

# AI Chatbots as Math Algorithm Problem Solvers: A Critical Evaluation of Its Capabilities and Limitations

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## Abstract

*AI-based chatbots are appearing as a powerful tool for solving mathematical algorithm problems. These chatbots, trained on extensive datasets and natural language models of text and/or code, can understand and generate mathematical expressions. They can show step-by-step solutions to math problems and explain the associated concepts. This paper evaluates AI chatbots like Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha as problem solvers for math algorithms for learners, teachers, and teacher educators from school to university. We discuss how AI recognizes mathematical expressions and equations from simple arithmetic, algebra, trigonometry, and statistics examples. We explore how AI-based chatbots solve basic to advanced math problems, their ability to offer personalized solutions, and their potential to improve students' math learning. We highlight their capabilities and limitations. Challenges faced by AI chatbots include a limited understanding of natural language models and prompt engineering, an inability to solve complex math problems, and the potential for bias. Future research should focus on improving AI chatbots' accuracy, reliability, and problem-solving capabilities. Despite the advancements in AI chatbots, students should continue interacting with human teachers to develop their cognitive math skills and conceptual understanding.*

## 1. Introduction

AI chatbots, such as ChatGPT, Google Bard, and Bing Chat, are advanced natural language models capable of producing responses that closely resemble those generated by humans [1-2] whereas Wolfram Alpha is an AI-based tool equipped with computational intelligence. On the other side, those trained on massive datasets of text and code can answer various questions, including math algorithm problems. Likewise, ChatGPT, Google Bard, and Bing Chat are also based on statistical approaches to training large language models (LLM). These chat tools have undergone extensive training using large-scale text data and possess the capability to address a wide range of inquiries, encompassing mathematical algorithmic problems. Indeed, the proficiency exhibited by AI models—natural language model and computational intelligence in solving complex equations and calculations has prompted inquiries regarding the potential uses of chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha, among others, in assisting with mathematical assignments. In this regard, Rawat and Mishra discussed the important role that mathematics plays in the development of AI [3]. They argued that mathematics is essential for AI in several ways for providing tools for data analysis and modeling [3]. AI algorithms need to be able to process large amounts of data to learn and make predictions. Mathematics offers data analysis and modeling tools like linear algebra, calculus, and statistics. Likewise, mathematics is constantly being used to develop new AI algorithms that are more powerful and efficient. Mathematics can also be used to understand the limitations of AI. For

example, it is possible to use mathematics to prove that there are some problems that AI will never be able to solve.

Moreover, chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha are known for their improved math skills and ability to help students do better in mathematics of any level. Students explore this AI tool by offering basic to advanced knowledge and information on various math topics, as well as thorough instruction and help with geometry [4]. For instance, Lee and Yeo used design-based research to develop and evaluate the chatbot [5]. In the first iteration of the chatbot, researchers worldwide qualitatively analyzed the training data to identify the most common types of questions that preservice teachers (PSTs) would ask. They then created corresponding responses for each type of question. In the second iteration, the researchers changed the chatbot's responses based on feedback from PSTs. Likewise, Wang and Lester further argued that the rapid development of AI technologies calls for designing and developing K-12 AI literacy curricula to support students entering a profoundly changed labor market [6]. Wang and Lester further defined AI literacy as the ability to understand the basic concepts and principles of AI, to evaluate AI systems critically, and to use AI tools and techniques to solve problems [6]. With the above background and gap, in this paper, we explore the potential uses of AI chatbots, including Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha, as problem solvers for mathematical algorithms across school to university level for mathematics learners. Also, we delve into how these AI chatbots recognize and solve mathematical problems ranging from basic arithmetic to complex statistics. Lastly, we highlight AI chatbots' capabilities of solving mathematical problems and critically evaluate the capabilities and limitations of using algorithms for solving such problems in mathematics.

