

## Commognitive review: challenges for lecturers for overcome the AI invasion in contextual problem-solving

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### Abstract

The use of artificial intelligence (AI) has often been found in solving contextual problems in the world of education, both secondary and university. Solving contextual mathematics problems at university requires a good and accurate understanding of concepts. This qualitative descriptive research was conducted on 20 private university students in Indonesia. A total of one contextual mathematics problem is given to be worked on for 20 minutes. One of the most appropriate student work results is selected from all students. The results of this work are then analyzed together with the results of AI work cognitively. The results of the analysis show that in the words use component, students and AI are able to use words or mathematical symbols correctly. However, in the visual mediators component, the AI experienced an error in illustrating an image that was contrary to the conditions it should be in. AI also conveys arguments that contradict the given conditions (narratives). The steps taken by AI in solving questions are also different from students who use conventional methods (routines). The research results show that students' conventional way of solving contextual mathematics problems is better than AI, in other words the invasion of AI into the world of education can still be overcome using conventional methods, especially when solving contextual problems.

**Keywords:** AI, commognitive, contextual problems.

### INTRODUCTION

The use of artificial intelligence (AI) has fundamentally shifted the educational paradigm, opening up new opportunities and complex challenges [1–4]. Currently is an era where technology is increasingly breaking into various aspects of life and the implementation of AI in the world of education promises significant progress [5–8]. AI enables more effective personalization of learning, expands educational accessibility, and streamlines administrative processes [1, 9]. However, like other technologies, the use of AI in education also raises questions about ethics, privacy and social impacts that need to be taken seriously [10, 11]. In the context of education, especially Mathematics, AI has great potential to change the way we learn and teach [6, 10]. With sophisticated data analysis capabilities, AI can help educators, namely Mathematics teachers and lecturers, in designing curricula that are more adaptive and responsive to the needs of individual students [5, 9]. The use of this technology can also increase efficiency in the evaluation process and provide more detailed feedback to students, allowing for better adjustments in learning strategies. AI can help in solving various mathematical problems given, including contextual problems [1]. This provides an opportunity for those who previously had difficulty understanding math problems so that it becomes easier. In this way, AI not only advances the quality of education, but also accelerates understanding of solving mathematical problems. However, the successful use of AI in education must also be balanced with the consideration that in solving

contextual problems there are several steps that must be taken. The steps for solving contextual problems must be sequential and clear, including the illustrations depicted [12–16]. The use of words, variables, symbols, images, graphs, arguments and problem-solving patterns must be clear [17–20].

Commognitive is a combination of communication and cognitive [21–23]. Commognitive consists of four components, namely word use, visual mediators, narratives and routines [24–26]. Commognitive analysis can be used to analyze student work results in solving mathematical problems [17–20, 27]. The results of student work using AI and conventional can be analyzed and compared in solving contextual problems. Collaboration between artificial intelligence and human intelligence is key to maximizing the potential of AI in education [6, 8, 28]. Although AI can provide in-depth data analysis and sophisticated personalization of learning, human intelligence remains irreplaceable in providing the more emotional, social, and moral aspects of the educational process [2, 10, 11, 29]. Lecturers remain central figures in providing motivation, guidance and inspiration to students, while AI plays a role as a supporting tool that helps increase learning efficiency and effectiveness. Thus, the implementation of AI in the world of education is not just about applying advanced technology alone, but also about how this technology can be integrated wisely to improve the learning experience holistically. A balance between technological innovation and traditional educational values is key in ensuring that the use of AI in education truly provides sustainable benefits for the development of education in the future, especially in solving problems. Even though AI has various advantages in solving problems, the use of AI in solving contextual mathematical problems is suspected to be different from conventional methods. Therefore, researchers consider it important to carry out this research to analyze the results of students' work in solving mathematical contextual problems in order to find differences in answers to AI results.

