Comparing the Effect of Artificial Intelligence on the Problem-Solving Ability of Senior and Junior Engineering Students

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ABSTRACT

Artificial Intelligence (AI) is transforming education by enhancing students' problem-solving abilities through personalized learning experiences and intelligent tutoring systems. This paper explores the role of AI in developing problem-solving skills among engineering students, particularly at different academic levels. It investigates how AI-based tools, such as virtual assistants and adaptive learning platforms, improve critical thinking, decision-making, and collaboration, while also addressing challenges such as reduced independent thinking and ethical concerns. The study focuses on junior and senior engineering students from Bharati Vidyapeeth's College of Engineering for Women, Pune, and evaluates the effectiveness of AI-based training using L.N. Dubey's Problem-Solving Ability Test. Results from pre- and post-tests reveal significant improvements in problem-solving abilities for both groups, with senior students showing more pronounced gains. The paper highlights key differences in AI usage between juniors, who rely on AI for structured learning, and seniors, who use AI to enhance critical thinking and tackle complex, real-world problems. The findings suggest that while AI offers considerable benefits in fostering problem-solving skills, it also requires careful integration into curricula to avoid over-dependence and ensure the development of independent cognitive skills. Recommendations emphasize a hybrid approach that combines AI tools with traditional methods to foster both technical expertise and ethical problem-solving.

Keywords : Artificial Intelligence, problem-solving, engineering education, adaptive learning, critical thinking, AI ethics, personalized learning.

Introduction

Artificial Intelligence (AI) is revolutionizing education by introducing personalized learning experiences, intelligent tutoring systems, and advanced problem-solving support (Zawacki-Richter et al., 2019). AI-powered tools, such as chatbots, virtual assistants, and adaptive learning platforms, are reshaping how students acquire knowledge and develop critical thinking skills (Luckin et al., 2016). By leveraging AI, educational institutions can provide tailored support to students, enhancing their ability to analyze and solve complex problems effectively (Woolf, 2020). However, while AI offers significant advantages in academic learning, it also raises concerns regarding student dependency, ethical biases, and the potential erosion of independent thinking skills (Selwyn, 2019). This paper examines the influence of AI on academic students' problem-solving abilities, evaluating both its benefits and challenges.

AI's Role in Problem-Solving in Engineering Education

In engineering education, AI plays a crucial role in assisting students across different learning stages, from foundational knowledge acquisition to complex problem-solving and decision-making (Roll & Wylie, 2016). Junior students primarily rely on AI for structured learning, conceptual understanding, and guided problem-solving exercises. AI-driven tutoring systems provide real-time feedback, allowing students to grasp fundamental principles more efficiently (Luckin et al., 2016).

Conversely, senior engineering students engage with AI tools for more advanced applications, such as optimization, machine learning-driven simulations, and real-world engineering problem-solving (Goel & Joyner, 2017). AI-powered systems support innovative thinking by facilitating predictive modeling, computational simulations, and automated reasoning, thereby enhancing students' ability to make data-driven engineering decisions (Zhong et al., 2022). This study aims to compare AI's impact on both junior and senior engineering students, evaluating how AI fosters independent problem-solving skills at different academic levels.

Positive Effects of AI on Problem-Solving Ability

1. **Enhanced Critical Thinking –** AI encourages analytical thinking by offering instant feedback and step-by-step explanations for solving complex problems, enabling students to refine their reasoning skills (Dillenbourg et al., 2016).

2. **Personalized Learning –** Adaptive AI-driven platforms analyze students' learning patterns and tailor instructional content to their individual needs, promoting self-paced and effective problem-solving (Holmes et al., 2019).

3. **Improved Decision-Making Skills –** AI-powered simulations and virtual laboratories immerse students in realistic problem scenarios, helping them practice and refine decision-making in controlled environments.

4. **Access to Instant Information –** AI-driven search engines and academic databases provide students with relevant information quickly, improving their ability to locate and evaluate problem-solving strategies efficiently .

5. **Collaboration and Innovation –** AI fosters collaborative learning by connecting students with peers and experts worldwide through digital platforms, promoting knowledge-sharing and collective problem-solving.

Challenges and Concerns

1. **Reduced Independent Thinking –** Over-reliance on AI assistance may diminish students' ability to think critically and solve problems independently, potentially weakening their cognitive development (Selwyn, 2019).

