



USING CHATGPT TO SOLVE MATHEMATICAL PROBLEMS ABOUT DIRECTLY AND INVERSELY PROPORTIONAL VARIABLES

O USO DO CHATGPT PARA RESOLVER PROBLEMAS MATEMÁTICOS SOBRE GRANDEZAS DIRETA E INVERSAMENTE PROPORCIONAIS

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Abstract: This article presents the results of a qualitative study about the interaction between users and ChatGPT in solving mathematical problems concerning direct and inversely proportional quantities. With an exploratory approach, the methodological procedure was divided into five stages: chatbot selection, choice of instructional materials, selection of mathematical problems, use of ChatGPT, and finally, analysis of responses according to the presented content. Four problems were input into ChatGPT for result analysis, highlighting its propensity for errors and emphasizing the need for preliminary testing. Despite limitations, we found that ChatGPT can contribute to the construction of mathematical knowledge as a viable alternative for the design of new pedagogical proposals combined with digital technologies. Advances in machine learning, such as increased accuracy in textual recognition, directly influence natural language, making didactic experiences with chatbots safer.

Keywords: Conversational Agents; Chatbots; Mathematics Education; Artificial Intelligence; Digital Technologies.

Resumo: Este artigo apresenta resultados de uma pesquisa qualitativa sobre a interação entre usuários e o ChatGPT na resolução de problemas matemáticos concernentes a grandezas direta e inversamente proporcionais. Com uma abordagem exploratória, o procedimento metodológico foi dividido em cinco etapas: seleção do chatbot, escolha do material didático, seleção dos problemas matemáticos, uso do ChatGPT e, por fim, análise das respostas conforme o conteúdo apresentado. Quatro problemas foram inseridos no ChatGPT para análise dos resultados, evidenciando sua propensão a erros e destacando a necessidade de testes prévios. Apesar das limitações, constatamos que o ChatGPT pode contribuir para a construção de conhecimentos matemáticos, como uma alternativa viável para o delineamento de novas propostas pedagógicas aliadas com as tecnologias digitais. Avanços na aprendizagem de máquina, como maior precisão no reconhecimento textual, influenciam diretamente na linguagem natural, tornando as experiências didáticas com chatbots mais seguras.

Palavras-chave: Agentes Conversacionais; Chatbots; Educação Matemática; Inteligência Artificial; Tecnologias Digitais.

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1 Introduction

We are living in a time when it is common to hear affirmations, normally based on common sense, about an omnipresence of digital technologies (DT) in daily activities of human beings. Many of these affirmations are based in the presence of physical devices such as smartphones, tablets, notebooks or desktops, or digital resources as games, mobile applications (apps) and software. This is justified by the general perception that we are dependent on those devices to perform daily activities such as communication, buying, accessing news and even simple activities like reading QR Codes in bars and restaurants, for example.

This perception is created based on a careful primary observation, when our eyes meet, in different moments, people communication through messages, making digital payments in mobile devices, listening to music in streaming platforms or even talking through visually undetectable microphones, integrated in their bluetooth headphones.

About the advance of internet, network and software presence, it is noticeable a growth in DT, which are used for different specificities, what brings impacts, both positive and negative in diverse areas of society, among which we highlight the educational. One example is the presence of robotics, expanded reality (ER), simulators and artificial intelligence (AI) in schools. Even if they are not present in all brazilian schools, it is not possible to deny that their presence is increasing.

In this context, AI is one of the resources which deserves attention and research related to the impacts and contributions that its use may bring must exist. Research as the ones from Zatti and Kalinke (2021); Mattos (2022); Zatti *et al.* (2022), Gabriel (2022) and Silva (2023), have been contributing to comprehensions of how AI based systems may be explored in contexts that involve learning and teaching processes.

In the fields of AI based systems, virtual assistants or chatbots, also known as chatterbots, which are agents of conversation or dialogue systems have been getting more attention (Silveira *et al.* 2019). One example that has become very popular, due to its capacity to interact with humans providing text answers for different questionings, is ChatGPT. In the scenario it is important to analyze how chatbots, in particular, ChatGPT provides answers to proposed mathematical problems.

Aiming to collaborate with the theme we present in this article, a qualitative research based on the interactions with ChatGPT about four situations involving mathematical problems then analyzing the provided answers aiming to comprehend how



this chatbot, by using AI, answers the presented problems. The intention here, is to answer the following question: How does ChatGPT solves mathematical problems involving directly and inversely proportional magnitude proposed for 9th grade students?

Seeking the answers to the formulated question, a deepening in the comprehension about chatbots through theoretical and historical basis was necessary. Following, problems were presented to ChatGPT and the results, provided by the dialogues and interaction with the user were analyzed. To analysis was made through the reading and interpretation of the provided answers while checking the mathematical procedure proposed by ChatGPT.