## METHOD

The research approach used in this research is a qualitative descriptive method. A total of 20 students from private universities in Indonesia were given contextual questions to work on for 20 minutes. The question given to students are as follows:

“Adi memiliki tanah berbentuk persegi panjang dengan ukuran 12 m x 10 m. Akan dibagi menjadi beberapa bagian berbentuk persegi dengan luas 16 m<sup>2</sup>. Tentukan luas tanah yang tidak terbagi dan gambarkan pembagiannya!”

other ways in English,

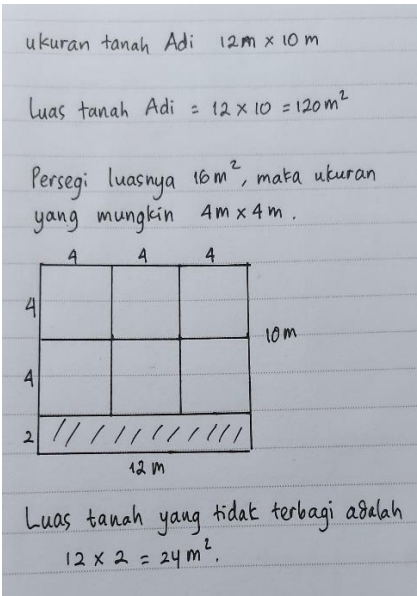

“Adi has rectangular land measuring 12 m x 10 m. It will be divided into several square sections with an area of 16 m<sup>2</sup>. Determine the area of undivided land and describe the division!”

Student work results are grouped based on the completion of the questions, namely the correctness and completeness of the answers. The correct work results and complete steps for solving the questions are then analyzed cognitively with the results of AI answers. The commognitive components used in the analysis are words use, visual mediators, narratives, and routines.

## RESULTS

In Table 1 below, the results of student work and the results of AI's work on the questions given will be presented.

Table 1. Student work results and AI work results

Student work results	AI work results
 <p>ukuran tanah Adi <math>12\text{ m} \times 10\text{ m}</math></p> <p>Luas tanah Adi <math>= 12 \times 10 = 120\text{ m}^2</math></p> <p>Persegi luasnya <math>16\text{ m}^2</math>, maka ukuran yang mungkin <math>4\text{ m} \times 4\text{ m}</math>.</p> <p>Luas tanah yang tidak terbagi adalah <math>12 \times 2 = 24\text{ m}^2</math>.</p>	<p>Untuk membagi tanah berbentuk persegi panjang dengan ukuran <math>12\text{ m} \times 10\text{ m}</math> menjadi beberapa bagian berbentuk persegi dengan luas <math>16\text{ m}^2</math>, kita perlu menghitung ukuran sisi persegi tersebut.</p> <p><b>Menghitung Sisi Persegi</b></p> <p>Luas persegi = sisi <math>\times</math> sisi</p> <p>Dari luas yang diberikan:</p> $\text{sisi}^2 = 16 \Rightarrow \text{sisi} = \sqrt{16} = 4\text{ m}$ <p><b>Menghitung Luas Tanah</b></p> <p>Luas tanah = panjang <math>\times</math> lebar</p> $\text{Luas} = 12\text{ m} \times 10\text{ m} = 120\text{ m}^2$ <p><b>Menghitung Jumlah Persegi yang Dapat Dibuat</b></p> <p>Luas satu persegi = <math>16\text{ m}^2</math>, jadi jumlah persegi yang dapat dibentuk adalah:</p> <p><b>Routines</b></p> $\frac{\text{Luas Tanah}}{\text{Luas Persegi}} = \frac{120\text{ m}^2}{16\text{ m}^2} = 7.5$ <p>Karena kita tidak dapat memiliki setengah persegi, kita hanya bisa membuat 7 persegi.</p> <p><b>Luas Tanah yang Terbagi</b></p> <p>Luas tanah yang terbagi menjadi persegi:</p> $7 \text{ persegi} \times 16\text{ m}^2 = 112\text{ m}^2$ <p><b>Luas Tanah yang Tidak Terbagi</b></p> <p>Luas tanah yang tidak terbagi:</p> <p><b>Narratives</b></p> $\text{Luas Tanah} - \text{Luas Tanah yang Terbagi} = 120\text{ m}^2 - 112\text{ m}^2 = 8\text{ m}^2$ <p><b>Pembagian Tanah</b></p> <p>Untuk menggambarkan pembagian tanah, berikut adalah representasi sederhana:</p>  <p><b>Visual Mediators</b></p> <p>Keterangan:</p> <ul style="list-style-type: none"> <li>"P" menunjukkan bagian persegi <math>4\text{ m} \times 4\text{ m}</math>.</li> <li>Bagian kosong di kanan bawah adalah luas yang tidak terbagi, yaitu <math>8\text{ m}^2</math>.</li> </ul> <p><b>Kesimpulan</b></p> <p>Luas tanah yang tidak terbagi adalah <math>8\text{ m}^2</math>.</p>

