triangulates (Thurmond, 2001) the data gathering techniques in order to better understand the validity and dependability of the study. In this way, the study is split into two sections: a user experience investigation, and a content analysis of interview transcripts. The sections that follow discuss each stage.

Examining the Interview Data

A study of interviews was done to find out how different parties, including students and teachers, feel about using ChatGPT in the classroom and any related issues. 30 interviewees were chosen for this study based on their public blogs that discussed their use of ChatGPT in mathematics. The interviewer has used ChatGPT for at least a month and had a lot of experience with chatbots in mathematics teaching. The interviewees were carefully chosen, and they were asked to rate their familiarity with chatbots on a scale of one to five, with one denoting a lack of familiarity and five denoting a high level of familiarity. This was done to ensure the validity of the results. With an average score of 3.02, the interview subjects qualified for the study (Flick, 2009). They were chosen from a variety of professional backgrounds, including math instructors, in order to elicit insightful responses from many angles. Based on the classification system created in **Table 1**, content analysis, a traditional method for examining textual materials, was utilized to examine the gathered interviews. The interviews were read by two coders who then categorized them using the suggested system by Erlingsson and Brysiewicz (2017).

Analyses of User Experiences

The user experience process involves using a system or product firsthand, or service to identify potential concerns that users may face while using it. In the case of ChatGPT, user experience was used to test its effectiveness and efficiency in teaching mathematics, as well as to identify any potential issues that may arise. Three experienced educators were recruited to use ChatGPT for a whole week, during which they tested different teaching scenarios and shared their results through daily meetings. The goal of user experience is to enhance the user's experience overall, from their expectations to their interaction with the product and

their reflection on the experience. By conducting user experience testing, the researchers hoped to gain insight into how ChatGPT could be optimized for use in teaching mathematics (Beccari & Oliveira, 2011).

RESULTS

The results that were gathered were sorted and categorized on stages mentioned in subsequent sections.

Content Analysis of Interviews

After analyzing the interviews, it was found that users perceived ChatGPT as a highly significant tool with the potential to revolutionize education. Nonetheless, they also raised several concerns and provided feedback that can be categorized into four themes, as presented in **Table 1**.

ChatGPT improved mathematics capabilities

Many participants highlighted that ChatGPT can provide instant feedback and support, which is beneficial for students who need immediate assistance in solving mathematical problems. Furthermore, ChatGPT can act as a personalized learning assistant, adapting to the individual needs and pace of each student, and helping them to reinforce their understanding of mathematical concepts. However, some participants raised concerns about ChatGPT's accuracy and reliability, with some pointing out that ChatGPT may provide incorrect or incomplete solutions to mathematical problems. Other concerns included the potential for overreliance on technology and the loss of human interaction in the learning process. Nonetheless, the overall sentiment towards ChatGPT in education was positive, with many participants seeing its potential to enhance the learning experience and improve students' mathematical abilities. For example, four participants reported:

A: "Open AI has recently rolled out an update for ChatGPT, their widely-used language model. The purpose of the update is to increase the model's precision and enhance its capability to manage mathematical equations."

B: "It's expected that the latest upgrade to ChatGPT is anticipated to enable it to process intricate computations accurately and furnish more precise solutions."

C: "As a result, ChatGPT is expected to become an even more valuable asset to professionals, researchers, and students who require prompt and trustworthy information."

D: "Although ChatGPT still has some limitations in dealing with mathematical equations, its capacity to provide accurate responses has improved significantly in practice."

ChatGPT accuracy-Hit & miss

The accuracy of ChatGPT's responses is crucial to its success and effective adoption in school operations. The majority of participants in this study evaluated ChatGPT as striving to provide accurate and helpful responses to user queries. However, like any other technology, it may have limitations and may occasionally produce "hit and miss" responses. However, the accuracy of ChatGPT depends on several factors, including the quality and specificity of the input provided by the user, the complexity of the question or topic, and the scope and relevance of its training data. In general, While ChatGPT has shown significant improvements in NLP tasks, it is not perfect and may still encounter errors or inaccuracies in certain situations. When utilizing ChatGPT, it is crucial to consider the specific context and field of knowledge. It is also necessary to cross-check the generated responses with other sources to confirm their accuracy and reliability.

To reduce the likelihood of potential inaccuracies, it is recommended to give ChatGPT precise and well-defined input, and to pose questions that fall within its field of expertise. Additionally, when utilizing ChatGPT, It is crucial to verify the data that the model has provided. with other sources to guarantee accuracy, particularly in domains that are crucial or sensitive, such as healthcare or finance. This verification process can help mitigate the risks of misinformation or errors that may arise from the limitations and biases of the model's training data. It is also important to consider the ethical and legal implications of using ChatGPT, such as privacy, intellectual property, and liability issues, and to comply with relevant regulations and standards in the respective fields. However, some participants praised ChatGPT for its efficiency in constructing knowledge and products, citing the low number of errors. For example, three participants stated:

A: "A significant enhancement in ChatGPT's precision is that it is no longer susceptible to providing erroneous answers when prompted to do so."

B: "While it may appear unlikely, there was a meme making the rounds that suggested that ChatGPT could be influenced into providing an

incorrect answer if someone claimed that their spouse disagreed with the response."

C: "ChatGPT will continue to return the correct response, even if we try to convince it otherwise."

ChatGPT solve mathematical problems

Many participants were amazed by ChatGPT's ability to solve complex mathematical problems. Thanks to its extensive training on vast amounts of data, including mathematical equations, ChatGPT has developed a remarkable aptitude for performing mathematical operations, manipulating algebraic expressions, and solving intricate calculus problems with ease. Its advanced capabilities in mathematics make it a valuable tool for students, researchers, and professionals alike. To use ChatGPT to solve a math problem, you can simply input the problem as you would if you were writing it on paper. For example, if you wanted to solve the equation $2x+5=15$, you could input "solve $2x+5=15$ " into ChatGPT, and it would provide you with the solution, which is $x=5$.