## 2. Recognize Math Expressions and Equations

An expression in mathematics consists of numbers, variables, and operations. A mathematical statement that establishes the equality of two expressions is known as an equation.  $5 + 2$ ;  $3x - 4$ ; and/or  $(2x + 1)(3x - 4)$  are examples of expressions.  $2x + 3 = 7$ ,  $x^2 - 4x + 4 = 0$ , and  $y = mx + b$  are examples of equations. The above numbers, variables, and operations can be solved by using AI chatbots. Likewise, AI also can be used to solve mathematical equations and expressions. For instance, see below to prompt in ChatGPT of the question of arithmetic—and embed code.

**Prompt to ChatGPT:** Ms. Bhandari wants to buy 2000 Bahrain Dinar paying Nepalese currency. If buying and selling rates of 1 Bahrain Dinar is Rs. 271.73 and Rs. 273.33. How much Nepali currency is required for the transaction?

**Response in embed code:** When you're buying a foreign currency, you will generally need to use the "buying" rate, which in this case is Rs. 271.73 per 1 Bahrain Dinar.

Ms. Bhandari wants to buy 2000 Bahrain Dinar. To find out how much Nepali currency is required for the transaction, you would multiply the amount of Bahrain Dinar she wants to buy by the buying rate:

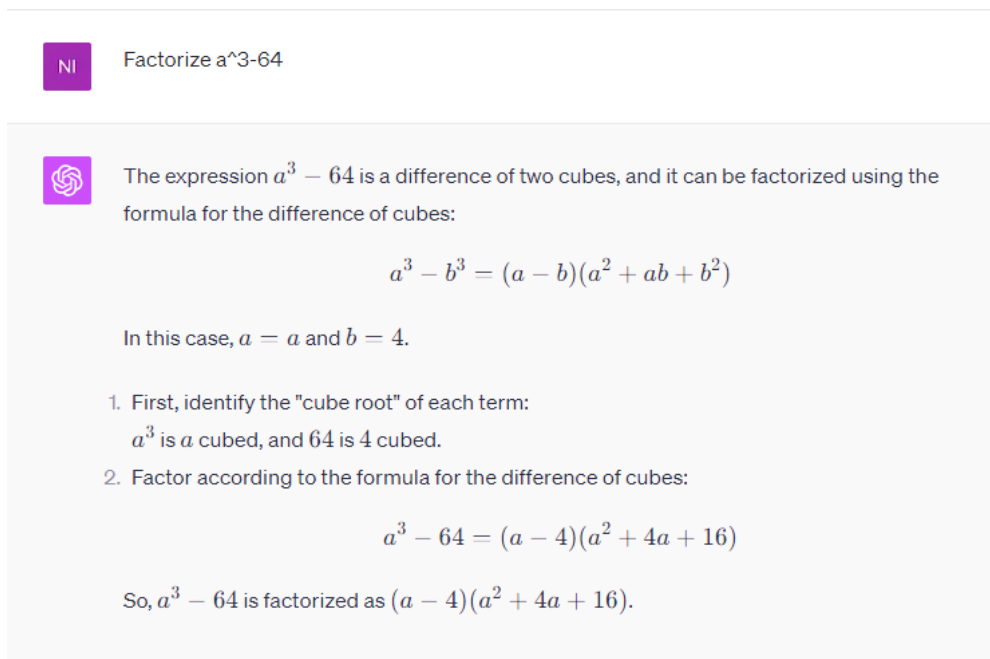
```
\[
\text{Total Cost in Nepali Rupees (Rs.)} = 2000 \, \text{Bahrain Dinar} \times 271.73 \, \text{Rs./Bahrain Dinar}
```

```
\[
\text{Total Cost in Nepali Rupees (Rs.)} = 543,460 \, \text{Rs.}
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\]
So, Ms. Bhandari would need 543,460 Nepali Rupees for the transaction to buy 2000 Bahrain Dinar.
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Further, Rawat and Mishra suggested some examples of how mathematics is used in AI, such as in linear algebra. At the same time, linear algebra is used to represent data in a way that AI algorithms can process [3]. For example, images can be represented as matrices, and text can be represented as vectors. Calculus is used to develop AI algorithms that can learn and make predictions. For example, gradient descent is a calculus-based algorithm used to train neural networks. Statistics are used to evaluate the performance of AI algorithms. Thus, chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha can process a fundamental part of mathematics such as equations and expressions.

Opposing the above, a chatbot like this can carry out simple mathematical operations like addition, subtraction, multiplication, and division. Next, Supriyadi and Kuncoro discussed the potential of ChatGPT, a large language model chatbot developed by OpenAI, to revolutionize mathematics teaching and argued that ChatGPT can be a powerful tool for mathematics education [7]. ChatGPT, Google Bard, and Bing Chat can generate personalized feedback, provide explanations of mathematical concepts, and help students solve problems. For instance, see Figure 1 to see the factorization processes in detail.



NI Factorize  $a^3 - 64$

The expression  $a^3 - 64$  is a difference of two cubes, and it can be factorized using the formula for the difference of cubes:

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

In this case,  $a = a$  and  $b = 4$ .

1. First, identify the "cube root" of each term:  
 $a^3$  is  $a$  cubed, and  $64$  is  $4$  cubed.
2. Factor according to the formula for the difference of cubes:

$$a^3 - 64 = (a - 4)(a^2 + 4a + 16)$$

So,  $a^3 - 64$  is factorized as  $(a - 4)(a^2 + 4a + 16)$ .

Figure 1: Factorized by ChatGPT

