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Impact of AI-Based Learning Tools on Students' Problem-Solving Ability

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Abstract:
AI-based learning technologies are transforming the world of education by providing dynamic feedback, customized learning experiences, intelligent tutorials, automated hints and problem-centered help. In this paper, the authors will discuss the effects of AI-based learning tools on students in modern educational environments on their ability to solve problems. Problem-solving is an essential higher-order cognitive ability, which implies finding the problems, analyzing information, creating options, experimenting with strategies, and weighing the results. Intelligent tutoring systems, adaptive learning platforms, chatbots, automated assessment systems, and AI-assisted simulations are examples of AI tools increasingly mediating such processes by assisting students in completing complex tasks and providing real-time assistance. The paper states that AI can increase the problem-solving skill of students in the context of scaffolding inquiry, formative feedback, and metacognition support. Nevertheless, AI can be used to enhance learning through pedagogical design, learner autonomy, teacher mediation, and ethical applications. The high dependence on AI-generated solutions can hinder critical thinking once students opt to rely on the systems only to get answers instead of coming up with the reasoning mechanisms. Based on the perspectives of constructivism, socio-cognitive, and self-regulated learning, this paper suggests five research objectives and three hypotheses on how AI-based learning tools and problem-solving outcomes relate to each other. The literature review reveals that AI-based learning systems are able to enhance engagement, conceptual learning, adaptive decision-making, and strategic thinking, particularly in mathematics, science, and technology-intensive project work. Simultaneously, the issues of bias, digital inequality, less cognitive effort, and low teacher preparedness remain important. The paper concludes that AI-based learning tools may have a positive influence on the problem-solving capability of students when implemented as a part of reflective, inquiry-driven, and ethically guided learning and not as the use of shortcuts to complete tasks.

Keywords: intelligent tutoring systems, problem-solving ability, artificial intelligence, adaptive learning, students.

1. Introduction

The ability to solve a problem has emerged one of the most significant learning outcomes in the 21st century since learners are not only supposed to memorize data, but also, learners have to think, analyze, and use the knowledge in new problems and analyze alternatives and make informed choices. Problem-solving in school education is directly related to academic performance, and innovation and employability in higher education. Meanwhile, the digital technologies, particularly the artificial intelligence (AI)-based educational tools, are rapidly transforming the classroom and now assist in tutoring, assessment, feedback, simulation, and personalized learning (Holmes, Bialik, and Fadel, 2019).

Educational technologies that adapt instruction and support learning tasks by using machine learning, natural language processing, learner analytics, or rule-based systems are called AI-based learning tools. They are intelligent tutoring systems, adaptive platforms, AI chatbots, automated writing assistants, recommendation engines, and virtual problem-solving environments (Luckin, Holmes, Griffiths, and Forcier, 2016; Zawacki-Richter, Marin, Bond, and Gouverneur, 2019). This has led to an interest in their increasing role in education, which has spawned questions of whether they enhance higher-order cognitive performance in students, and in particular, problem-solving skills.

Problem solving entails problem insight, choice of strategies, process tracking and performance evaluation. Artificial intelligence could assist these phases by providing guidelines, clues, stepwise instructions, real-time feedback, and adaptable learning journeys. As an illustration, a smart tutoring system may identify student mistakes and offer specified scaffolds whereas a chatting AI may assist students to clarify arguments, critically evaluate alternatives, and hone answers. Efficiency and strategic thinking may be improved with such functions.

However, AI has a positive impact on problem-solving not necessarily. The students can develop the addictive attitude toward automated assistance, unquestioningly take the output of AI, or provide superficial answers instead of profound reasoning. That is why the key question does not lie in the presence of AI in the educational field, but in its pedagogical application. To determine how AI-based learning tools affect the problem-solving skill of students, the paper introduces research objectives, hypotheses, a literature review, a conceptual framework, a discussion on the analysis, tables, and an illustrative graph to explain how AI-supported learning and problem-solving development are related to one another.

2. Research Objectives

1. To examine the relationship between AI-based learning tools and students' problem-solving ability.
2. To identify which types of AI-based learning tools most effectively support problem-solving processes.
3. To analyze the pedagogical conditions under which AI improves students' strategic and independent thinking.
4. To explore the risks of overdependence on AI tools in relation to problem-solving performance.
5. To suggest educational strategies for integrating AI tools in ways that strengthen rather than weaken student reasoning.