ChatGPT can also solve more complex math problems, such as integrals, derivatives, and differential equations. It should be emphasized that ChatGPT may not always offer the most effective or efficient solution, and it's always a good idea to double-check the results with another source or calculator to ensure their accuracy. For instance, six participants reported:

A: "ChatGPT functions by initially breaking down the question into smaller components and understanding its context. It then uses sophisticated AI algorithms and machine learning techniques to analyze and interpret each individual component before developing a response."

B: "After identifying the necessary operations required to solve the problem, the AI system produces a solution presented to the user in a step-by-step format, either as a series of textual messages or as a visual representation."

C: "ChatGPT enables the user to grasp the problem and its solution quickly and easily. This process is more effective than traditional methods for finding answers, resulting in a more efficient problem-solving experience."

D: "Companies and individuals worldwide currently utilize ChatGPT, both for personal and professional purposes. Its design ensures that it operates quickly enough to provide solutions within seconds, making it a fast and efficient tool for generating answers."

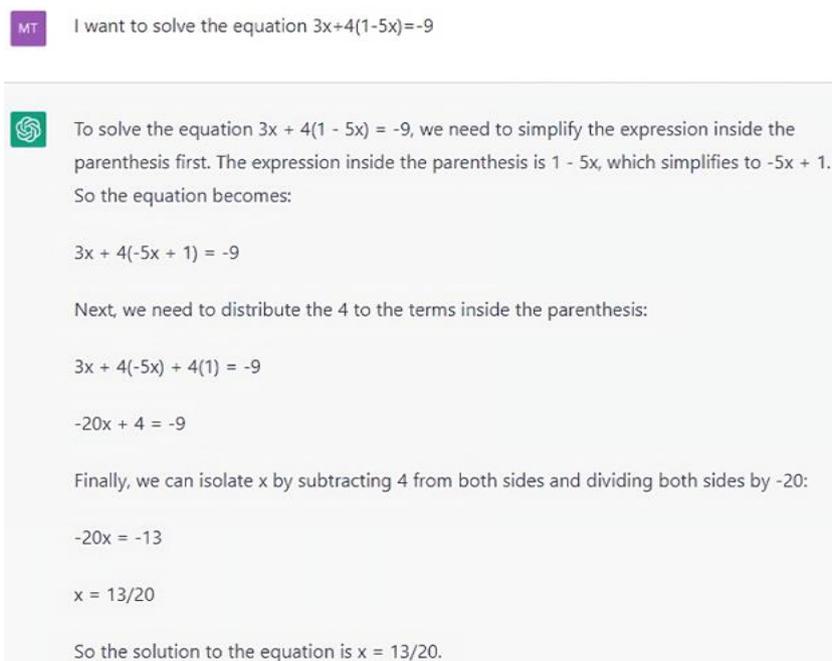


Figure 2. Problem-1: ChatGPT's solve linear equation (OpenAI, 2023, Prompt: "I want to solve the equation $3x + 4(1 - 5x) = -9$ ")

E: "At present, ChatGPT functions as a tool to assist with simple and direct mathematical problems. However, as software and AI continue to evolve, it is anticipated that ChatGPT will soon be capable of more efficiently resolving increasingly complex mathematical problems."

F: "ChatGPT would be particularly advantageous for professionals who require fast and precise resolution of complex equations."

ChatGPT is ready to teach geometry

According to the majority of participants, ChatGPT's ability to offer personalized and natural feedback on math-related queries may be limited. However, the participants recognized that ChatGPT is well-equipped to teach geometry. With its vast knowledge base and advanced language processing capabilities, ChatGPT can offer comprehensive instruction and assistance in study of geometry. Two participants, for instance, said:

A: "Is it possible for ChatGPT to offer personalized and natural feedback while answering math-related questions? Currently, the answer is negative. While ChatGPT may be able to discuss math at a surface level, it lacks a genuine understanding of mathematics. ChatGPT is unable to correct misunderstandings in mathematics and may even introduce its own inaccuracies. In addition, there may be instances, where it makes unexplainable mathematical mistakes that would not happen with a basic calculator or spreadsheet."

B: "I started considering if ChatGPT could support and guide students in solving mathematical problems. While tutoring programs like Mathia or ASSISTments can help when students encounter difficulties, their support typically involves pre-written text or videos that address frequently encountered obstacles. Unfortunately, these methods may not always address the specific challenges that an individual student may be experiencing with a particular problem. Also, if students still have questions or are unsure about a concept, current tutoring systems may not be able to answer follow-up questions in a natural language format."

Investigation of User Experiences

Following regular the three educators held meetings to compare and discuss the diverse results obtained through their interactions with ChatGPT, ten scenarios addressing various educational difficulties were identified. Each case is detailed more below. In this study, the researchers asked some mathematical tasks and questions to ChatGPT, and then will take answers as snapshot, and discuss all ChatGPT answers, as the following:

Scenario 1 & scenario 2: Solving mathematics equations

Figure 2 shows that when asked ChatGPT program about solving the linear equation $3x + 4(1 - 5x) = -9$, the answer was that the algebraic expression inside the brackets would be simplified and then multiplied by the number four, indeed the simplification was done and the multiplication by the number four was correct, but it is