It can also be used to create engaging and interactive learning experiences. Instead, Qiu et al. explored the effectiveness of AI in improving students' deep learning in primary school mathematics teaching in Fujian Province and acknowledged that studying mathematics can be challenging for primary school students and suggested that AI can be used to evaluate individual student's learning challenges and provide personalized support to optimize their success in mathematics classes [8]. So, these chatbots can resolve complex equations, including systems of linear equations and quadratic equations. Overall, Monte-Serrat and Cattani argued that the ethical design of AI systems requires a deep understanding of the relationship between mathematics and human behavior [9]. They call for mathematicians and computer scientists to work together with ethicists and social scientists to develop ethical guidelines for developing and using AI systems.

### 3. Solving Basic and Advanced Math Problems

Simple math problems like addition, subtraction, multiplication, and division can be solved by chatbots such as ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha. For instance, if you ask any of the chatbots mentioned above what  $25+25$  is, they will all display the right answer, 50. In the same way, if you ask it what  $200-95$  is, it will give you the correct answer of 105. See Figure 2 below as an example responded to by Google Bard.

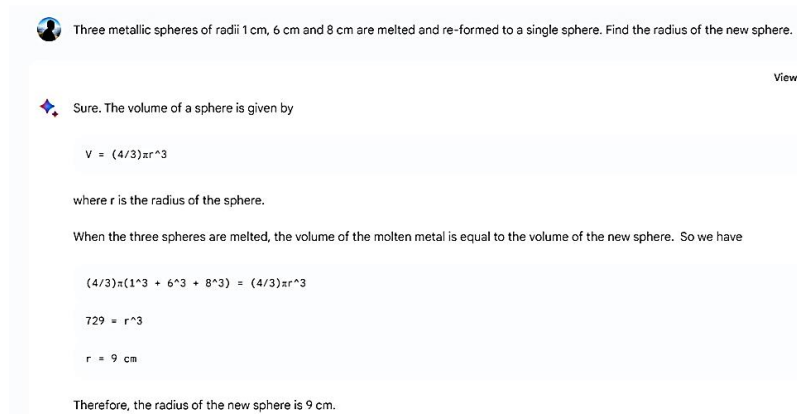


Figure 2: Response by Google Bard

Furthermore, chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha can resolve more challenging mathematical problems like calculus, differential equations, geometry, and trigonometry. Martínez-Sevilla and Alonso concluded by arguing that AI has the potential to revolutionize mathematics education [10]. They call for more research on the use of AI in mathematics education and for developing new AI-enabled learning tools that can help students learn mathematics more effectively. Next, Davies et al. added that “the practice of mathematics involves discovering patterns and using these to formulate and prove conjectures, resulting in theorems.” [11, p. 70]. Moreover, these chatbots can comprehend the issue and produce a solution using deep learning algorithms. But, because these chatbots are natural language models equipped with computational intelligence, they might not always be able to find the right solution, particularly if the problems are difficult or call for a particular approach or formula. In contrast, chatbots like ChatGPT, Google Bard, and Bing Chat will be able to perform math to a certain degree of accuracy.

### 4. How to Learn Math with Chatbots

Qawaqneh et al. investigated the impact of virtual laboratories (VLabs) based on AI on students' motivation toward learning mathematics and concluded that AI-based VLabs can effectively increase students' motivation toward learning mathematics [12]. Likewise, Martínez-Sevilla and Alonso added that the potential of AI to support mathematics education on monumental heritage and suggested that AI can be used to create new learning experiences that are more engaging and interactive and that can help students to develop a deeper understanding of mathematics [10]. Further, Chang et al. investigated the effects of online STEAM hands-on learning on AI learning, creativity, and creative emotions with 25 preservice teachers and found that STEAM hands-on learning can effectively improve AI learning, creativity, and creative emotions [13]. Hence, chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha can explain the underlying ideas and formulas and offer step-by-step solutions to math problems. This can help students understand the reasoning behind the solution and develop their mathematical abilities. Martínez-Sevilla and Alonso

remarked that AI has the potential to revolutionize mathematics education by creating new learning experiences that are more engaging, interactive, and personalized [10].

Chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha can also generate plenty of math practice problems for students to finish, which will help them get better and/or unique solutions. With the help of chatbots like ChatGPT, Google Bard, Bing Chat, and Wolfram Alpha, students can take on more of the role of the teacher. Making the most of the potential that these platforms have offered students can be accomplished by using customized instructions. See Figure 3 for the solution generated by Bing Chat.

The price of a motorcycle is Rs. 2,25,000. If its price is depreciated per year by 8%, after how many years will the motorcycle price be Rs. 1,75,204.80? Find it.

The depreciation of the motorcycle's price can be modeled using the formula for exponential decay, which is  $P = P_0 * (1 - r)^t$ , where:

- $P$  is the final price,
- $P_0$  is the initial price,
- $r$  is the rate of depreciation, and
- $t$  is the time in years.

Given that  $P_0 = \text{Rs. } 2,25,000$ ,  $P = \text{Rs. } 1,75,204.80$ , and  $r = 8\% = 0.08$ , we can substitute these values into the formula and solve for  $t$ .

Doing so gives us:

$$1,75,204.80 = 2,25,000 * (1 - 0.08)^t$$

Dividing both sides by 2,25,000 gives us:

$$(1,75,204.80 / 2,25,000) = (1 - 0.08)^t$$

Taking the natural logarithm of both sides allows us to solve for  $t$ :

$$t = \ln(1,75,204.80 / 2,25,000) / \ln(1 - 0.08)$$

Calculating this gives us approximately  $t \approx 3$  years.

So, it will take approximately **3 years** for the motorcycle's price to depreciate to Rs. 1,75,204.80.

Figure 3: Solution Generated by Bing Chat

## 5. Capabilities and Limitations of Chatbots for Math Problem Solving

Monte-Serrat and Cattani argued that mathematics plays an important role in the development of AI, which has implications for the ethical design of AI systems [9]. So, AI chatbots have been designed to solve a wide range of math problems, from basic arithmetic to complex calculus from basic to university level among the different areas of mathematics. They can also generate proof for mathematical theorems and help students understand complex concepts. In this regard, Wang and Lester argued that AI literacy is essential for preparing students for future jobs and ensuring that they can participate in a democratic society in which AI plays an increasingly important role [6]. So, the wide range of capabilities of AI chatbots in solving math problems is the ability to understand natural language and computational intelligence, the ability to generate step-by-step solutions, the ability to explain mathematical concepts, the ability to explain mathematical concepts, and the ability to generate proofs. See below for one more computation of the mean generated by ChatGPT.

**Prompt to ChatGPT:** Find the mean of [200-300, 40], [300-400, 55], [400-500, 68], [500-600, 77], [600-700, 80].

**Response in embed code:** To find the mean of the given grouped data, you can use the following steps:

#### Finding the Mean:

1. First, find the mid-point of each class interval:

$$- \ ( (200+300)/2 = 250 \ )$$

$$- \ ( (300+400)/2 = 350 \ )$$

$$- \ ( (400+500)/2 = 450 \ )$$

$$- \ ( (500+600)/2 = 550 \ )$$

$$- \ ( (600+700)/2 = 650 \ )$$

2. Next, multiply each mid-point by its corresponding frequency:

$$- \ ( 250 \ \text{times} \ 40 = 10000 \ )$$

$$- \ ( 350 \ \text{times} \ 55 = 19250 \ )$$

$$- \ ( 450 \ \text{times} \ 68 = 30600 \ )$$

$$- \ ( 550 \ \text{times} \ 77 = 42350 \ )$$

$$- \ ( 650 \ \text{times} \ 80 = 52000 \ )$$

3. Sum up these products:

$$\ ( 10000 + 19250 + 30600 + 42350 + 52000 = 154200 \ )$$

4. Sum up the frequencies:

$$\ ( 40 + 55 + 68 + 77 + 80 = 320 \ )$$

5. Calculate the mean:

$$\ ( \text{Mean} = \frac{154200}{320} = 481.875 \ )$$

So, the mean of the given data set is 481.875.