3. Research Hypotheses

H1: The use of AI-based learning tools has a significant positive effect on students' problem-solving ability.
H2: AI-based learning tools improve problem-solving ability more effectively when they provide adaptive feedback and guided scaffolding than when they simply generate answers.
H3: The positive relationship between AI-based learning tools and students' problem-solving ability is moderated by teacher guidance, student self-regulation, and task design.

4. Literature Review

AI in education has evolved since the first intelligent tutoring systems to modern adaptive platforms and generative AI systems. The current literature implies AI can affect the learning process of students by customizing learning, identifying confusion, and facilitating the learning environment with the rich feedback (Luckin et al., 2016). Among the most compelling theoretical arguments in support of AI in education, it is possible to state that it can support students when completing complicated assignments, which leads to the increased efficiency of learning and high-order thinking.

The ability to solve problems is often considered to be the one that allows to analyze a problem, come up with potential solutions, select an appropriate strategy and consider the consequences. It is a cognitive, metacognitive and motivational aspect. Effective problem-solving, based on this argument, entailed that learners needed to be exposed to real, ill-structured problems, in which reasoning and decision-making is important (Jonassen, 2011). AI tools can also play a role in this process by making the thinking of students more transparent and providing customized prompts at important points.

Significant research on the intelligent tutoring systems demonstrates that AI may enhance the performance of students due to the provision of immediate and personalized assistance. These kinds of systems monitor student reactions, identify mistakes, and offer promptings that assist learners to the solution approaches as opposed to merely explaining the solution (Aleven, Roll, McLaren, and Koedinger, 2016). This is specifically relevant in mathematics and science, where students can usually enjoy the benefits of step-by-step instructions and feedback feedback loops. The recent systematic reviews also mention that AI-enabled educational systems are often effective in enhancing performance, engagement, and learning efficiency, particularly when adaptive personalization is incorporated into the platform (Niakan Kalhori, Rakhshan, Keikha, and Ghazi Saeedi, 2021; Zawacki-Richter et al., 2019).

Another significant field is adaptive learning platforms. These systems are based on the learner data to modify the levels of difficulty, pacing, and task paths to allow students to work at a personalized level of challenge. This kind of calibration can aid students to have productive struggle, which is a significant requirement towards building problem-solving ability. When the task is too simple, minimal thinking is done and when too difficult then frustration can disrupt learning. The AI can assist in equalizing these conditions by tailoring assistance.

More current literature about generative AI programs like conversation agents and large language models promises and poses risk. On the one hand, these tools may assist the students in brainstorming methods, getting explanations, and analyzing various methods of how to solve the problem. Conversely, when the learners become dependent on AI to provide them with quick answers, their thought processes might decrease. Reviews of AI in educational research Experimental studies on ChatGPT in education indicate that learning benefits may be found, though weaker or less robust in higher-order tasks when AI are used passively, as opposed to interactive (Kasneci et al., 2023; Sung, Chen, Chang, and Ke, 2025). This is an important difference between guided support and answer substitution.

Teacher mediation has also been cited as a key variable in the literature. The most useful use of AI tools is when teachers create activities which need to be explained, contemplated and authenticated to verify the AI results. The socio-cognitive and self-regulated learning theories note that students need to think about, challenge, and defend their thoughts, and not just take the information on (Zimmerman, 2002). Therefore, AI can be applied to solve problems, but it depends on whether it promotes strategic thinking, metacognition, and perseverance. Overall, the existing studies prove the positive, yet conditional nature of the correlation between AI-based learning tools and the problem-solving capacity of students.

5. Theoretical Framework

The constructivist learning theory, scaffolding theory, and self-regulated learning theory inform this paper. According to constructivism, students develop knowledge through active interactions with problems, and not passively as they receive the content (Piaget, 1972). Learning tools based on AI can facilitate this process by offering interactive exercises and responsive routes.

The theory is the self-regulated learning theory which describes the way students plan, monitor, and evaluate their learning (Zimmerman, 2002). These self-monitoring behaviors can be enhanced by AI tools

that can offer feedback in time, diagnose errors and display performance dashboards. The scaffolding theory, which has its background in Vygotskyian views, is also applicable, since AI can also be used as cognitive aids that enable students to do a task that they are only at the edge of being able to do (Vygotsky, 1978). Nevertheless, scaffolds should be progressive towards independence as opposed to indefinite dependence.