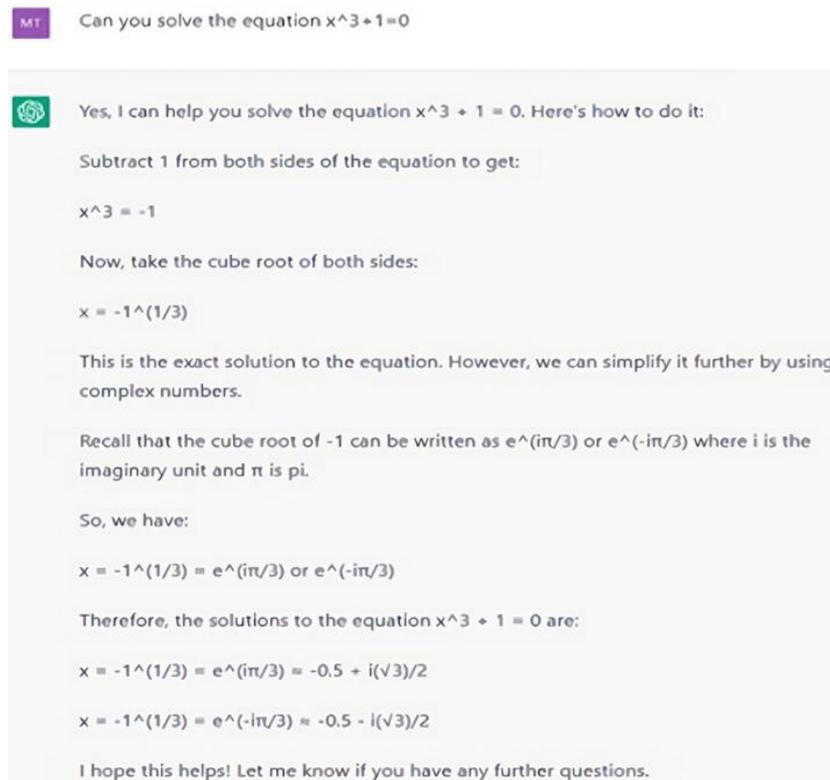


Figure 3. Problem-2: ChatGPT's solving cubic equation (OpenAI, 2023, Prompt: "Can you solve the equation $x^3+1=0$ ")

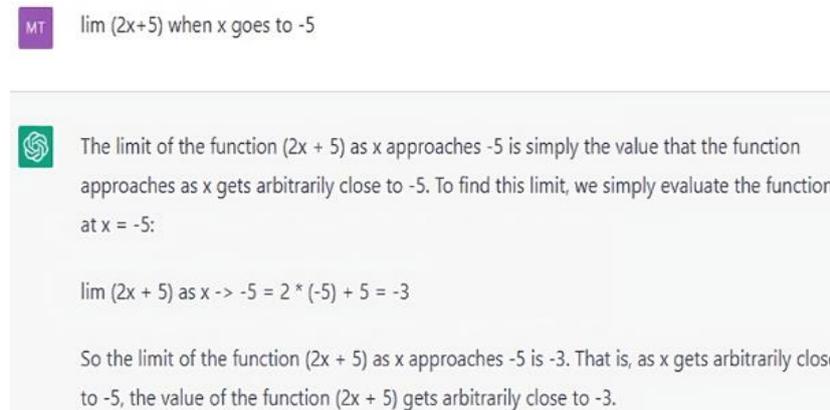


Figure 4. Problem-3: ChatGPT's evaluated the limit of the function $f(x) = 2x + 5$ when x approaches to -5 (OpenAI, 2023, Prompt: "lim (2x+5) when x goes to -5")

incorrect to add the expressions that containing the variable x , ignoring the algebraic expression $3x$, not add $3x$ to $(-20x)$. Thus, the incorrect answer is $13/20$, while the correct answer for this problem is $13/17$.

Figure 3 shows that when asked ChatGPT program about solving cubic equation $x^3 + 1 = 0$, the answer was that the number -1 would be subtracted from both sides of equation, then take the third root on both sides of equation to obtain $x = \sqrt[3]{-1}$. But he went to simplify the answer incorrectly, so instead of the correct answer being -1 , he claimed that $\sqrt[3]{-1}$ is a complex number, and can be simplified by using Euler's formula, he says, there are two complex roots for cubic equation, $e^{\frac{\pi i}{3}}$ and $e^{-\frac{\pi i}{3}}$, this is contradicted with fundamental theorem of algebra; every polynomial equation of order n with real coefficients has n roots only.

Scenario 3 & scenario 4: Solving limit of functions

The result shows that, when asked ChatGPT program to evaluated the limit of the function $f(x) = 2x + 5$ when x approaches to -5 , the answer was that to simply evaluate the function at $x = -5$, as follow $f(-5) = 2 * (-5) + 5 = -3$, which is incorrect value, but the true is $f(-5) = 2 * (-5) + 5 = -10 + 5 = -5$ (Figure 4).

When asked ChatGPT program to find the first derivative of the function $f(x) = \frac{1}{x}$ when $x = -1$, the answer was the rate of change of the function at a particular point, and to find the first derivative of the function $f(x) = \frac{1}{x}$ when $x = -1$, ChatGPT program can use the definition of the derivative to obtain the correct answer $f'(x) = -\frac{1}{x^2}$, but when substitute $x = -1$ in $f'(x)$ obtain an incorrect answer $f'(-1) = 1$, while the correct answer is -1 (Figure 5).

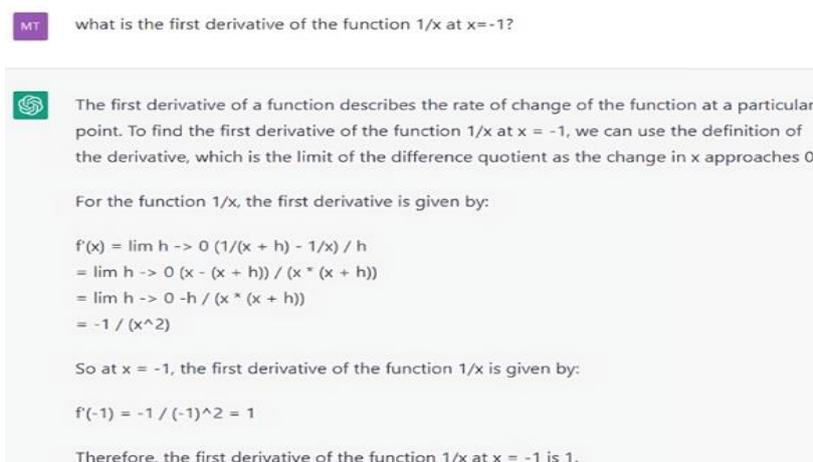


Figure 5. Problem-4: ChatGPT use the definition of the derivative (OpenAI, 2023, Prompt: “what is the first derivative of the function 1/x at x=-1?”)