AI chatbots can understand natural language questions with computational intelligence about math, even if they are not phrased in a formal mathematical way. This makes them accessible to a wider range of students, including those who are not fluent in mathematical notation. Likewise, AI chatbots can generate step-by-step solutions to math problems, which can be helpful for students who are learning to solve problems independently. Next, AI chatbots can explain mathematical concepts concisely, which can be helpful for students who are struggling to understand a particular concept. Also, AI chatbots can generate proofs for mathematical theorems, which can be helpful for students who are learning how to prove theorems on their own.

On the contrary, powerful tools for math problem-solving, chatbots like Google Bard, ChatGPT, Bing Chat and Wolfram Alpha, have some limitations. One drawback is that these chatbots might only occasionally be able to resolve challenging mathematical equations and big statistical analysis that call for a particular approach or formula. See below to distinguish the simplification of  $\frac{1}{y+b} + \frac{1}{y+c} + \frac{1}{y+d} + \frac{by}{y^3+by^2} + \frac{cy}{y^3+cy^2} + \frac{dy}{y^3+dy^2}$  by researchers and Wolfram Alpha—AI-based tool equipped with computational intelligence in Figure 4.

$$= \frac{1}{y+b} + \frac{1}{y+c} + \frac{1}{y+d} + \frac{by}{y^2(y+b)} + \frac{cy}{y^2(y+c)} + \frac{dy}{y^2(y+d)}$$

$$= \frac{1}{y+b} + \frac{1}{y+c} + \frac{1}{y+d} + \frac{b}{y(y+b)} + \frac{c}{y(y+c)} + \frac{d}{y(y+d)}$$

$$= \frac{1}{y+b} + \frac{b}{y(y+b)} + \frac{1}{y+c} + \frac{c}{y(y+c)} + \frac{1}{y+d} + \frac{d}{y(y+d)}$$

$$= \frac{y+b}{y(y+b)} + \frac{y+c}{y(y+c)} + \frac{y+d}{y(y+d)}$$

$$= \frac{1}{y} + \frac{1}{y} + \frac{1}{y}$$

$$= \frac{3}{y}$$

$[1/(y+b)] + [1/(y+c)] + [1/(y+d)] + [(b*y)/((y*y)*(y+b))] + [(c*y)/((y*y)*(y+c))] + [(d*y)/((y*y)*(y+d))]$

NATURAL LANGUAGE    MATH INPUT    EXTENDED KEYBOARD    EXAMPLES    UPLOAD    RANDOM

Input  

$$\frac{1}{y+b} + \frac{1}{y+c} + \frac{1}{y+d} + \frac{b y}{(y y)(y+b)} + \frac{c y}{(y y)(y+c)} + \frac{d y}{(y y)(y+d)}$$

Result  

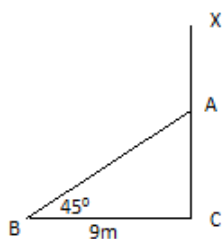
$$\frac{b}{y(b+y)} + \frac{1}{b+y} + \frac{c}{y(c+y)} + \frac{1}{c+y} + \frac{d}{y(d+y)} + \frac{1}{d+y}$$

Alternate form  

$$\frac{3}{y}$$

Figure 4: Simplification by Wolfram Alpha

Furthermore, these chatbots might not always offer the best solution to a problem. Next, since logical reasoning is still one of the weaknesses of chatbots like Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha, these chatbots might not always be able to solve issues requiring real-world contextual knowledge or context. However, chatbots are likely to be capable of solving problems in linear algebra, calculus, and statistics by providing step-by-step solutions. So, human intelligence is still essential for tasks that cannot be accomplished through statistical big data approaches. AI has not yet reached that level of capability. As such, teachers and students should adapt to the age of AI by employing new training methods. See below to distinguish the solutions done by researchers and ChatGPT of the question—the upper part of a straight tree broken by the wind makes an angle of  $45^\circ$  with the plane surface at a point 9 m from the foot of the tree. Find the height of the tree before it was broken.



Correct figure and description

In rt. angled  $\Delta ABC$

$$\tan 45^\circ = \frac{AC}{9}$$

Or,  $AC = 9\text{m}$

Also, In rt. angled  $\Delta ABC$

$$\cos 45^\circ = \frac{9}{AB}$$

Or,  $AB = 9\sqrt{2} \text{ m}$

$\therefore CX = AB + AC = 21.72 \text{ m}$

Figure 5: Solution by Researchers