Based on the results of student work carried out conventionally and the results of work using AI, a commognitive analysis was obtained as in Table 2 below.

Table 2. Analysis of student work results and AI work results

Commognitive Components	Student work results	AI work results
Words use	Students are able to use words and write numbers and mathematical symbols correctly	AI is able to use words and write numbers and mathematical symbols correctly
Visual mediators	Students are able to illustrate pictures correctly	AI illustrates that the undivided part of the land has the same image size as the part of the land resulting from the division, even though the land areas are different, namely 16 m <sup>2</sup> and 8 m <sup>2</sup> . AI illustrates a picture of dividing the length of land into four parts, even though the length of the land is 12 m so the length of the land resulting from the division is only 3 m, contrary to the square land size of 4 m x 4 m
Narratives	Students are able to convey arguments about their work results correctly	AI is able to explain the arguments for how to obtain the division results, but this is contrary to the fact that the size of the resulting land must be a square
Routines	Students carry out steps to solve problems based on the knowledge they have mastered correctly	AI performs the steps to solve the problem correctly but ignores the condition that must be met, namely a square

## DISCUSSION

Solving problems using AI and conventional methods sometimes has differences. In the line with [4, 7, 28], contextual problems solved using AI should have a more accurate level of correctness and a faster processing speed than conventional methods using teacher methods. However, contextual questions with certain conditions sometimes have different solutions to the conventional method as taught by the teacher. Commognitively, in the words use component, AI can have the same abilities as students, namely being able to use mathematical words, use symbols and symbols correctly. However, students are actually vulnerable in using the correct mathematical words or symbols, depending on their understanding of previous knowledge. In the line with [24, 25, 30, 31] that their knowledge of concepts that have been studied but are not understood properly can result in errors in the use of mathematical words or symbols. When solving contextual mathematics problems, the knowledge that students understand well can influence the correctness of the answers in their work results. This straight with [18–20] said that students who are able to understand well the knowledge of the concepts being studied have a tendency to be able to solve problems correctly.

In the line with [2, 6] that said that compared to AI that solves contextual mathematics problems, AI actually has the potential to make mistakes, especially when solving contextual mathematics problems with certain conditions. AI's limitations result in errors in carrying out problem solving steps (routines) because the arguments expressed by AI ignore certain conditions or conditions such as the shape of the land which must be square compared to the original land shape which is rectangular (narratives). This neglect by AI results in errors when it illustrates images based on terms or conditions that must

be met. The AI results that depict illustrations are different from the conventional method used by students. This difference can result in errors in solving contextual mathematics problems and the final results and conclusions are also wrong. Therefore, the use of AI in solving contextual mathematics problems requires caution and must be re-examined conventionally. Based on this, to face the challenge of AI invasion in learning, lecturers need to emphasize to students that solving contextual mathematics problems based on conventional concepts and methods is still very necessary even though AI also provides solution suggestions.