1.1 Chatbots

Basically, an AI system uses algorithms where the machine learning is responsible for analyzing the “data to identify patterns and build models to predict future values. The bigger the volume (experiences) better the result tends to be” (Zatti; Kalinke, 2021, p. 78).

Some gradate advances have been observed regarding different AI algorithms as in the case of voice recognition, probabilistic reason, which allows systems to detect the level of learning of a student and optimization of instructions to personify the learning, among others.

A chatbot, understood as an AI system, may be offered by platforms with free or paid services. In general terms those platforms use mechanisms of machine learning and deep learning in its programming. Chatbots may be built by different types of software architecture⁴, and this influences in the results of access and interaction with the user. Its functionalities may be executed through message apps, websites, mobile apps, virtual environments, 3D virtual worlds and intelligent tutoring systems (Melo; Pessoa; Paschoal, 2022).

⁴ According to Gallotti (2016), there are different software architectures that may be used in local networks (LAN) or wide (WAN), and serve to specific purposes, as the **MVC (model-view-controller)** to web systems, managing information as for example, keyboard inputs and mouse clicks. The **architecture in layers** organize the system in layers with related functionalities as the cases of online virtual libraries that provide copyright documents. The **client-service architecture** distributes functionalities into services, exemplified by streaming platforms like Amazon Prime or Netflix, just to mention some among many other available architectures. In the context of ChatGPT, its GPT architecture is part of a neutral network developed by OpenAI to train models of natural language (Espírito Santo *et al.* 2023, p. 56).



The popularization of those smart assistants happened starting in 2011 with the advent of Siri⁵. However, historically, the first conversation agent was created in 1966, with Eliza, a chatbot that simulates therapy session, acting as a virtual psychologist, developed by the mathematician, computing scientist and professor at the Massachusetts Institute of Technology (MIT), Joseph Weizenbaum. Gabriel (2022) states that there are the ones who gives it to Alan Turing, because Turing's test, created in 1950, may be considered the first chatbot in history.

To comprehend the concept of a chatbot, initially it is needed to know the concept of bot. According to Gabriel (2022) bot is a designation to a robot software, a virtual robot absent of physical body. They are computational programs which exercise automatic activities. Therefore, chatbots are bots which talk through natural language, as chatbot A.L.I.C.E (*Artificial Linguistic Internet Computer Entity*)⁶, considering the first of these resources to be used through a computer and developed in 1955 by the professor, researcher and computing scientist Richard Wallace, in the University of Lehigh, Pennsylvania, United States (Gabriel, 2022).

A human-chatbot interactive process results from the conversation between an user and a information system, through algorithms previously programmed, that compose the AI of the system, making possible the transmission of voice commands or text messages. This movement consists of a demand, comprehend afterwards through natural language processing. Thus, the chatbot will be allowed to locate the solicited information by the user in a preexistent and available knowledge base (Melo; Pessoa; Paschoal, 2022).

The general design template for an intelligent assistant involves knowledge of human activities, the ability to extract information from perceptual data streams and text, and a learning process that adapts the assistant to the user's particular circumstances (Russel, 2021, p. 72, tradução dos autores).

⁵ Siri is Apple's virtual assistant present in devices such as iPhones and Macs since 2011. It answers natural voice commands and execute tasks such as sending messages, making calls, reproduce music and provide information. It uses natural language processing technologies and machine learning to understand and improve its answers through time. Its Presence in a variety of objects makes it a central part of the user experience inside Apple's ecosystem.

⁶ Entity of linguistical artificial computer on internet.



There are many smart assistants available, such as Siri⁷, developed by Apple; Alexa⁸, developed by Amazon; Cortana⁹, by Microsoft; ChatGPT¹⁰, by OpenAI; and more recently, Google Gemini¹¹.

With the continuous development of AI based systems and consequently the proliferation of chatbots, it is understood there is a need of new research related to different areas that will be impacted by its presence, as in the educational area, where these research and environments start to become present. When teaching computation, chatbot TOB-STT¹², helps in the construction of tests that are capable of revealing problems in software, while GanttBot¹³ presents alerts, advice and motivational messages to the students involved in academical projects in courses such as Computing Science and Engineering (Melo; Pessoa; Paschoal, 2022). Also, Silveira *et al* (2019) presented in experimental research investigating aspects related to a chatbot and its capacity to motivate and motivate students during knowledge construction, having as base Vygotsky's socioconstrutivism.

Among the studied and tested chatbots nowadays ChatGPT must be highlighted, created by a north american AI research lab, called OpenAI which presents itself as a non-profit organization. OpenAI is placed in San Francisco (California) and was founded in december 2015 e “patroned by a group of investors and partners, between those, Microsoft” (Murta, 2023, p. 16).

ChatGPT has as one of its functions to answer questions, even the ones related to mathematics, and its form of interaction with the use happens by text. It can be accessed for free through computer or smartphone after filling a simple form. In a direct interaction with the environment, by questioning what it could do, the answer obtained was “do a lot” followed by the reaction presented in Figure 1.