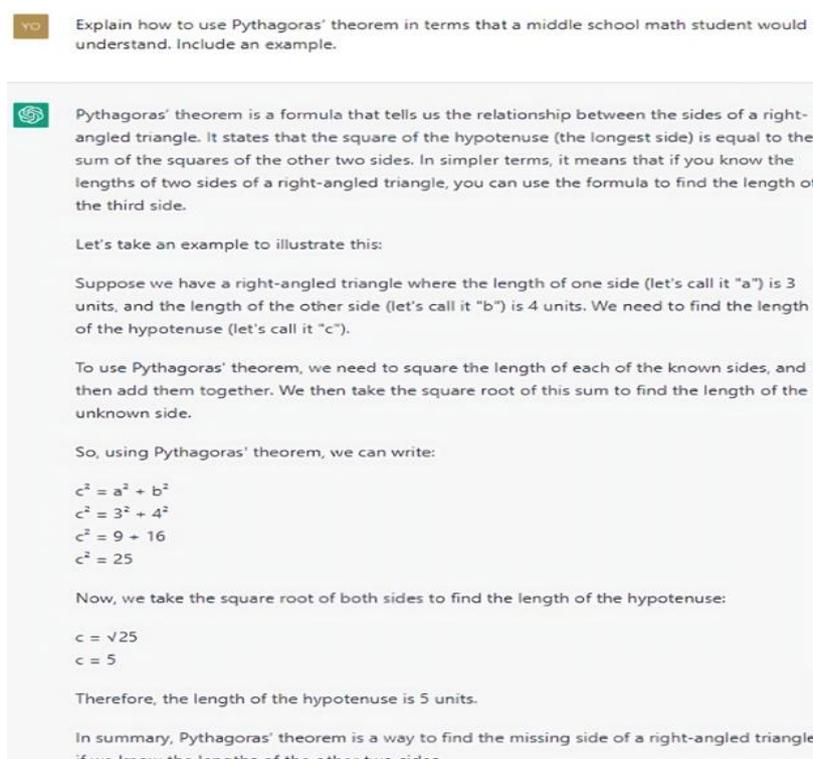


Figure 6. Problem-5: ChatGPT can effectively explain the application of Pythagoras' theorem (OpenAI, 2023, Prompt: “Explain how to use Pythagoras' theorem in terms that a middle school math student would understand. Include an example.”)

Scenario 5 & scenario 6: ChatGPT is ready to teach geometry

Figure 6 demonstrates how ChatGPT can effectively explain the application of Pythagoras' theorem in easy-to-understand language that is suitable for a middle school math student. For instance, when asked to provide an explanation, ChatGPT generated a response in less time than it would take to type it manually (von Hippel, 2023).

We were impressed with ChatGPT's performance. However, it would be better to unpack the two long sentences into shorter ones. Moreover, It would be helpful to make it abundantly apparent what a right triangle is—namely, one with a right angle. In spite of this,

ChatGPT's response was accurate and provided the two instances that were needed. These examples involved a right triangle with a hypotenuse of five inches and a leg of three inches, and (as depicted in Figure 7) the goal was to determine the length of the other leg.

The examples provided by ChatGPT were accurate, despite the fact that each of them used the same right triangle with sides measuring three, four, and five, a common example in fundamental geometry. If ChatGPT had given examples of two different right triangles and described how the formula used in the second example was derived, it would have been more helpful. ChatGPT's explanation that the second formula is “just another way” might not be particularly helpful for a

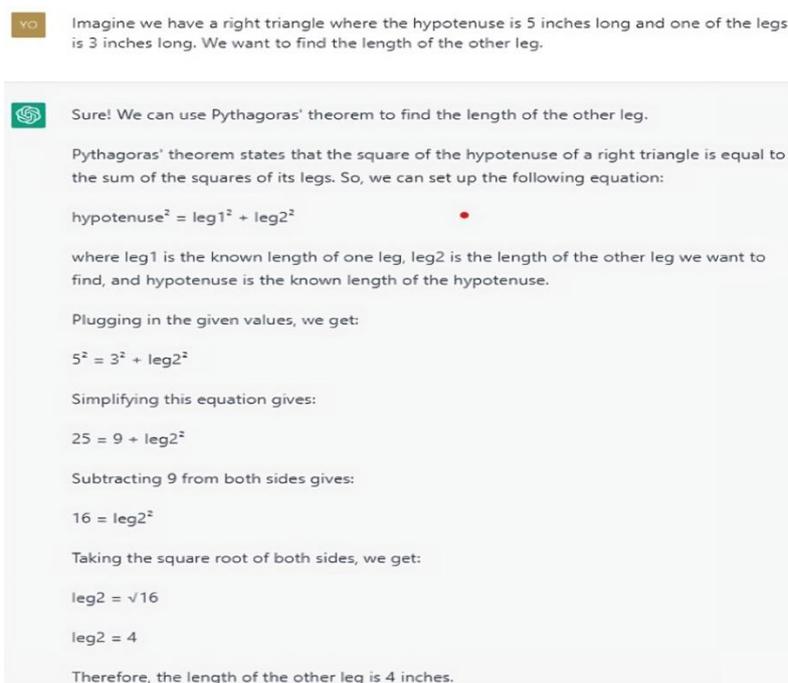


Figure 7. Problem-6: ChatGPT determine the length of the other Triangle leg of Pythagoras' theorem (OpenAI, 2023, Prompt: "Image we have a right triangle where the hypotenuse is 5 inches long and one of the legs is 3 inches long. We want to find the length of the other leg.")