**Prompt to ChatGPT:** The upper part of a straight tree broken by the wind makes an angle of  $45^\circ$  with the plane surface at a point 9 m from the foot of the tree. Find the height of the tree before it was broken.

**Response in embed code:** To find the height of the tree before it was broken, we can use trigonometric functions. Specifically, we will use the tangent function.

The tangent of an angle  $\theta$  in a right triangle is defined as the ratio of the opposite side to the adjacent side.

For a 45-degree angle,  $\tan(45^\circ) = 1$

In the case of the broken tree, let  $h$  be the original height of the tree before it was broken. The part of the tree that is broken and is leaning makes an angle of 45 degrees with the ground.

If the tree is broken at a point that is 9 m from its base, then the length of the part of the tree that is leaning would also be 9 m (since the angle is 45 degrees and  $\tan(45^\circ) = 1$ ).

Thus, the original height of the tree would be  $h = 9 \text{ m (height of unbroken part)} + 9 \text{ m (height of broken part)}$ .

$h = 9 \text{ m} + 9 \text{ m}$

$h = 18 \text{ m}$

So, the height of the tree before it was broken was 18 meters.

On the other hand, Google Bard, ChatGPT, and Bing Chat's capabilities will continue to grow and advance. Chatbots like Google Bard, ChatGPT, and Bing Chat are evolving to a multimodal model that outperforms these chatbots in many ways, including its capacity to solve mathematical problems as the successor emerges. These chatbots still perform at a high level of difficulty, but future updates to the GPT model will only improve their math skills and make them more intelligent.

Chatbots such as Google Bard, ChatGPT, and Bing Chat lack a comprehensive understanding of geometry and are unable to correct misunderstandings effectively. The accuracy and effectiveness of the solutions provided by Chatbots such as Google Bard, ChatGPT, and Bing Chat may depend on the complexity of the equation, the input data, and the instructions provided to Chatbots such as Google Bard, ChatGPT, and Bing Chat. It is anticipated that chatbots such as Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha will become more effective at solving increasingly complex mathematical problems (Wardat et al., 2023). On the whole, AI chatbots have the potential to revolutionize mathematics education. They can be used to provide personalized instruction, help students learn at their own pace, and make math more accessible to everyone. AI has the potential to revolutionize the way we solve mathematical problems. Even more, AI math solvers can quickly and accurately solve complex equations and problems, even those that would be difficult or impossible for humans to solve accurately in a short interval of time. Chatbots such as Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha can also provide step-by-step explanations of their solutions, which can help students learn and understand math concepts. Speed and accuracy, step-by-step explanations, and access to difficult problems are some potential benefits of using AI math solvers. And cost, accuracy, and creativity are limitations to AI math solvers.

On the contrary, Lee and Yeo described developing and evaluating an AI-based chatbot that preservice teachers can use to practice responsive teaching skills [5]. Responsive teaching is a teaching approach that involves using questioning and other strategies to adapt instruction to the needs of individual students. The chatbot was engineered to function as a simulated student exhibiting misunderstandings about fractions. PSTs were able to interact with the chatbot in real time, asking questions and providing feedback.

In addition to the potential benefits and limitations mentioned above, there are a few other things to consider when using AI chatbots as math solvers. First, it is important to make sure that the AI math solver is reliable and accurate. There are a number of different AI math solvers as chatbots



