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INTEGRATING AI LITERACY IN SOLVING LINEAR PROGRAMMING PROBLEMS: A STUDY WITH PROSPECTIVE TEACHERS USING MADURA BATIK CONTEXTS

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ABSTRACT

Linear programming is a crucial aspect of optimization mathematics. Prospective mathematics teachers are required to be proficient in solving linear programming problems using graphical methods, the simplex method, and computational technology. However, challenges such as modeling real-world problems, computational complexity, and difficulty understanding graphical visualizations often hinder understanding the material. This study aims to describe the solution of linear programming problems based on the local wisdom of Madurese batik, incorporating AI literacy tools such as ChatGPT, DeepSeek, Grok, Wolfram Alpha, and GeoGebra AI. This study employed a qualitative, descriptive approach. The subjects consisted of 23 prospective teachers, and three representative subjects were selected. The instruments used were a contextual problem of Madurese batik and an interview questionnaire. The results were analyzed and compared with the interview results. The results show that AI helps facilitate prospective teachers in solving linear programming problems. The research findings suggest that AI has transformative potential in mathematics learning for prospective teachers. AI improves efficiency, visual comprehension, flexibility, and confidence. However, challenges such as technological barriers and potential decreases in learning intensity need to be addressed through thoughtful pedagogical design. Prospective teachers must remain meticulous in problem-solving because AI can make mistakes. Prospective teachers may feel the need for intensive learning because problems can be easily solved by AI. AI should be viewed as a tool that supports exploration and understanding, not as a complete substitute for the learning process. Mathematics learning needs to integrate AI as an aid, not a replacement for manual skills.

Keywords: *Problem-solving, Linear Programming, Prospective Teachers, Artificial İntelligence Literacy, Batik.*

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INTRODUCTION

Linear programming is a mathematical discipline that focuses on optimizing linear functions with constraints in the form of linear equations or inequalities. In education, this material is taught to develop data-driven problem-solving and decision-making skills (Vanderbei, 2014). Prospective mathematics teachers, as learning facilitators, need to master solution methods such as graphical methods for two-variable problems, the simplex method for multivariable problems, and computational approaches for efficiency. However, research shows that prospective teachers often struggle to understand algorithmic steps, model contextual problems, and interpret graphical solutions (M. Baidawi, 2020; Hadi & Novita, 2019).

Linear programming involves finding the maximum or minimum value of an objective function with constraints in the form of a system of linear inequalities (M. Baidawi, 2019; Hillier & Lieberman, 2010). In higher education, this topic is taught to train prospective teachers in mathematical modeling, such as cost or resource optimization. Primary solution methods include graphical methods that depict the feasible region as the intersection of linear inequalities and determine optimal points at the vertices. The simplex method uses table iteration to find optimal solutions to multivariable problems. Computational approaches utilize software to speed up calculations and visualization.

Artificial intelligence (AI) offers solutions to simplify complex calculations, visualize abstract concepts, and provide instant feedback (Zawacki-Richter et al., 2019). Tools such as ChatGPT, DeepSeek, Wolfram Alpha, and GeoGebra enable rapid solution of linear equation systems and optimization problems, and provide interactive visual representations for understanding feasible regions and optimal points.

AI in education can improve the efficiency and effectiveness of learning through three main functions: computational automation; AI can solve matrix operations or systems of equations with high accuracy (Wolfram, 2010); interactive visualization; tools like GeoGebra allow users to manipulate graphs in real time, strengthening conceptual understanding (Preiner, 2008); and adaptive feedback; AI can detect errors in solution steps and suggest corrections (Chen et al., 2020). This study aims to describe the problem-solving ability of prospective mathematics teachers in solving linear programming problems using Madura Batik contexts, supported by artificial intelligence literacy

METHOD

This study used a qualitative approach with a descriptive research type. This study aims to describe the solution of linear programming problems in the context of Madura batik using AI literacy. The subjects of this study consisted of 23 prospective mathematics teachers from the Mathematics Education study program at a university in Malang, and three relevant answers were selected. The research instruments were linear programming problems with the context of Madurese batik and a validated interview sheet. In the research procedure, prospective teachers were given a linear programming problem, and then solved the linear programming problem using AI literacy. After the prospective teachers completed the problem, they were continued with interviewed. Data analysis was carried out based on the results of the problem solving and the interview results.