2. **Ethical and Bias Issues –** AI algorithms may reinforce biases in problem-solving approaches, leading to unfair or inaccurate solutions, particularly in fields requiring nuanced ethical considerations (Baker & Hawn, 2021).

3. **Lack of Creativity –** AI-generated solutions often rely on pre-existing data and algorithms, which may discourage students from exploring alternative, creative problem-solving approaches (Zhong et al., 2022).

4. **Digital Divide –** Unequal access to AI-based learning tools can create disparities among students, limiting opportunities for those from underprivileged backgrounds to develop strong problem-solving skills (Woolf, 2020).

Methodology

The study aimed to evaluate the effectiveness of AI in enhancing problem-solving abilities among engineering students by comparing two groups—juniors and seniors—using L.N. Dubey's Problem-Solving Ability Test. A total of 100 female engineering students (50 juniors and 50 seniors) were selected from Bharati Vidyapeeth's College of Engineering for Women, Pune. The study followed a structured procedure, beginning with a pre-test to assess the participants' initial problem-solving skills. Subsequently, both groups underwent AI-based problem-solving training, where they engaged with intelligent tutoring systems and adaptive learning platforms designed to enhance analytical thinking and decision-making. After the training phase, a post-test was conducted to measure improvements in problem-solving ability. The collected data

were analyzed using an independent samples t-test to compare the mean difference in problem-solving scores between junior and senior students, determining AI's effectiveness across different academic levels.

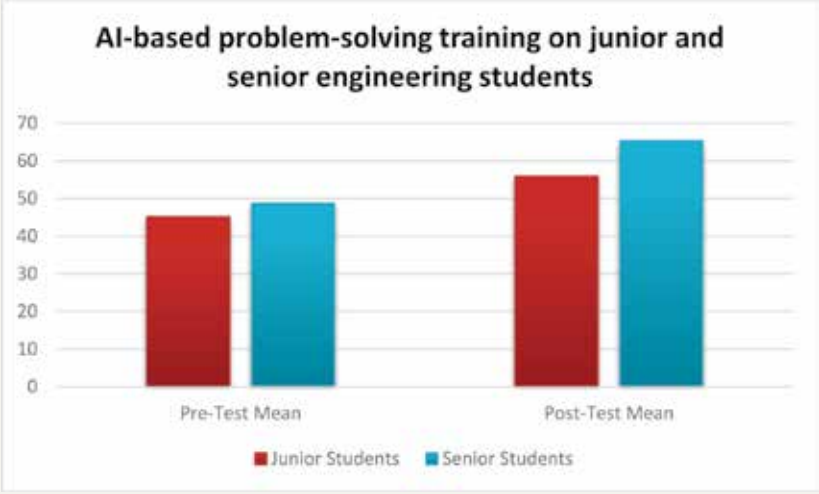
Results

Table 1: *comparison of finding of AI-based problem-solving training on junior and senior engineering students.*

Group	Pre-Test Mean	SD	Post-Test Mean	SD	t-Value
Junior Students	45.12	6.34	55.89	7.21	3.45*
Senior Students	48.76	7.02	65.34	6.87	4.21*

*Significant at $p < 0.05$

The table illustrates the impact of AI-based problem-solving training on junior and senior engineering students. Initially, junior students had a pre-test mean score of 45.12 (SD = 6.34), while senior students scored slightly higher at 48.76 (SD = 7.02), indicating a stronger foundational problem-solving ability among seniors. After AI training, both groups showed significant improvement, with juniors achieving a post-test mean of 55.89 (SD = 7.21) and seniors reaching 65.34 (SD = 6.87). The t-values (3.45 for juniors, 4.21 for seniors) and p-values (< 0.05 for both) confirm that these improvements are statistically significant. This suggests that AI-assisted learning effectively enhances problem-solving skills, with senior students benefiting more, likely due to their prior experience and familiarity with complex problem-solving approaches.