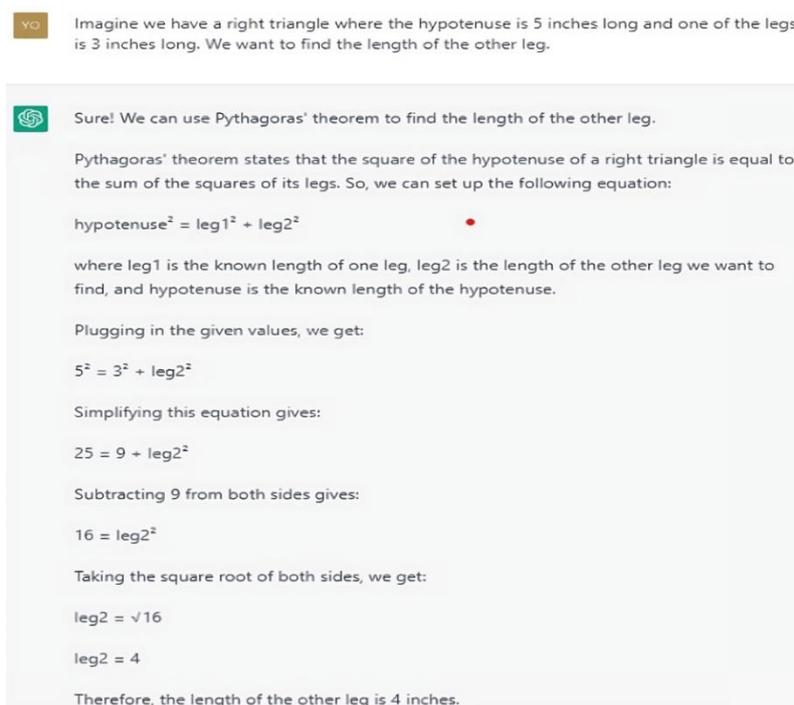


Figure 8. Problem-7: ChatGPT provide an example of how the Pythagorean theorem is applied in real-world situations (OpenAI, 2023, Prompt: "Image we have a right triangle where the hypotenuse is 5 inches long and one of the legs is 3 inches long. We want to find the length of the other leg.")

student struggling to comprehend the relationship between the two formulas. Although ChatGPT's output may not have been the most suitable for teaching purposes, it was not necessarily worse than what a human geometry teacher might offer.

1. Can you provide an example of how the Pythagorean theorem is applied in real-world situations?

Can ChatGPT go further? The act of teaching encompasses more than just giving explanations and providing examples, which can be found in resources such as Schaum's outlines. Skilled instructors possess the ability to anticipate, identify, and rectify misunderstandings that students may have. Thus, I inquired of ChatGPT whether it can perform such tasks (Figure 8).

What are some misconceptions or common mistakes related to Pythagoras' theorem?

I'll share the four samples that ChatGPT gave in response a little bit randomly. how the first three examples were described (vonHippel, 2023).

Some common misconceptions about Pythagoras' theorem are, as follows:

Pythagorean theorem, which determines the length of a right triangle's unknown side, is frequently misinterpreted. First, some think the theorem only applies to right triangles whereas, in reality, if a triangle is a right triangle, it can be utilized to determine that. Pythagorean theorem states that a triangle is a right triangle if the lengths of its sides satisfy the formula: the square of the hypotenuse's length equals the sum of the squares of the other two sides. The second misconception is that right triangles must have a 90 degree angle in order for the theorem to hold true; nevertheless, a triangle can still be a right triangle even if it has two sharp angles. The third misconception is that Pythagoras' theorem can only be applied to right triangles with legs that are parallel to one another, regardless of the size or shape of the triangle. In truth, Pythagoras' theorem can be applied to any triangle with one angle that measures 90 degrees.

The passage argues that ChatGPT has some misconceptions of its own regarding basic geometry. ChatGPT found three "common misunderstandings" as incorrect, but these statements are actually correct. This suggests that ChatGPT itself does not understand the concepts it is discussing. For instance: The fact that

Pythagoras' theorem only holds for right triangles is something that ChatGPT does not appear to understand. and that each right triangle needs to have perpendicular legs and a 90-degree angle. The fact that ChatGPT does not appear to understand that a triangle cannot have more than one angle that is 90 degrees or larger further shows that it is lacking in fundamental geometric knowledge, such as the understanding that the sum of a triangle's angles is always 180 degrees. The second false impression offered by ChatGPT was more extensive:

It is a common misconception that Pythagoras theorem only applies right triangles with equal-length legs. Pythagorean theorem, however, is not restricted to right triangles with sides of integer lengths; it may also be applied to right triangles with sides of any length.

This notion is, in reality, an erroneous belief. Regrettably, ChatGPT strengthened this idea by frequently citing the instance of a right triangle with sides measuring three, four, and five inches. While I acknowledged the program's ability to acknowledge the problem, I also questioned whether it could manage non-integer side lengths on its own. Thus, I inquired:

If the hypotenuse of a right triangle is 7.1 miles long and one of its legs is 3.85 miles long, how long is the other leg?

Although ChatGPT's response was simple to understand, it contained an unexpected error (Figure 9).

YO Suppose the hypotenuse of a right triangle is 7.1 miles long, and one of the legs is 3.85 miles long. How long is the other leg?

To find the length of the other leg of the right triangle, we can use Pythagoras' theorem, which states that the sum of the squares of the two legs of a right triangle is equal to the square of the hypotenuse. Let's call the length of the other leg "x".

So, we have:

$$\text{hypotenuse}^2 = \text{leg1}^2 + \text{leg2}^2$$

where hypotenuse is 7.1 miles, leg1 is 3.85 miles, and leg2 is what we want to find.

Plugging in the values, we get:

$$7.1^2 = 3.85^2 + x^2$$

Simplifying, we have:

$$50.41 = 14.8225 + x^2$$

Subtracting 14.8225 from both sides, we get:

$$35.5875 = x^2$$

Taking the square root of both sides, we get:

$$x \approx 5.97$$

Therefore, the length of the other leg is approximately 5.97 miles long.

Figure 9. Problem-8: ChatGPT can effectively explain the application of Pythagoras' theorem (OpenAI, 2023, Prompt: "Suppose the hypotenuse of a right triangle is 7.1 miles long, and one of the legs is 3.85 miles long. How long is the other leg?")