available, so it is important to do some research to find one that has a good reputation and accuracy. Second, it is important to use AI math solvers as chatbots in a way that is beneficial to learning. AI math solvers can be a great way to get help with difficult problems, but they should not be used as a substitute for learning the material. Finally, it is important to remember that AI math solvers on chatbots are still under development. As AI technology continues to improve, AI math solvers on chatbots will become even more powerful and versatile.

## **6. Conclusions**

Math problem-solving chatbots like Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha are effective tools. These chatbots can explain concepts and formulas, provide step-by-step solutions, and solve simple and complex math problems in seconds. Likewise, AI chatbots are powerful tools that can be used to solve math problems and help students learn mathematics at their own pace and speed with accuracy and step-by-step explanations by accessing difficult problems. However, it is important to be aware of their limitations and use them in the most beneficial way for learners. Next, AI chatbots have the potential to be effective tools for tackling algorithms math problems starting from arithmetic to statistics from school to university level. They can be used to create practice problems, explain the underlying ideas and formulas, and offer step-by-step solutions to problems. This can be useful for anyone needing math help, including students, teachers, teacher educators, among others. However, AI chatbots have some limitations when it comes to solving algorithms and math problems. Even more, chatbots such as Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha cannot always understand the subtleties of human language to start with. This may result in misinterpretations and mistakes in the solutions they offer. Furthermore, they are only as good as the training data. They might not be able to solve problems outside of their training set if they are not trained in a diverse enough range of problems. Despite these drawbacks, AI chatbots have the potential to be a useful resource for resolving issues with algorithms and math problems at the basic to university level. On the whole, AI-based chatbots, such as Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha, have shown significant potential in solving mathematical algorithm problems. They can understand and generate mathematical expressions, provide step-by-step solutions, and enhance students' learning experiences. However, challenges such as limited understanding of natural language models, inability to solve complex problems, and potential bias shall emerge. Future research should focus on improving these areas to increase their accuracy and reliability. Despite these advancements, it is crucial for students to continue interacting with human teachers to develop their cognitive math skills and conceptual understanding.

To sum up, chatbots such as Google Bard, ChatGPT, Bing Chat, and Wolfram Alpha function through the extensive training of large language models (LLMs), natural language models (NLMs), and computational intelligence using enormous datasets. Despite this, there remain specific areas where human intelligence continues to outperform AI, necessitating a nuanced strategy for educating both math teachers and students in the age of artificial intelligence. By blending the strengths of humans and machines, we can forge a more effective educational approach. Given their current capabilities and limitations, we hope that AI chatbots will increasingly serve as a standard resource for math education and problem-solving in the future.

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