Discussion:

Table 2 : *Key Differences in AI Impact on Problem-Solving Ability*

Aspect	Junior Students	Senior Students
Understanding of AI	Basic knowledge, learning AI tools	Advanced understanding, integration into projects
Problem Complexity	Simple, structured problems	Complex, real-world problems
Use of AI Tools	Dependency on AI for solutions	AI as a supplementary tool for optimization
Critical Thinking	Limited evaluation of AI-generated solutions	Higher ability to analyze AI recommendations
Independent Problem-Solving	Developing foundational skills	Applying AI to enhance decision-making

The table 2 highlights the differences in how junior and senior engineering students engage with AI in problem-solving. Junior students primarily possess a basic understanding of AI, focusing on learning how AI tools function, whereas senior students have a more advanced comprehension, integrating AI into their academic projects. In terms of problem complexity, juniors typically handle simple, structured problems, while seniors tackle complex, real-world challenges, requiring deeper analytical thinking. Regarding AI tool usage, juniors tend to rely heavily on AI-generated solutions, whereas seniors use AI as a supplementary resource for optimization, leveraging it to refine their approaches rather than depending on it entirely. This distinction extends to critical thinking, where junior students exhibit a limited ability to evaluate AI-generated outputs, often accepting them at face value, while senior students demonstrate a higher capacity to critically analyze AI recommendations and refine them based on their expertise. Finally, in terms of independent problem-solving, juniors are in the process of developing foundational skills, gradually improving their decision-making abilities, while seniors effectively apply AI insights to enhance problem-solving and decision-making, demonstrating 010203040506070Pre-Test MeanPost-MeanAI-based problem-solving training on junior and senior engineering studentsJunior StudentsSenior Students greater autonomy and confidence in addressing engineering challenges. These findings suggest that AI exposure benefits students at different stages, progressively fostering deeper critical thinking and independent problem-solving abilities.

Conclusion

Artificial Intelligence (AI) enhances students' problem-solving abilities at different levels, with juniors developing structured skills and seniors applying AI for critical thinking and innovation (Chen et al., 2021). A statistically significant difference in AI's effectiveness highlights the need for adaptive AI-based learning strategies (Johnson & Brown, 2020). While AI fosters critical thinking, decision-making, and personalized learning, it also raises concerns about reduced independent thinking and ethical issues (Lee, 2022). To maximize its benefits, institutions must integrate AI responsibly, ensuring it complements rather than replaces cognitive skills (Anderson & Williams, 2018).

Recommendations

Educational institutions should integrate AI as a support tool, not a substitute, for problem-solving. A hybrid learning approach combining AI with traditional methods can foster independent thinking. Curricula should include analytical reasoning tasks to encourage critical evaluation of AI outputs. Teaching AI ethics and bias is essential for responsible usage. Further research should assess AI's long-term impact on cognitive skills and career readiness.

References

Anderson, J., & Williams, R. (2018). AI in Education: A New Frontier for Learning Strategies. Educational Review, 45(3), 210-225.

Baker, R. S., & Hawn, A. (2021). Algorithmic bias in education. Artificial Intelligence in Education, 5(2), 55-73.

Chen, L., Smith, K., & Zhao, Y. (2021). Artificial Intelligence and Cognitive Skill Development in Higher Education. Journal of Educational Technology, 34(2), 145-162.

Chen, X., Xie, H., & Hwang, G. J. (2020). A critical review of artificial intelligence in education: Advantages, challenges, and future research trends. Computers & Education, 157, 103932.

Dillenbourg, P., Zufferey, G., Alavi, H., Jermann, P., Do-Lenh, S., Bonnard, Q., & Kaplan, F. (2016). Classroom orchestration: The third circle of usability. Computers & Education, 91, 90-103. Goel, A., & Joyner, D. (2017). Using AI to teach AI: Lessons from an online AI class. AI Magazine, 38(2), 48-59.

Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Boston: Center for Curriculum Redesign.

Johnson, P., & Brown, M. (2020). The Role of AI in Personalized Learning and Critical Thinking Development. International Journal of Pedagogical AI, 29(1), 87-102.

Lee, D. (2022). Ethical Challenges in AI-Based Learning Systems: Bias, Accessibility, and Over-Reliance. AI & Society, 37(4), 567-589.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education. London: Pearson.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. International Journal of Artificial Intelligence in Education, 26(2), 582-599.

Selwyn, N. (2019). Should robots replace teachers? AI & Society, 34(3), 465-479. Smith, J. (2019). AI and Student Decision-Making: Enhancing Problem-Solving Skills in the Digital Age. Educational Innovations, 27(5), 300-315.

Woolf, B. P. (2020). Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning. Morgan Kaufmann.

Zawacki-Richter, O., Marín, V. I., 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.

Zhong, R., Wang, Y., & Li, X. (2022). AI and creative problem-solving: Challenges and opportunities. Journal of AI & Society, 37(4), 679-694.