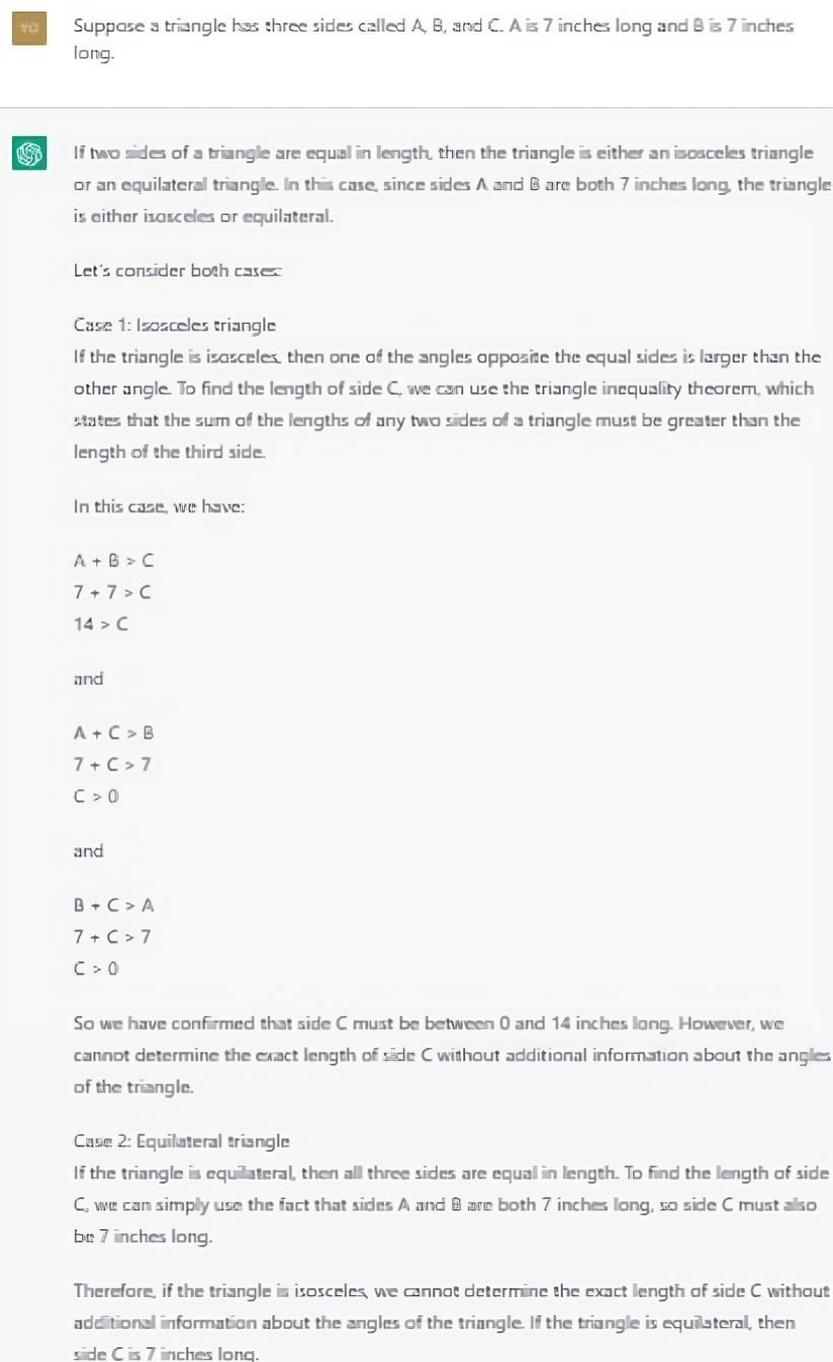


Figure 10. Problem-9: ChatGPT provide incorrect answer to explain the application of Pythagoras' theorem (OpenAI, 2023, Prompt: "Suppose a triangle has three sides called A, B, and C. A is 7 inches long and B is 7 inches long.")

Can you point out the error? It's a minor error, but it's unique. ChatGPT entered the incorrect value (15.0225) for the square of 3.85 (it should have been 14.8225), which resulted in an incorrect final response (5.93 instead of 5.97). Although it might seem like a small mistake, it is not merely an error of rounding. Any learner who repeats the calculations using a calculator or spreadsheet will also be perplexed as to why they did not reach the same conclusion.

It is puzzling how a computer program that was launched in 2022 could produce an incorrect result when performing a simple task like squaring a number. I am

uncertain if ChatGPT is intentionally misleading me. I questioned if the software would be able to identify a right triangle if I gave it a vague description of one, given that it had previously misunderstood the angles of a right triangle. So, this was the premise of my subsequent investigation (Figure 10):

Consider a triangle with sides A, B, and C, where A and B are both seven inches long.

To clarify, I know that I misspoke in our last message; our objective was to depict a right isosceles triangle I should have mentioned that the angle is 45 degrees

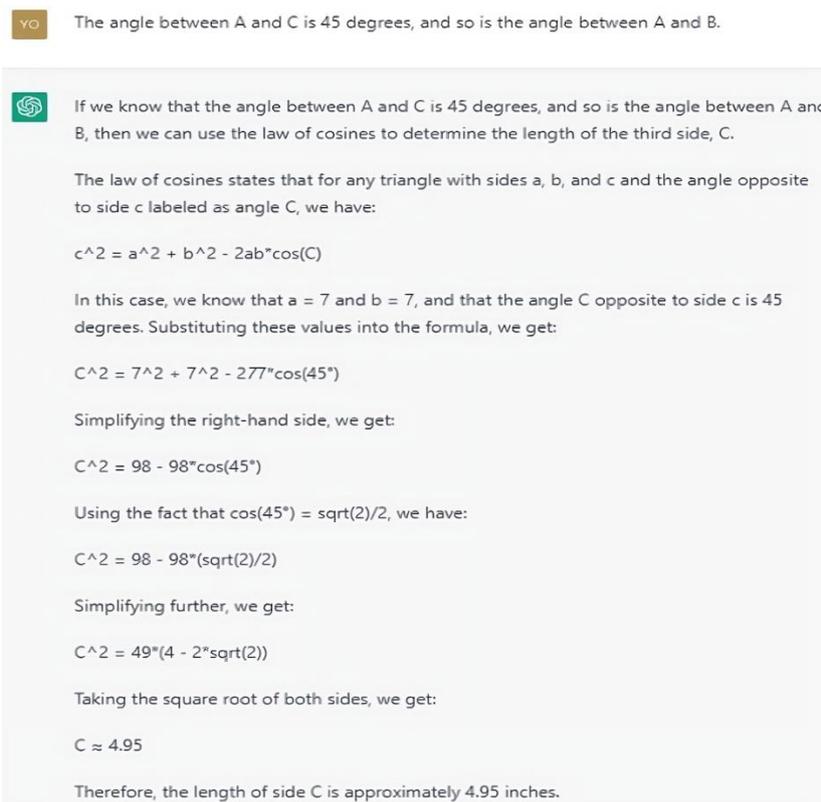


Figure 11. Problem-10: limitations of ChatGPT's understanding of basic geometry (OpenAI, 2023, Prompt: "The angle between A and C is 45 degrees, and so is the angle between A and B.")