⁷ Available at: <https://www.apple.com/br/siri/>. Access in: 04 mar. 2024.

⁸ Available at: <https://www.amazon.com.br/b?ie=UTF8&node=19949683011>. Access in: 04 mar. 2024.

⁹ Available at: <https://apps.microsoft.com/store/detail/9NFFX4SZZ23L?hl=pt-br&gl=BR>. Access in: 04 mar. 2024.

¹⁰ Available at: <https://chat.openai.com/>. Access in: 04 mar. 2024.

¹¹ Available at: <https://gemini.google.com/app>. Access in: 04 mar. 2024.

¹² Available at: <https://www.labes.icmc.usp.br/~tob-stt/>. Access in: 04 mar. 2024.

¹³ The access to GanttBot is done by students with use of *smartphones*, using Telegram. By seeking the contact @GanttBot, it is activated a brief presentation of the bot and afterwards, all available commands (Pereira; Díaz, 2021, n.p.).

**Figure 1:** answer provided by ChatGPT

1. **Responder Perguntas:** Posso responder a perguntas sobre uma ampla variedade de tópicos, desde fatos gerais até informações mais específicas.
2. **Assistência na Escrita:** Posso ajudar na redação de textos, fornecer sugestões e revisar gramática e estilo.
3. **Explicar Conceitos:** Posso explicar conceitos complexos de maneira mais simples e acessível.
4. **Fornecer Informações:** Posso fornecer informações sobre história, ciência, tecnologia, cultura, esportes e muito mais.
5. **Realizar Cálculos:** Posso fazer cálculos matemáticos simples ou complexos.
6. **Traduzir Textos:** Posso traduzir texto de um idioma para outro.
7. **Gerar Texto Criativo:** Posso criar histórias, poemas, músicas e outros tipos de conteúdo criativo.
8. **Assistência em Programação:** Posso ajudar com código, explicar conceitos de programação e fornecer exemplos de código.
9. **Assistência em Planejamento:** Posso ajudar a criar listas de tarefas, planos de viagem, calendários e muito mais.
10. **Conversar:** Posso manter uma conversa casual e discutir uma variedade de tópicos.

Source: research data (2023).

Topic 5 indicates viability of use to perform mathematical calculus, including the ones it presents as “complex”, however, without specifying of what such term refers to. After analyzing the context of the phrase, it is assumed that by complex it understands the calculus which are not “simple” since they are opposites. This may bring discussions about the use of terms and definitions, that are so precious to mathematicians and to whom complex can be for example a numerical group C defined by $C = \{a + bi \mid a, b \in \mathbb{R}\}$, with $i = \sqrt{-1}$.

Assuming ChatGPT possesses such skill, among which, possibilities of translating, executing tasks of writing, create tables. Help coding, perform calculations among other activities (ChatGPT, 2024)¹⁴, it can be, in priori, using, to solve mathematical problems, what brings us to seek comprehensions about what answers he provides to the proposed problems, and, how it presents it. One of the aspects that deserves to be highlighted, is related to algorithmic language and refers to the reliability of the AI based systems. It is comprehended that this is an essential factor in research about the use of chatbots in educational activities. The authors consider there is still a considerable distance between the systems and the fields of ethics, with a question of epistemological nature that is the transparency and opacity of AI, compared by the authors

¹⁴ Available at: <https://chat.openai.com/>. Access in: 04 mar. 2024.



with a opaque glass box. The development of algorithms which are used for some online services, for example, follows some patterns which are still considered obscure, non-transparent to the general user.

As result of this model of algorithm conception, Russo, Schliesser e Wagemans (2023) consider that AI, through machine learning, still fails in recognizing some patterns, what makes it tendentious when offering some services. This reinforces some forms of inequality that prejudice directly some minorities, as the ones in social vulnerability. The authors present the example of automatized real estate loan systems in USA, that after pattern recognition excluded candidates due to the neighborhoods they lived for example.

In this case, the authors suggest a more ethical epistemological model that prioritizes the development of algorithms that incorporate values in the most transparent way possible, since the first phase of its creation (design process), passing through the implementation, use and finally ending in a process of evaluation, performed by experts and non-experts (Russo; Schliesser; Wagemans, 2023).

Other aspect related to AI to be investigated is related to the question of knowledge construction and how it happens is directly related to the processes of human-chatbot interactivity. Some experts, such as Gary Marcus, professor at the University of New York, point out significant concerns about reliability of those systems because of the answer's impression, as in the case of occurrences related to ChatGPT. Marcus considers the most recent version of this system to a "bull in a porcelain store, reckless and hard to control" (Suzuki, 2023). He also alerted, only four months before the suicide of a Belgium user, allegedly persuaded by chatbot Eliza, when he wrote that: "maybe a chatbot is going to hurt someone so deeply that the person is going to terminate his life. In 2023, maybe we face our first chatbot related death" (Suzuki, 2023).