## CONCLUSION

The invasion of AI into the world of education, both secondary and university, can still be overcome with conventional learning, especially when solving contextual mathematics problems. Even though AI and students are able to use words or write mathematical symbols correctly, when illustrating pictures based on given conditions, solving problems with solution steps, and conveying arguments, AI still makes mistakes compared to conventional methods used by students. Therefore, it can be said that the invasion of AI into the world of education can still be prevented by providing contextual questions, in this research contextual mathematics questions, so that the impact can be avoided because AI still has shortcomings and errors in solving questions. Based on this, it is highly recommended that lecturers when carrying out exams should use contextual questions to give to students.

## REFERENCE

- [1] X. Zhai et al., "A Review of Artificial Intelligence (AI) in Education from 2010 to 2020," Complexity, vol. 2021, 2021.
- [2] S. Rifky, "Dampak Penggunaan Artificial Intelligence Bagi Pendidikan Tinggi," Indones. J. Multidiscip. Soc. Technol., vol. 2, no. 1, pp. 37–42, 2024.
- [3] I. Saputra, M. Astuti, M. Sayuti, and D. Kusumastuti, "Integration of Artificial Intelligence in Education: Opportunities, Challenges, Threats and Obstacles. A Literature Review.," Indones. J. Comput. Sci., vol. 12, no. 4, pp. 1590–1600, 2023.
- [4] A. Yang, "Challenges and Opportunities for Foreign Language Teachers in the Era of Artificial Intelligence," Int. J. Educ. Humanit., vol. 4, no. 1, pp. 39–50, 2024.
- [5] J. A. Muarif, F. A. Jihad, M. I. Alfadli, and D. I. Setiabudi, "Hubungan Perkembangan Teknologi Ai Terhadap Pembelajaran Mahasiswa," J. Pendidik. IPS, vol. 4, no. 2, pp. 53–60, 2023.
- [6] ..., E. Dhaniswara, O. Arifudin, and B. A. Rukiyanto, "Analisis Dampak Kolaborasi Pemanfaatan Artificial Intelligences (AI) Dan Kecerdasan Manusia Terhadap Dunia Pendidikan Di Indonesia," Innov. J. ..., vol. 4, pp. 9312–9319, 2024.
- [7] Y. Wardat, M. A. Tashtoush, R. AlAli, and S. Saleh, "Artificial Intelligence in Education: Mathematics Teachers' Perspectives, Practices and Challenges," Iraqi J. Comput. Sci. Math., vol. 5, no. 1, pp. 60–77, 2024.
- [8] W. A. Fitri and M. H. H. Dilia, "Optimalisasi Teknologi AI dalam Meningkatkan Efektivitas Pembelajaran," Cendekia Pendidik., vol. 4, no. 4, pp. 50–54, 2024.
- [9] Suariqi Diantama, "Pemanfaatan Artificial Intelegent (AI) Dalam Dunia Pendidikan," DEWANTECH J. Teknol. Pendidik., vol. 1, no. 1, pp. 8–14, 2023.