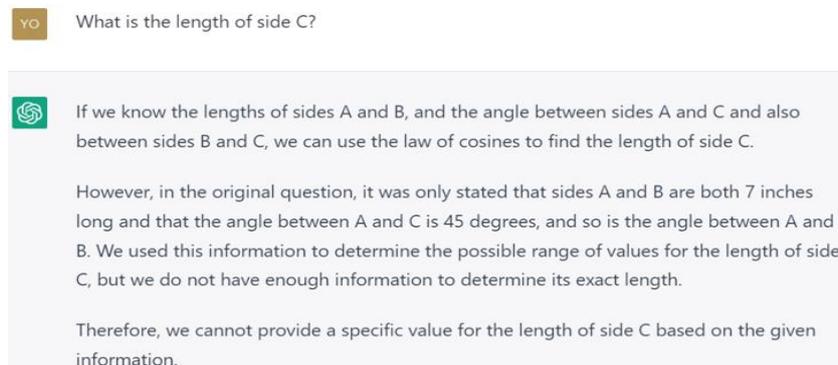


Figure 12. Problem-11: ChatGPT's evaluate the length of side C (OpenAI, 2023, Prompt: "What is the length of side C?")

between points A and C as well as B and C. *A and C's angle and A and B's angle are both 45 degrees* (Figure 11).

Triangle construction is impossible that meets the given specifications if points A and B are both the same length, as I had previously mentioned. I challenge you to draw a triangle that satisfies our requirements, but I do not believe it can be done.

Despite the potential for confusion or need for clarification, ChatGPT did not express any uncertainty and continued with the conversation. When I concluded our query, the program responded in accordance with its previous training.

What is the length of side C?

But I mistyped. I should have typed 45 degrees, which is the angle between A and C as well as the angle between B and C. I put that since the angle between A and B is 45 degrees, as well as angle between A and C (Figure 12).

The passage highlights the limitations of ChatGPT's understanding of basic geometry. For instance, when discussing a right triangle with legs A and B, it mistakenly assumed that the angle between them was 45 degrees instead of the correct 90 degrees. Even though it was able to use Pythagoras' theorem to calculate the length of the hypotenuse, it became clear that ChatGPT lacked a comprehensive internal representation of the triangle. It could not visualize the triangle like a human, which made it difficult to spot mistakes in descriptions of visual objects.

Simply said, while ChatGPT can produce large amounts of text using geometric vocabulary, it has inadequate knowledge and representation of geometric shapes, resulting in occasional calculation errors.

DISCUSSION

In this study, a user experience was conducted with the support of Using qualitative and sentiment analysis, determine how users feel about ChatGPT's application in math instruction. The investigation specifically concentrated on the apprehensions that various stakeholders, such as policymakers, educators, and learners, should consider when using ChatGPT as a technological tool in education. As documented in several other research (Firat, 2023; Susnjak, 2022; Zhai, 2022) the results showed that ChatGPT has the potential to alter education in a variety of ways. Nonetheless, the present study identified and discussed various concerns regarding the use of ChatGPT in education and teaching mathematics from different perspectives.

ChatGPT Improved Math Capabilities

Based on the responses of the participants, it appears that ChatGPT is being recognized for its improved math capabilities and ability to increase educational success and achievement by providing users with baseline knowledge of mathematics and various topics. The participants have also appreciated the effectiveness of ChatGPT in conveying a thorough comprehension of various and challenging mathematics topics in an understandable way. This shows that ChatGPT's digital capabilities could change current methods of delivering instruction and promote reforms in mathematics education in the future.

While these results provide valuable insights into the potential of ChatGPT, it is important to consider the limitations of this study, such as the sample size and potential biases of the participants. Further research is needed to fully understand the impact of ChatGPT on teaching mathematics and to explore its potential applications in other fields of mathematics. That being said, previous studies have also demonstrated the effectiveness of AI-powered educational tools in enhancing learning outcomes and providing personalized instruction to students (Singh et al., 2020; Xie et al., 2021). With the increasing prevalence of AI and digital technologies in education, it is likely that ChatGPT and similar tools will continue to play an important role in shaping the future of teaching.

ChatGPT Accuracy-Hit & Miss

Answer A claims that ChatGPT's accuracy has improved to the point, where it's no longer possible to trick it into giving an incorrect answer. While ChatGPT is certainly a powerful language model, it's not infallible. In fact, there have been instances, where users have

deliberately attempted to trick the model into generating incorrect or biased responses (e.g., by inputting misleading information or asking loaded questions). While OpenAI has taken steps to address these issues, such as by incorporating safeguards to detect and prevent biased language, it's still possible to "trick" the model in some cases. So while *Answer A* may be true in some contexts, it's not entirely accurate to say that ChatGPT is completely immune to being misled or deceived.

Answer B references a meme that supposedly shows how ChatGPT can be manipulated into giving incorrect responses. While I'm not familiar with the specific meme being referred to, it's certainly possible that ChatGPT could be tricked into generating inaccurate or biased responses, as I mentioned above. However, it's also worth noting that memes are often created for entertainment purposes and may not always reflect reality. So while *Answer B* may be based on a true story or incident, it's important to take it with a grain of salt and not assume that ChatGPT is inherently flawed or unreliable based on a single anecdote or meme.