In this context, computational reliability aspects reflect the possibility of production of false results presented in a chatbot, even for mathematical problems. Facing the searching, use and test results of the users, OpenAI affirmed that not always there will be precision in the answers, without however, indicating if the errors would be corrected or would stay unaltered.



In late march, a bizarre case caught attention. A person asked ChatGPT to name academics involved in sexual harassment episodes. The list mentioned an american law professor, Jonathan Turley. The program said that Turley made sexually suggestive comments to a student during a trip to Alaska and tried to touch her. The response cited as evidence a 2018 report from The Washington Post. But none of this ever existed: neither the trip, nor the report, nor even the accusation. Only the professor and his reputation were real. It's as if the robot had invented a slander (Suzuki, 2023, n.p., tradução dos autores).

Considering computational reliability aspect in the production of knowledge, the research will present in the following section chatbot ChatGPT was used. To answer the main question presented we propose the development of a research of qualitative approach with the intention to analyze answers provided by ChatGPT to mathematical problems previously selected in a didactic book adequate to the 9th grade.

2 Research data

This article comprehends qualitative research, assuming as principle an investigation the emphasis description, induction, exploration and analysis of a determined object of study. This kind of research “[...] demands the world to be examined with the idea that nothing is trivial, everything has the potential to build a clue that allows us to establish a more clarifying comprehension of our object of study” (Bogdan; Biklen, 1994, p. 49).

In this sense, this research seeks to comprehend qualitative phenomena related to an object, in our case ChatGPT. The investigation to understand such object focus on the process as a whole, where the data collected are predominantly descriptive. According Bicudo (2004, p. 104, tradução dos autores):

[...] The qualitative research encompasses the idea of the subjective, capable of exposing sensations and opinions. The meaning attributed to this research concept also encompasses notions about perceptions of differences and similarities in comparable aspects of experiences, such as, for example, the redness of red, etc.

Moreover, this work is advised by exploratory research, using experimental procedure. Exploratory research is one that “[...] has as goal to provide more familiarity to the problem aiming to make it more explicit or build hypothesis” (Gil, 2002, p.41).

In this sense, exploratory research seeks to understand an object through interaction or by the elements that surround it. “its planning is, therefore, flexible, in a



way that is possible to consider different aspects related to the fact” (Gil, 2002, p.41).

Thus, the experimental procedure was used in our research because:

[...] experimental research essentially consists of determining an object of study, selecting the variables capable of influencing it, and defining the forms of control and observation of the effects that the variable produces on the object. Therefore, it is a research in which the researcher is an active agent, not a passive observer (Gil, 2002, p.48, tradução dos autores).

In this sense, the methodological procedures for this research were divided in 5 steps: 1) chatbot selection; 2) didactic material selection; 3) Mathematical problems selection; 4) Use of chatbot to acquire answers; 5) analysis of the provided answers.

In the first step the selected chatbot was ChatGPT for being one platform that is gaining space among Brazilian users and is present in general media. In a quick search about the theme “ChatGPT in media” on Google¹⁵. 1250 news were found. The used version was 3.5 for being the most recent free one. There is a more recent called GPT-4 which demands payment to be used. OpenAI defines the used version as:

[...] GPT-3.5 is a language model developed by OpenAI, based on the GPT-3.5 architecture. It is part of the GPT (Generative Pre-trained Transformer) family of models, which are designed to understand and generate natural language text. GPT-3.5 is a more advanced version of the previous model, GPT-3, with better performance on a variety of natural language processing tasks (OpenAI, 2023, n.p., tradução dos autores).

We also consider as a significant aspect the choice of a conversational agent, facility of access, taking into consideration that any user with a google account has the possibility of logging in in the website e use through computer or smartphone.

For the second step of the investigation, the didactic material from where the problems were chosen and presented as prompts¹⁶ to the chatbot. We chose the teacher’s book from Acerta Brasil material, used for mathematics teaching, directed to the 9th grade (Acerta Brasil, 2020). It must be highlighted that the intention is not to evaluate the quality of the problems presented, but to use the problems withdraw from the existent materials aiming to verify the answers given by the chatbot and compare them with the official

¹⁵ Available at: [google.com](https://www.google.com). Access in 04 mar. 2024.

¹⁶ Prompt engineering is a technique used to help artificial intelligence to understand what to say or write. It involves to select and Project the right words to guide the model in the production of the desired answer. This technique helps to improve precision and consciousness of the language models while generating text in natural language (Correia, 2023).



answers. Within this proposal, the choice of the book was made because is a material already used by the researcher in his teaching activities.

In the third step, three problems were chosen to be presented to ChatGPT and, to fulfill the step we observed the suggestions of Oliveira e Pinto (2023) who recommend the use of five steps about questions to be made to a chatbot: be clear and specific, avoid wide questions, make factual questions, be polite and respectful and use adequate formatting.