RESULT

This study presents prospective teachers with a linear programming problem based on the local wisdom of Madurese batik. The prospective teachers then solve the problem using AI literacy. The linear programming problem presented to the prospective teachers is as follows:

> A Madurese batik entrepreneur produces three types of batik. Marine biota motif batik, plant motif batik, and geometric motif batik. The three types of batik require the following resources: marine motif batik, 3 hours; leaf motif, 2 hours; and geometric motif, 4 hours, with a total of 240 hours of batik time available. Batik dyes utilize natural dyes, while marine biota motifs require 2 liters of natural dye, leaf motifs 3 liters, and geometric motifs 2 liters, with a maximum availability of natural dyes at 180 liters. This batik production requires craftsmen. Marine biota motif batik requires 4 craftsmen, leaf motifs 2 people, and geometric motifs 3 people, with a maximum availability of 270 people. The profit from each type of batik, leaf motif batik, Rp. 100,000 per sheet, leaf motif Rp. 80,000 per sheet, geometric motifs 90,000 per sheet. The questions are: 1) State the mathematical model of the problem in the form of a system of linear inequalities and its objective function. 2)

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Determine the combination of batik production to achieve maximum profit. 3) Calculate the maximum profit that can be obtained.

From this linear programming problem, prospective teachers solve it by modeling it in a linear programming language, determining the constraint function, the objective function, and the optimal value using AI.

The results of completing Subject 1 are as follows,

Misalkan:

- - x = jumlah batik motif biota laut yang diproduksi (lembar)
- - y = jumlah batik motif daun yang diproduksi (lembar)
- - z = jumlah batik motif geometris yang diproduksi (lembar)

Fungsi Tujuan:

Maksimalkan Z = 100.000x + 80.000y + 90.000z

Kendala-kendala:

1. Waktu membatik maksimal 240 jam: $3x + 2y + 4z \leq 240$

2. Pewarna alami maksimal 180 liter: $2x + 3y + 2z \leq 180$

3. Tenaga pengrajin maksimal 270 orang: $4x + 2y + 3z \leq 270$

4. Syarat non-negatif: $x \geq 0, y \geq 0, z \geq 0$

Figure 1. Determining the Constraint Function and Objective Function

From Figure 1, it can be explained that the variable determination is correct, and the constraint function is correct. With this, prospective teachers can determine the variables and the objective function correctly. Next, solving the problem using the simplex method with iteration using AI as in Figure 2, found the value of x = 30, the value of y = 0, and the value of z = 30. As in Figure 3, the optimum value is obtained at 5,700,000.

Basis	x	y	z	s_1	s_2	s_3	RHS
s_1	3	2	4	1	0	0	240
s_2	2	3	2	0	1	0	180
s_3	4	2	3	0	0	1	270
Z	-100000	-80000	-90000	0	0	0	0

Figure 2: Simplex Table

Melalui perhitungan (baik manual atau dengan software), diperoleh:

x = 30 (motif biota laut)

y = 0 (motif daun)

z = 30 (motif geometris)

Z = 100.000(30) + 80.000(0) + 90.000(30) = Rp. 5.700.000

Figure 3: Optimal Solution

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Furthermore, the results of Subject 2's work are as follows,

Langkah 1: Definisikan Variabel

Misalkan:

- $x = jumlah\ batik\ motif\ biota\ laut$
- $y = jumlah\ batik\ motif\ tumbuhan$
- $z = jumlah\ batik\ motif\ geometris$

Figure 4: Mathematical model of the linear programming problem

Subject 2 determines the variables of each number of batik motifs, then continues by modeling the linear programming problem with a mathematical model.

Langkah 2: Model Matematika

Fungsi Objektif (Tujuan):

Maksimalkan keuntungan:

$$Maks\ L = 100.000x + 80.000y + 90.000z$$

Kendala:

1. Waktu membatik (jam):
$$3x + 2y + 4z \leq 240$$
2. Pewarna alami (liter):
$$2x + 3y + 2z \leq 180$$
3. Tenaga kerja (orang):
$$4x + 2y + 3z \leq 270$$
4. Tidak boleh negatif:
$$x \geq 0, y \geq 0, z \geq 0x$$

Figure 5: Mathematical model of the linear programming problem

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Subject 2 continues by finding the optimal value as follows,

Langkah 3: Menentukan Kombinasi Produksi Optimal

Coba beberapa kombinasi untuk memaksimalkan L, dengan tetap memenuhi semua kendala.