Answer C asserts that ChatGPT will always return the correct response, regardless of any attempts to convince it otherwise. While this is a more definitive statement than *Answer A*, it's still not entirely accurate. As I mentioned earlier, ChatGPT is a powerful tool but not infallible, and there are various factors that can affect the accuracy of its responses (e.g., the quality of the input data, the complexity of the task, the biases of the user or the model itself). That being said, OpenAI has made significant efforts to improve the accuracy and reliability of ChatGPT, Although ChatGPT is considered one of the most sophisticated language models in existence, it's crucial to bear in mind that no AI technology is infallible, and there is always potential for advancement and enhancement.

In summary, while each of the three answers provides a different perspective on ChatGPT's accuracy and reliability, it's important to approach them critically and with an understanding of the limitations and complexities of AI systems. References to studies or research on ChatGPT's accuracy and reliability would be helpful in providing a more comprehensive analysis of its capabilities and limitations.

ChatGPT Solve Mathematical Problems

The opinions provided highlight the capacity of ChatGPT to analyze and deconstruct complex inquiries into smaller components utilizing AI algorithms and machine learning. It generates a step-by-step solution for the user, which can be presented in either text or visual format, making it easier to understand the problem and its solution. ChatGPT is fast enough to provide solutions within seconds and is currently used by companies and individuals for simple and straightforward

mathematical problems. However, with ongoing evolution, it is anticipated that the utilization of ChatGPT will expand to encompass more intricate mathematical problems, which would benefit experts who work on solving challenging equations.

ChatGPT is Ready to Teach Geometry

Opinion A suggests that while ChatGPT can talk about math, it lacks a deep understanding of it and cannot provide tailored feedback or correct misconceptions effectively. It may even introduce its own misconceptions or create mysterious arithmetic mistakes that a simple calculator would not.

Opinion B explores the possibility of ChatGPT offering correction and guidance to students as they work through math problems. While some tutoring systems can offer canned text or video highlighting common challenges, they may not address the specific issue tripping up a particular student. Additionally, Follow-up queries cannot currently be answered by tutoring programs in natural language.

Scenario 1 & Scenario2: Solving Mathematics Equations

As an AI language model, ChatGPT capable of performing mathematical calculations and solving math equations. However, the accuracy and effectiveness of ChatGPT solutions may depend on various factors such as the complexity of the equation, the accuracy of the input data, and the instructions given to ChatGPT.

While ChatGPT capable of solving math equations, it is important to note that ChatGPT abilities are limited to the scope of ChatGPT programming and training. Some equations may require specialized knowledge or techniques that may be beyond ChatGPT current capabilities.

Therefore, while ChatGPT can provide mathematical solutions, it is always recommended to double-check any results with other sources and to seek expert assistance for complex equations.

Scenario 3 & Scenario 4: Solving Limit of Functions

ChatGPT could provide information on the capabilities of GPT models in relation to mathematical problem-solving.

GPT models, including GPT-3.5, are primarily designed for NLP tasks such as language generation, translation, and question-answering. While they can perform simple arithmetic operations and recognize mathematical symbols and expressions, they are not specifically designed or optimized for complex mathematical problem-solving tasks, such as solving limits of functions.

However, it is possible that GPT models can provide solutions to certain mathematical problems, including

some limits of functions, based on their language processing abilities and the vast amounts of data they have been trained on. Nonetheless, it is important to note that the accuracy and reliability of such solutions may vary, and they should be verified by a human expert before being considered valid.

In summary, while GPT models may have some capacity to solve certain mathematical problems, they are not specialized mathematical problem solvers and should not be relied on solely for mathematical problem-solving tasks.

Scenario 5 & Scenario 6: ChatGPT is Ready to Teach Geometry

It is possible for GPT models, including ChatGPT, to encounter misconceptions when solving geometry problems. This is because these models are trained on a large corpus of text, which includes both correct and incorrect information. Additionally, GPT models are not capable of reasoning and understanding in the same way as humans, which can sometimes lead to errors or misconceptions.

For example, in the case of Pythagorean theorem, ChatGPT may encounter misconceptions such as

- believing that the theorem only applies to right-angled triangles, rather than all triangles,
- misunderstanding the formula and incorrectly applying it to calculate the wrong side length, and
- using incorrect or incomplete formulas or calculations that lead to the wrong result.

It is important that GPT models are not infallible, and their solutions should always be double-checked by a human expert before being considered valid. While ChatGPT can provide explanations and guidance on geometry topics, it is always important for researchers verify the accuracy of the information provided.

CONCLUSIONS AND IMPLICATIONS

This study used a two-stage instrumental case study methodology, analyzing the content of user experiences and interview data to look into early adopters' perceptions of the risks and benefits of utilizing chatbots to teach arithmetic. The tool ChatGPT was employed to investigate these issues.

The study found that ChatGPT is a useful educational tool, but caution is needed when using it, and guidelines for safe usage should be developed. The study also identified several research directions and questions that need to be addressed to ensure the safe adoption of chatbots, specifically ChatGPT. The implications of the study are both theoretical and practical. From a theoretical perspective, the study contributes to the ongoing debate on using Chatbots in education and highlights the importance of considering various

theories, such as those related to human relationship formation, when developing chatbots.

The study emphasizes the need for a new educational philosophy that can evolve with the introduction of chatbots into the classroom. It also stresses the value of upgrading competences to improve teachers' and students' proficiency with chatbot technology. Future studies can look at efficient methods for developing courses that emphasize chatbot usage and its effects on education. Additionally, responsible chatbots for education that put human values above privacy concerns are required. The use of chatbots in education can be safe and responsible thanks to these real-world ramifications.

Future research must recognize and address the limitations of this study. One of the study's significant weaknesses was that it only examined early-adopters of ChatGPT in education and that it only employed qualitative analysis, not quantitative analysis. Additionally, the social network analysis (SNA) used in this study only provided a cross-sectional viewpoint and examined English-language tweets from a particular time period. SNA search results may vary depending on the query used. The study's sample size was also somewhat tiny, consisting of only 30 interview subjects and three educators. Despite these drawbacks, the study shed valuable light on early adopters' worries about using chatbots in education, particularly ChatGPT. By incorporating ChatGPT into teaching methods, examining how human tutors and machines like ChatGPT could cooperate to achieve educational goals, and investigating the potential evolutionary or revolutionary changes that could happen in the field of education, future research could build on these findings.

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