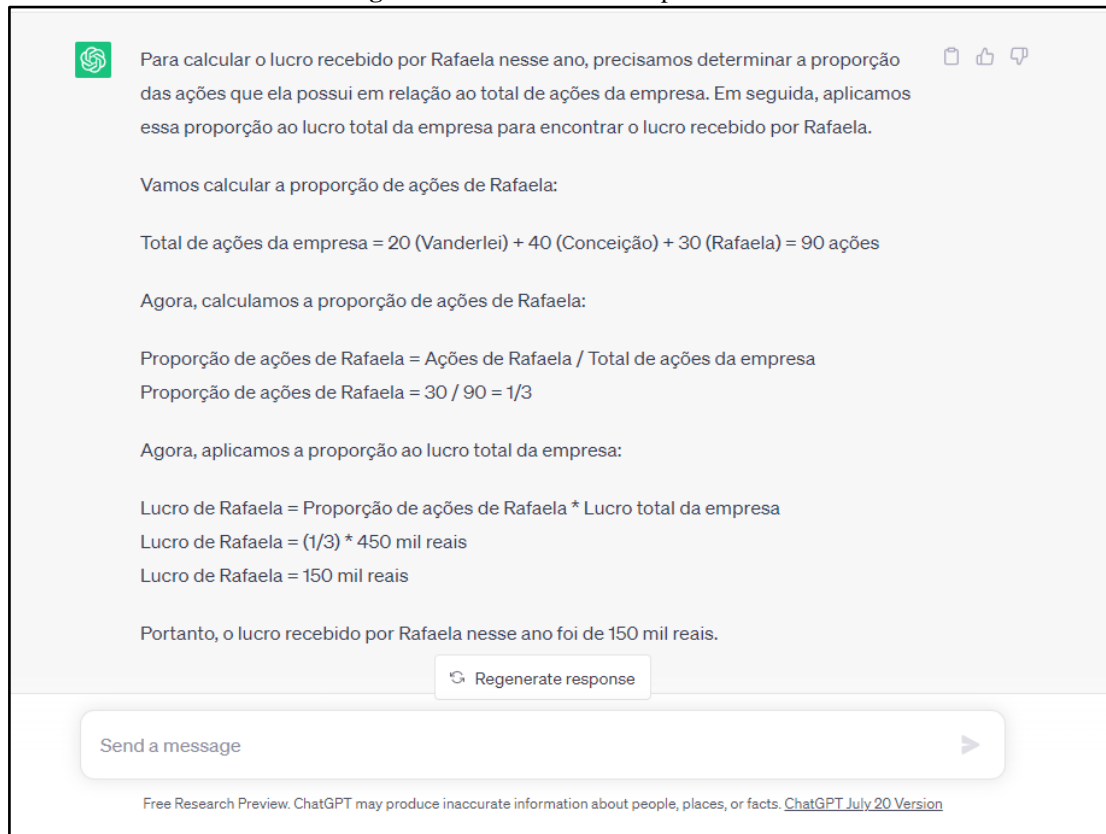
In order to choose the mathematical problems we defined that they should have mathematical concepts related to skill EF08MA13, present in Algebra thematic unity in National Common Curricular Base (NCCB), that establishes “solve and elaborate problems which involve directly or inversely proportional magnitudes through different strategies.” (Brasil, 2018, p. 313). Such choice is justified for being a subject that allows the use of mathematical problems formulated in situations that simulate real world and do not demand the use of mathematical symbols or formula to be presented. In this sense, they could be presented to ChatGPT in a natural language format, without the need of symbolical resources. Subject defined, the three problems were chosen. They are present in the topic “Valendo” of “Missão 9” (Acerta Brasil, 2020, p. 35). In the fourth step ChatGPT was used by asking that the three problems were solved, one at a time. The first problem had as subject directly proportional magnitude and can be visualized in Figure 2.


Figure 2: First Mathematical Problem

- 1.** Vanderlei, Conceição e Rafaela são os únicos acionistas de uma empresa. Vanderlei possui 20 ações, Conceição possui 40 e Rafaela, 30. Em determinado ano, a empresa obteve lucro de 450 mil reais e a divisão do lucro foi calculada de forma proporcional às quantidades de ações. Qual foi o lucro recebido por Rafaela nesse ano, em milhares de reais?
- (A) 100
(B) 150
(C) 200
(D) 250
- Resposta: alternativa B.

Fonte: Acerta Brasil (2020, p. 35).

To interact with ChatGPT, we used as prompt the same content of the chosen material, copying the same enunciate, excluding the alternatives. No other phrase or content was inserted. The results are in Figure 3.