Percobaan 1: $x = 30, y = 30, z = 0$

- Cek kendala:
  - $Waktu$: $3(30) + 2(30) + 4(0) = 90 + 60 = 150 \leq 240$
  - $Pewarna$: $2(30) + 3(30) + 2(0) = 60 + 90 = 150 \leq 180$
  - $Tenaga$: $4(30) + 2(30) + 3(0) = 120 + 60 = 180 \leq 270$
- Keuntungan:

  $100.000(30) + 80.000(30) + 90.000(0) = 3.000.000 + 2.400.000 = 5.400.000$

Percobaan 2: $x = 20, y = 20, z = 20$

- $Waktu$: $3(20) + 2(20) + 4(20) = 60 + 40 + 80 = 180$
- $Pewarna$: $2(20) + 3(20) + 2(20) = 40 + 60 + 40 = 140$
- $Tenaga$: $4(20) + 2(20) + 3(20) = 80 + 40 + 60 = 180$
- Keuntungan:

  $100.000(20) + 80.000(20) + 90.000(20) = 2.000.000 + 1.600.000 + 1.800.000 = 5.400.000$

Percobaan 3: $x = 20, y = 30, z = 10$

- $Waktu$: $3(20) + 2(30) + 4(10) = 60 + 60 + 40 = 160$
- $Pewarna$: $2(20) + 3(30) + 2(10) = 40 + 90 + 20 = 150$
- $Tenaga$: $4(20) + 2(30) + 3(10) = 80 + 60 + 30 = 170$
- Keuntungan:

  $100.000(20) + 80.000(30) + 90.000(10) = 2.000.000 + 2.400.000 + 900.000 = 5.300.000$

Figure 6: Searching for Optimal Solutions

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After the optimal solution was found, subject 2 summarized his answer as follows,

Langkah 4: Jawaban Akhir

1) Model Matematika:

$$Maksimalkan\ L = 100.000x + 80.000y + 90.000z$$

dengan kendala:

$$\begin{cases} 3x + 2y + 4z \leq 240 \\ 2x + 3y + 2z \leq 180 \\ 4x + 2y + 3z \leq 270 \\ x, y, z \geq 0 \end{cases}$$

2) Kombinasi Produksi Optimal:

Salah satu kombinasi optimal adalah:

$$x = 30, y = 30, z = 0 \qquad atau \qquad x = 20, y = 20, z = 20$$

3) Keuntungan Maksimum:

$$Rp\ 5.400.000$$

Figure 7: Summary of Subject 2's Work Results

Subject 2 solves the problem by first determining the variables and then continuing by modeling the linear programming problem with a mathematical model, then determining the optimum solution, and providing a summary of the results of his work.

Subject 3 solves the linear programming problem as follows,

Diketahui:

Misalkan:

x = jumlah batik **motif biota laut**

y = jumlah batik **motif daun**

z = jumlah batik **motif geometris**

Figure 8: Determining the variable number of batik motifs

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a. Kendala waktu:

- Biota laut: 3 jam
- Motif daun: 2 jam
- Geometris: 4 jam
  Ketersediaan: 240 jam

$$3x+2y+4z\leq 240$$

b. Kendala pewarna:

- Biota laut: 2 liter
- Daun: 3 liter
- Geometris: 2 liter
  Ketersediaan: 180 liter

$$2x+3y+2z\leq 180$$

d. Kendala non-negatif:

$$x\geq 0, y\geq 0, z\geq 0$$

Fungsi tujuan (fungsi keuntungan):

- Keuntungan per lembar:
  - Biota laut: Rp 100.000
  - Daun: Rp 80.000
  - Geometris: Rp 90.000

Maksimalkan $Z=100{,}000x+80{,}000y+90{,}000z$

Figure 9: Determining the constraint function and objective function

The results of Subject 3's work in Figures 7 and 8 in determining the variables and constraint functions are correct.