- [10] H. Zeinz, "Digitalization and A.I. as Challenges and Chances for Future Teaching and Teacher Education: A Reflection," *Beijing Int. Rev. Educ.*, vol. 1, no. 2–3, pp. 427–442, 2019.
- [11] K. Marlin et al., "Manfaat dan Tantangan Penggunaan Artificial Intelligences (AI) Chat GPT Terhadap Proses Pendidikan Etika dan Kompetensi Mahasiswa Di Perguruan Tinggi," *Innov. J. Soc. Sci. Res.*, vol. 3, no. 6, pp. 5192–5201, 2023.
- [12] N. Abdullah, L. Halim, and E. Zakaria, "VStops: A thinking strategy and visual representation approach in mathematical word problem solving toward enhancing STEM literacy," *Eurasia J. Math. Sci. Technol. Educ.*, 2014.
- [13] A. K. Jitendra et al., "Teaching Mathematical Word Problem Solving: The Quality of Evidence for Strategy Instruction Priming the Problem Structure," *J. Learn. Disabil.*, 2015.
- [14] L. S. Fuchs et al., "The role of cognitive processes, foundational math skill, and calculation accuracy and fluency in word-problem solving versus prealgebraic knowledge," *Dev. Psychol.*, 2016.
- [15] E. Novak and J. L. Tassell, "Studying preservice teacher math anxiety and mathematics performance in geometry, word, and non-word problem solving," *Learn. Individ. Differ.*, 2017.
- [16] K. Hoogland, J. de Koning, A. Bakker, B. E. U. Pepin, and K. Gravemeijer, "Changing representation in contextual mathematical problems from descriptive to depictive: The effect on students' performance," *Stud. Educ. Eval.*, 2018.
- [17] E. Putut, L. Emanuel, and F. Anam, "Sebuah Tinjauan Commognitive : Apakah Matriks Singular ?," *BRILIANT J. Ris. dan Konseptual*, vol. 7, no. 54, pp. 922–930, 2022.
- [18] E. P. L. Emanuel and Meilantifa, "Dimanakah Nilai Ekstrim Fungsi Kuadrat Ditinjau dari Lensa Commognitive ?," *BRILIANT J. Ris. dan Konseptual*, vol. 7, no. 54, pp. 269–279, 2022.
- [19] E. Putut, L. Emanuel, T. Nusantara, A. Rahman, and R. Rahardi, "Why am I confused ? Commognitive Conflict in Non-ordinary Question About Number Division," *J. Reatt. Ther. Dev. Divers.*, vol. 6, no. 5s, pp. 891–901, 2023.
- [20] E. Putut, L. Emanuel, T. Nusantara, and R. Rahardi, "Does Domain of Absolute Value Function Always Positive ? Commognitive-Conflict Analysis of Students of First Semester," *Qalamuna J. Pendidikan, Agama, dan Sos.*, vol. 16, no. 2, pp. 795–806, 2024.
- [21] N. Presmeg, "Commognition as a lens for research," *Educ. Stud. Math.*, 2016.
- [22] R. Toscano, J. M. Gavilán-Izquierdo, and V. Sánchez, "A study of pre-service primary teachers' discourse when solving didactic-mathematical tasks," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 15, no. 11, 2019.
- [23] V. Mudaly and S. Mpofu, "Learners' views on asymptotes of a hyperbola and exponential function: A commognitive approach," *Probl. Educ. 21st Century*, 2019.
- [24] A. Thoma and E. Nardi, "Transition from School to University Mathematics: Manifestations of Unresolved Commognitive Conflict in First Year Students' Examination Scripts," *Int. J. Res. Undergrad. Math. Educ.*, 2018.
- [25] D.-J. Kim et al., "Discourses of Functions – University Mathematics Teaching Through a Commognitive Lens," *Educ. Stud. Math.*, 2019.
- [26] T. Nachlieli and E. Heyd-Metzuyanim, "Commognitive conflicts as a learning mechanism towards explorative pedagogical discourse," *J. Math. Teach. Educ.*, 2021.
- [27] E. P. L. Emanuel, Y. G. Meidiana, and Suhartono, "Studi Komparasi Penggunaan Google Meet Dan Whatsapp Group Terhadap Hasil Belajar Siswa SMA Hangtuh 4 Surabaya," *Briliant J. Ris. dan Konseptual*, vol. 6, no. 4, pp. 849–853, 2021.

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- [30] A. Jamal, "The Role of Artificial Intelligence (AI) in Teacher Education: Opportunities & Challenges," *Int. J. Res. Anal. Rev.*, vol. 10, no. 1, pp. 139–146, 2023.
- [31] S. J. H. Yang, "Guest Editorial: Precision Education - A New Challenge for AI in Education," *Educ. Technol. Soc.*, vol. 24, no. 1, pp. 105–108, 2021.
- [32] E. Pratiwi, T. Nusantara, S. Susiswo, and M. Muksar, "Textual and contextual commognitive conflict students in solving an improper fraction," *J. Educ. Gift. Young Sci.*, 2020.
- [33] J. Lu, Y. Tao, J. Xu, and M. Stephens, "Commognitive responsibility shift and its visualizing in computer-supported one-to-one tutoring," *Interact. Learn. Environ.*, 2020.