Figure 3: Answer to the first problem

 Para calcular o lucro recebido por Rafaela nesse ano, precisamos determinar a proporção das ações que ela possui em relação ao total de ações da empresa. Em seguida, aplicamos essa proporção ao lucro total da empresa para encontrar o lucro recebido por Rafaela.

Vamos calcular a proporção de ações de Rafaela:

Total de ações da empresa = 20 (Vanderlei) + 40 (Conceição) + 30 (Rafaela) = 90 ações

Agora, calculamos a proporção de ações de Rafaela:


Proporção de ações de Rafaela = Ações de Rafaela / Total de ações da empresa
Proporção de ações de Rafaela = 30 / 90 = 1/3

Agora, aplicamos a proporção ao lucro total da empresa:

Lucro de Rafaela = Proporção de ações de Rafaela * Lucro total da empresa
Lucro de Rafaela = (1/3) * 450 mil reais
Lucro de Rafaela = 150 mil reais

Portanto, o lucro recebido por Rafaela nesse ano foi de 150 mil reais.

[Regenerate response](#)

Send a message 

Free Research Preview. ChatGPT may produce inaccurate information about people, places, or facts. [ChatGPT July 20 Version](#)

Source: Research data (2023).

It is possible to understand that the answer offered by ChatGPT matches the alternative presented as correct by the didactic book, corresponding to answer “B”. It is important to observe that, while in traditional mathematics classes this problem could be solved by the equality $\frac{30}{90} = \frac{x}{450}$, then $\frac{1}{3} = \frac{x}{450}$, so, $3x = 450$ and $x = 150$ mil reais, ChatGPT uses its main functionality, that is, natural language, detailing the calculus, as if it was talking to the user, presenting step by step the procedures that brought the answer.

Afterwards the second problem is presented and regards directly proportional magnitudes, illustrated in Figure 4.

Figure 4: second mathematical problem

2. Para preparar um suco, é necessário misturar uma parte de suco concentrado de fruta e três partes de água. Deve-se preparar 60 litros de suco para uma festa. Qual volume de água, em litros, é necessário para preparar essa quantidade de suco?

(A) 15
(B) 20
(C) 30
(D) 45

Resposta: alternativa D.

Source: Acerta Brasil (2020, p. 35).

After presenting this question to ChatGPT, Figure 5 answer was obtained.

Figure 5: Answer to the second problem

Para preparar 60 litros de suco, você precisará misturar uma parte de suco concentrado de fruta com três partes de água. Isso significa que a quantidade de água necessária será três vezes maior que a quantidade de suco concentrado.

Vamos calcular o volume de água necessário:

1 parte de suco concentrado + 3 partes de água = 4 partes no total

Volume de água necessário = 3 partes de água / 4 partes no total * 60 litros de suco

Volume de água necessário = (3/4) * 60 litros

Volume de água necessário = 45 litros

Portanto, você precisará de 45 litros de água para preparar 60 litros de suco.

Source: research data (2023).

In a traditional solution, this problem could be solved by the proportion $\frac{3}{4} = \frac{x}{60}$, then $4x = 180$ and $x = 45$ litros. The answer generated by ChatGPT coincides again with the numerical answer pointed as correct by the didactic book, alternative “D” (45 liters) and was presented in a dialogue where the calculus reasoning was also presented and developed to the user step by step.

To finish, the third problem was presented as illustrated in Figure 6, which presented a problem related to inversely proportional magnitudes, different from the previous problems that were of directly proportional nature.

Figure 6: Third mathematical problem

3. Três arqueólogos, com a mesma eficiência, inspecionam uma área de 12 000 m² em 3 dias, trabalhando 8 horas por dia. Se mais 2 arqueólogos de mesma eficiência se juntarem aos anteriores e trabalharem 6 horas por dia, durante 4 dias, conseguirão inspecionar uma área maior.

Essa área equivale a:

- (A) 20 000 m².
- (B) 24 000 m².
- (C) 30 000 m².
- (D) 36 000 m².

Resposta: alternativa A.

Source: Acerta Brasil (2020, p. 35).

The following answer was presented by ChatGPT, as illustrated in Figure 7.

Figure 7: Answer to the third problem

Para resolver esse problema, primeiro precisamos calcular a taxa de trabalho dos três arqueólogos iniciais e, em seguida, usá-la para determinar a área que os cinco arqueólogos podem inspecionar em 4 dias.

Vamos começar calculando a taxa de trabalho dos três arqueólogos iniciais:

Área inspecionada por 3 arqueólogos em 1 dia = 12.000 m² ÷ 3 dias = 4.000 m²/dia
 Área inspecionada por 3 arqueólogos em 1 hora = 4.000 m² ÷ 8 horas = 500 m²/hora

Agora, com a taxa de trabalho dos três arqueólogos, podemos calcular a área que cinco arqueólogos podem inspecionar em 4 dias trabalhando 6 horas por dia:

Área inspecionada por 5 arqueólogos em 1 hora = 500 m²/hora (mesma eficiência que os três arqueólogos)
 Área inspecionada por 5 arqueólogos em 1 dia = 500 m²/hora × 6 horas = 3.000 m²/dia
 Área inspecionada por 5 arqueólogos em 4 dias = 3.000 m²/dia × 4 dias = 12.000 m²

Portanto, os cinco arqueólogos conseguirão inspecionar uma área de 12.000 metros quadrados.