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2) Menentukan kombinasi produksi optimal

Kita akan gunakan metode **Simplex** atau software pemrograman linear (karena 3 variabel).

Untuk saat ini, kita bisa menghitung dengan pendekatan numerik memakai **Excel Solver**, **GeoGebra**, atau menyelesaikan secara manual jika kasusnya sederhana.

Namun, saya akan selesaikan di sini dengan pendekatan numerik cepat:

Kita coba **uji beberapa titik sudut** (corner points) dari sistem pertidaksamaan:

x	y	z	Cek kendala	Hitung Z
0	0	0	semua kendala terpenuhi	0
0	0	60	4×60=240 jam, 2×60=120 liter, 3×60=180 orang	90,000×60=5,400,000
0	60	0	2×60=120 jam, 3×60=180 liter, 2×60=120 orang	80,000×60=4,800,000
80	0	0	3×80=240 jam, 2×80=160 liter, 4×80=320 melebihi tenaga	
60	0	0	3×60=180 jam, 2×60=120 liter, 4×60=240 orang	100,000×60=6,000,000

Sudah terlihat bahwa:

- x=60,y=0,z=0 memberikan **Z = Rp 6.000.000** dan **memenuhi semua kendala**.

Figure 10: Determining the optimum value using Excel solver

Subject 3 in determining the optimum value using a numerical approach obtained the results as in Figure 10. From the calculation results obtained the optimal value of IDR 6,000,000.

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3) Jawaban akhir:

Model Matematika:

Maksimalkan Z=100,000x+80,000y+90,000z

dengan:

$3x+2y+4z \leq 240$

$2x+3y+2z \leq 180$

$4x+2y+3z \leq 270$

$x \geq 0, y \geq 0, z \geq 0$

Kombinasi Produksi Optimal:

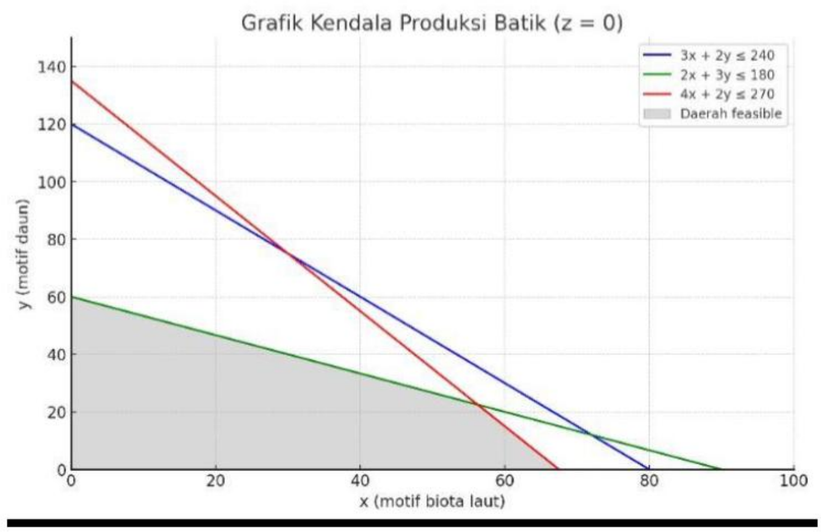
$x=60, y=0, z=0$

(Hanya memproduksi 60 batik motif biota laut)

Keuntungan Maksimum:

$Z=100,000 \times 60=$Rp 6.000.000

Figure 11: Answer Summary



Berikut adalah grafik sistem pertidaksamaan produksi batik:

- Garis-garis warna mewakili kendala:
  - Biru: waktu membatik
  - Hijau: pewarna alami
  - Merah: tenaga kerja
- Daerah abu-abu adalah daerah layak (feasible region) yang memenuhi semua kendala.
- Titik hitam (60, 0) adalah titik optimum, yaitu kombinasi produksi 60 batik motif

Figure 12. Graph of the solution to the linear programming problem

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Subject 3's work in Figure 12 is still inaccurate. This is because the variables in the constraint function consist of three variables and three equations. When graphed, the result is three-dimensional. This suggests that AI also has limitations, meaning its answers aren't always correct.