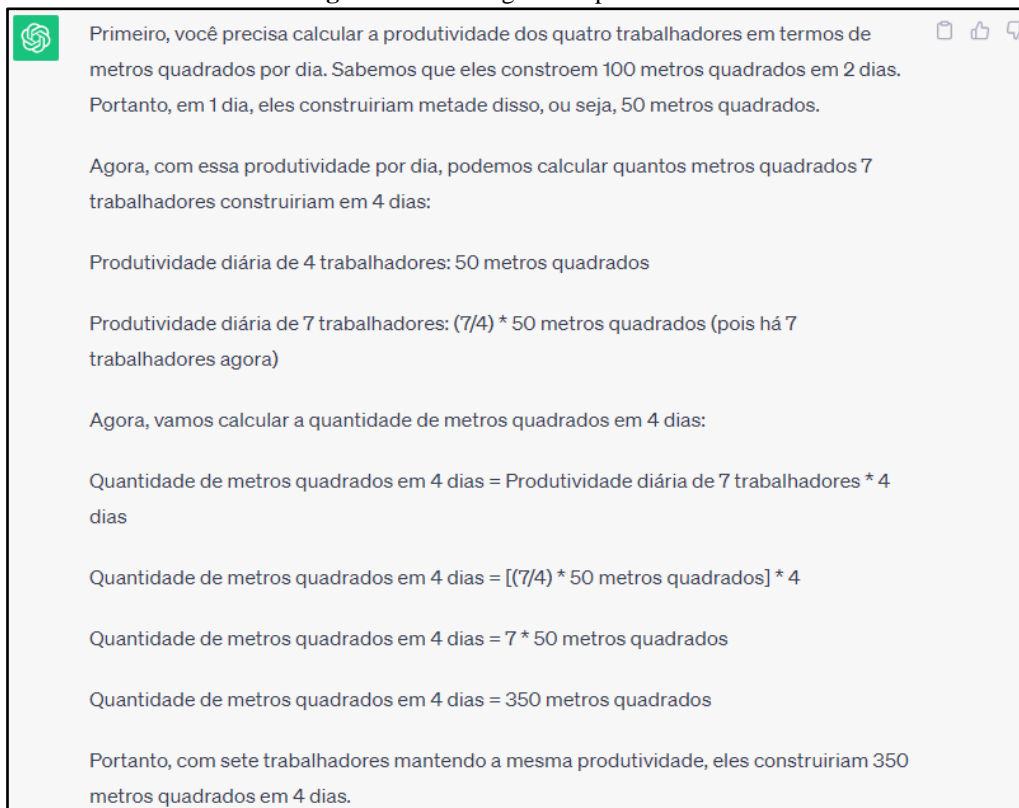
Source: Research data (2023).

At this point, a divergence was found between the chatbot answer and the one presented in the didactic book which marks option “A”, with the value of 20.000 m². ChatGPT presented the answer as 12.000 m². The mathematical resolution could be presented as $\frac{3}{5} = \frac{12000}{x} \cdot \frac{6}{8}$, then $3x = 60.000$ and $x = 20.000$ m². The wrong result presented by ChatGPT presented us evidence of a chatbot problem to understand the presented problem. The mistake committed by it was to interpret that, if the efficacy of three archeologists is the same of five of them, then the area affected by three would be the same of five.



This problem could suggest that the chatbot present difficulties to comprehend mathematical problems that use inversely proportional magnitudes. To test such hypothesis, we presented a new problem about the subject. To keep the similarity with the previous problems the theoretical part of the didactic book was analyzed and presents the following affirmation: “the bigger the quantity of workers building the wall the lesser the time needed to finish the wall. Thus ‘quantity of workers’ and ‘time of building’ are inversely proportional magnitudes” (Acerta Brasil, 2020, p. 34). Based on this information, we proposed to ChatGPT the following problem: four workers build a hundred squared meters of a wall in two days. Keeping the productivity, how many squared meters will be built by seven workers, in four days? One example of the resolution for this problem would be to use the equality $\frac{4}{7} = \frac{100}{x} \cdot \frac{4}{2}$, then $8x = 2800$ and $x = 350 \text{ m}^2$. The solution presented by ChatGPT is indicated in Figure 8.

Figure 8: Answer given to problem four



Source: research data (2023).

In this case ChatGPT answered correctly to the problem, presenting that the difficulty is not to work with inversely proportional magnitudes but to interpret the text of the third question. Considering the mistake could have been caused by the prompt suggested to the chatbot, it is possible to assume that if the chatbot receives insufficient



data to solve a problem, it will offer a equally unsatisfactory answer. Starting from those observations the next step of the research, data analysis will be presented.

3 Data Analysis

Regarding the data obtained, in a total of three problems simulated in ChatGPT, two related to directly proportional magnitudes and one related to inversely proportional we obtained 2 correct and 1 wrong answer. The only problem that ChatGPT presented a wrong answer was related to inversely proportional answers. When trying to comprehend the reason of the mistake a fourth problem was prompted from an example given by the very didactic book. This problem was correctly answered, providing clues that the mistake was not caused by factors related to any kind of mathematical complexity but by difficulties in the prompt comprehension (problem enunciate) that made an affirmation that was wrongly understood by chatbot. In this sense Freire and Santos (2023, p. 128, tradução dos autores), argue that:

The accuracy of the prompt still requires that the expected result be declared and that different inputs are made, adding perspectives with the aim of reaching a more complete and satisfactory answer. As well as Google, ChatGPT is full of answers, but the talent for building good questions is human.

The enunciate of this problem, by indicating that the archeologists maintain the efficiency, is telling the reader that, if each of the three, in the initial situation explores 'x' squared meters in the following conditions, with five of them working, the efficacy will be maintained and will explore the same quantity of squared meters. Therefore, its mistake was to calculate the efficiency of each archeologist, which would be $\frac{500}{3}$. In this case the result would be: $\frac{500}{3} \cdot 5.6.4 = 20000 \text{ m}^2$.

The mistakes committed by environments as ChatGPT are common and explored by those who are against the use of DT in educational activities. This may be understood by two points of view: technological and pedagogical. Regarding the knowledge construction supported by technological artifacts, Cupani (2009) brought attention to the fact that technologies could not be blindly trusted. In his words:

[...] In thesis and as mentioned before, the functioning of an artifact can, in theory, attest to the truth of the scientific information that made it possible. However, this does not mean that technological production can be taken as a sure sign of scientific truth, especially of the most profound or advanced scientific truth (Cupani, 2009, p. 108, tradução dos autores).



Based on the studies of Cupani (2009; 2016) it is possible to comprehend that the technology (this includes digital artifacts as chatbots) possesses an important role in knowledge construction. However, we must still be cautious to the certainty of the provided answers, what can be proved with this research experiment, in a small sample of questions formulated to ChatGPT.

Regarding the approach under the pedagogical perspective, the question to be analyzed is not in the fact of the platform answer correctly or not but how the teacher can conduct his classes, or activities, using what the platform offers. He can help pointing that the chatbot provided the wrong answer and do not advise its use, or can use this error to conduct activities, in which, by the existent mathematical knowledge, discuss the presented answer and verify then if they agree or not with it.

Beyond that, it is possible to solicitate, by the perception of the mistake committed by the chatbot, that the student finds the error in the interpretation of the enunciate by ChatGPT and seek new formulations to the mathematical problems presented, in a way that the chatbot may be able to understand correctly the question and present an adequate answer. In this activity, the conventional agent may serve as auxiliar to the students to develop mathematical concepts and consequently, build new knowledge.

In this perspective, even considering that a certain platform is useful, or even contribute to the construction of knowledge by the students it should be previously analyzed and tested by the teacher, once we are still in the initial phase of the sharpening of AI systems.

4 Conclusion

It was possible to understand that the use a conversational agent (chatbot), in an AI supported environment, applied in mathematical education activities, may bring contributions, both positive and negative. It was possible to comprehend that the characteristically natural language of this resource may contribute to the process of knowledge construction, when present the answers to mathematical problems in the current language, detailed step by step, translating to the user what mathematicians normally present through formulas and equations. On the other hand, it was possible to observe that the presented solutions cannot be trusted, and it is necessary to confront it with the traditional mathematical procedures. Thus, it is in the intersection of these



situations that the pedagogical possibilities of DT use, in particular AI, in mathematics learning and teaching process are amplified.

Despite the uncertainties, the advance of these platforms is a continuous process, thus, since there is a significative possibility that AI based systems will be improved, what will make the platforms safer and more trustable for future application in educational activities.

This way, it is important that teachers who propose to work with pedagogical concepts using a chatbot seek constantly validation of the produced answers, based on trustable theoretical support about the subjects to be discussed. By accepting that AI based systems reliability is still affected by algorithms, it is also assumed that this does not compromise totally its use, since these systems are sharpened by the training of its algorithms. Therefore, it can be used in a way to improve mathematics classes, being considered a possibility to the construction of new knowledge starting from activities that use DT and AI in classes of that subject.

For being a relatively recent in mathematical education, we hope to have contributed with inherent aspects about the use of conventional agents with didactical purposes and hope new research about the theme gather attention of the scholar community and thought new investigations the comprehensions about the subject amplified.

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