From the interview results, prospective teachers felt helped by AI but needed to be re-digested because AI answers can be wrong. As shown in the following interview, my experience when using AI was very helpful when I tried to solve a problem, but could not find the answer. By getting answers from AI, I was able to study it further and also understand it, however, I also had to be careful because sometimes AI also makes mistakes. AI helped prospective teachers in visualizing graphs, as the following statement: GeoGebra AI is very helpful for graphic visualization. I can directly see the area of the solution set and the position of the maximum or minimum points interactively. This made me more quickly grasp the relationship between constraints and solutions. AI reduces the learning intensity of prospective teachers, believing it can solve all their problems. As the following statement suggests, AI also has a negative impact on me, as it reduces my learning time, as it can be done through AI.

DISCUSSION

This research yielded five main themes reflecting the experiences and perceptions of prospective teachers in solving linear programming (LP) problems using artificial intelligence (AI). Each theme reflects both the benefits and challenges of integrating intelligent technology into mathematics education.

The use of AI has been shown to increase time efficiency in solving simplex problems. AI automates iterative calculations that would otherwise be time-consuming when performed manually. According to Jiang & Kong (2020), AI in mathematics learning can reduce the cognitive load associated with complex procedures and increase focus on conceptual understanding.

AI provides interactive visual representations, such as 2D/3D graphs of feasible regions, objective functions, and constraint boundaries, which help clarify relationships between variables. Zhou et al. (2021) found that AI-based visual representations improved students' understanding of abstract mathematical concepts through direct interaction.

The use of AI increased prospective teachers' confidence due to the instant feedback and reduced fear of calculation errors. A study by Nguyen et al. (2020) found that AI-based systems that provide real-time support can improve students' self-efficacy in completing complex tasks.

AI allows the exploration of various problem-solving strategies without the worry of making procedural errors. This creates a more flexible learning environment and supports trial-and-error-based learning. Research by Lee & Yun (2022) shows that the flexibility offered by AI in mathematics education encourages increased engagement and metacognitive reflection.

Although AI is very helpful, some prospective teachers experience initial difficulties in using this technology due to limited digital experience. Consistent with the findings of Park & Kim (2019), digital barriers remain a significant issue in the implementation of educational technology.

Some prospective teachers feel that with AI, they no longer need to learn the simplex method, as the system will handle the entire process. However, according to Wang et al. (2023), there is a risk of excessive cognitive offloading if the technology is not accompanied by appropriate pedagogical guidance.

The results of the study show that AI significantly improves prospective teachers' ability to solve linear programming problems, particularly in visualization and contextual modeling. AI reduces the cognitive load in matrix calculations, allowing focus on solution interpretation. This is in line with Heung and Cheu (2025) who stated that the use of AI has an effective impact

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on engaging prospective teachers' cognition in learning. With its interactive features, it helps prospective teachers intuitively understand the concepts of feasible regions and optimal points. This finding supports the research of Chen et al. (2020), which asserts that AI-based visualization can strengthen conceptual understanding.

However, barriers to digital literacy highlight the need for more intensive technology training. Furthermore, reliance on AI can weaken manual skills, which remain crucial in classroom instruction without access to technology (Hadi & Novita, 2019). A hybrid approach, combining manual and AI methods, could be a solution to balance technical and technological competencies.

CONCLUSION AND SUGGESTIONS

This research shows that AI has transformative potential in mathematics learning for prospective teachers. AI improves efficiency, visual comprehension, flexibility, and confidence. However, challenges such as technological barriers and potential learning impairments need to be addressed through thoughtful pedagogical design. AI should be viewed as a tool that supports exploration and understanding, not as a complete substitute for the learning process.

This study confirms that artificial intelligence (AI) tools such as ChatGpt, DeepSeek, Wolfram Alpha, and GeoGebra significantly improve the skills of prospective mathematics teachers in solving linear programming problems. AI not only speeds up calculations and simplifies visualization, but also increases confidence and learning flexibility. However, digital literacy challenges emphasize the importance of adequate technology training. Furthermore, the use of AI in problem-solving needs to be re-evaluated, as AI solutions can be flawed. This study recommends integrating AI into mathematics learning with a hybrid approach to ensure a balance between manual skills and technology.

Educational institutions should develop technology training modules to improve the digital literacy of prospective teachers before using AI. Further research could explore the integration of AI in other mathematical topics, such as analytical geometry or statistics. Developing more intuitive and user-friendly AI tools can reduce technical barriers. Mathematics instruction needs to include explicit guidance on using AI as a tool, not a substitute for manual skills.

REFERENCES

Baidawi M., Pertiwi RI., Esti EAJ., (2019). The portrait of learning the linear program in ındonesian universities. 6th ınternational conference on community development. *Atlantis Press. Advances in Social Science, Education and Humanities Research, volume 349*. https://doi.org/10.2991/iccd-19.2019.92

Baidawi, M., Pertiwi, RI, & Esti, EAJ (2020). Needs of students and lecturers on linear programming as an ınstructional strategy in solving national economic problems: comparison. *Anatolian Journal of Education, 5(2),* 143-150. https://doi.org/10.29333/aje.2020.5212a

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology: qualitative research in psychology, 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: a review. *IEEE Access, 8* , 75264–75278. https://doi.org/10.1109/ACCESS.2020.2988510

GeoGebra. (2024). Interactive mathematics learning tools . Accessed from https://www.geogebra.org

Hadi, S., & Novita, R. (2019). Students' difficulties in solving linear programming problems in mathematics education. *Journal of Physics: Conference Series, 1320 (1),* 012087. https://doi.org/10.1088/1742-6596/1320/1/012087

Jurnal Pendidikan Matematika (JPM) is licensed under a Creative Commons Attribution 4.0 International License

Hillier, F.S., & Lieberman, G.J. (2010). Introduction to operations research (9th ed.). McGraw-Hill.

Jiang, X., & Kong, S. C. (2020). The effects of an Aİ-based learning tool on students' conceptual understanding ın mathematics. *Computers & Education*, 150, 103850. https://doi.org/10.1016/j.compedu.2020.103850

Lee, H. J., & Yun, H. (2022). Exploring metacognitive learning through ai-powered mathematics environments. *International Journal of STEM Education*, 9(1), 34. https://doi.org/10.1186/s40594-022-00323-z

National Council of Teachers of Mathematics (NCTM). (2000). Principles and standards for school mathematics . NCTM.

Nguyen, T., Tang, X., & Wang, Z. (2020). Enhancing student confidence through aı-based learning analytics feedback ın higher education. *British Journal Of Educational Technology*, 51(5), 1524–1540. https://doi.org/10.1111/bjet.12940

Park, M., & Kim, H. (2019). Barriers to ıntegrating AI tools ın teacher education: a review of digital readiness. *Educational Technology Research and Development*, 67(4), 963–984. https://doi.org/10.1007/s11423-019-09655-4

Preiner, J. (2008). Geogebra: free dynamic mathematics software for all levels of education. *International Journal of Emerging Technologies in Learning, 3 (1)*, 23–28.

Vanderbei, R. J. (2014). Linear programming: foundations and extensions (4th ed.). *Springer.*

Wang, R., Zhang, Y., & Huang, L. (2023). Balancing AI Use And Deep Learning: An Empirical Study On Cognitive Offloading In STEM Education. Journal of Educational Computing Research, 61(2), 345–367. https://doi.org/10.1177/07356331231112345

Wolfram Research. (2024). Wolfram alpha: computational ıntelligence . Retrieved from https://www.wolframalpha.com

Wolfram, S. (2010). The wolfram alpha computational data engine. *Journal of Computational Science,* 1 (2), 65–70.

YME, Heung. & TKF, Chiu. (2025) How chatgpt ımpacts student engagement from a systematic review and meta-analysis study, *Computers and Education: Artificial Intelligence,* vol 8, 100361, https://doi.org/10.1016/j.caeai.2025.100361

Zawacki-Richter, O., Marín, VI, Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education. *International Journal of Educational Technology in Higher Education, 16 (1)*, 39. https://doi.org/10.1186/s41239-019-0171-0

Zhou, Y., Chen, L., & Tsai, M. J. (2021). The role of aı-based visualization ın mathematical problem solving: ımpacts on student understanding. *Interactive Learning Environments*, 29(7), 1043–1059. https://doi.org/10.1080/10494820.2020.1737278

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