6. Methodology

This paper uses a **qualitative conceptual research design** based on critical review and synthesis of existing scholarly literature. It is not an empirical experiment; instead, it develops an academically grounded interpretation of how AI-based learning tools affect students' problem-solving ability.

6.1 Research Design

The study is analytical, interpretive, and literature based. It draws on peer-reviewed journal articles, review studies, books, and conceptual papers related to AI in education, intelligent tutoring, adaptive learning, and problem-solving.

6.2 Data Sources

Sources were selected from established academic discussions on educational technology and AI-supported learning. The review focuses on literature discussing tutoring systems, adaptive learning platforms, chatbots, and AI-based instructional tools.

6.3 Inclusion Focus

The paper includes literature addressing:

- AI-based educational tools,
- student problem-solving ability,
- adaptive and intelligent tutoring systems,
- higher-order thinking and metacognition,
- pedagogical and ethical implications of AI in education.

6.4 Analytical Procedure

The literature was analyzed thematically across four dimensions:

1. Types of AI-based learning tools,
2. Mechanisms influencing problem-solving,
3. Pedagogical facilitators, and
4. Risks and limitations.

7. Types of AI-Based Learning Tools and Their Educational Functions

Table 1- Major AI-Based Learning Tools and Their Role in Problem-Solving

AI Tool Type	Core Function	Problem-Solving Contribution	Limitation
Intelligent Tutoring Systems	Stepwise hints and error diagnosis	Supports strategy selection and correction	May narrow exploration if over-scripted
Adaptive Learning Platforms	Personalized pathways and pacing	Maintains optimal challenge level	Depends on data quality and design
AI Chatbots / Generative AI	Explanation, questioning, idea generation	Supports brainstorming and alternative solutions	Risk of answer dependency

Automated Assessment Tools	Instant feedback and performance tracking	Encourages revision and self-monitoring	May privilege measurable tasks only

These tools differ in how directly they support thinking. Systems that scaffold reasoning tend to promote stronger problem-solving than systems used only for quick answer production.

8. Impact of AI-Based Learning Tools on Problem-Solving Ability

Problem-solving can be enhanced through AI-based learning tools through a variety of interdependent methods. To begin with, they offer feedback in real time, and this allows the students to recognize the misconceptions and to revise the strategies when the problem is still in cognitive memory. Second, they provide adaptive support, which allows students to perform at a productive level of challenge. Third, many AI applications enhance the awareness of metacognition through the presentation of progress, error patterns, or suggested subsequent steps.

Intelligent tutoring systems can be used in mathematics education, e.g., to assist learners in making a transition between procedural errors and conceptual knowledge by providing hints to them. Simulation with the help of AI can stimulate experimentation, control of variables, and inference based on evidence in science education. Conversational AI can be used in writing and design activities to assist a learner to explain the issue, evaluate options, and perfect a plan. Such affordances indicate that AI can be used as a cognitive partner under the conditions when the students are actively involved.

Nevertheless, not every use has a good result. The biggest influences are made when students must justify, clarify or challenge their reasoning. In the case when AI only offers a refined answer, students might not go through the cognitive process of having a real solution. Therefore, AI is beneficial as a reasoning scaffold and not a replacement of reasoning.

9. Challenges and Risks

Although it has potential, AI usage in education has several challenges. Cognitive dependence is one of the major concerns. When planning, analysis or generation of solutions is a regular practice that students delegate to AI systems, their ability to solve problems independently will decline with time. The other issue is unverified trust. Students can believe the explanations provided by AI even though they are not factual or logical.

Equity concerns exist as well, as students that have increased access to devices, internet connection, and AI literacy may disproportionately benefit. Such ethical concerns as privacy, bias, and transparency are also important. Also, educators might not be professionally trained to create AI-assisted tasks that encourage critical thinking, as opposed to shortcut behavior.

Table 2- Benefits and Risks of AI-Based Learning Tools in Problem-Solving

Benefits	**Risks**
Personalized guidance	Overdependence on AI support
Faster formative feedback	Reduced independent reasoning
Increased engagement	Uncritical acceptance of outputs
Better error diagnosis	Bias and misinformation
Support for self-paced learning	Unequal access and digital divide

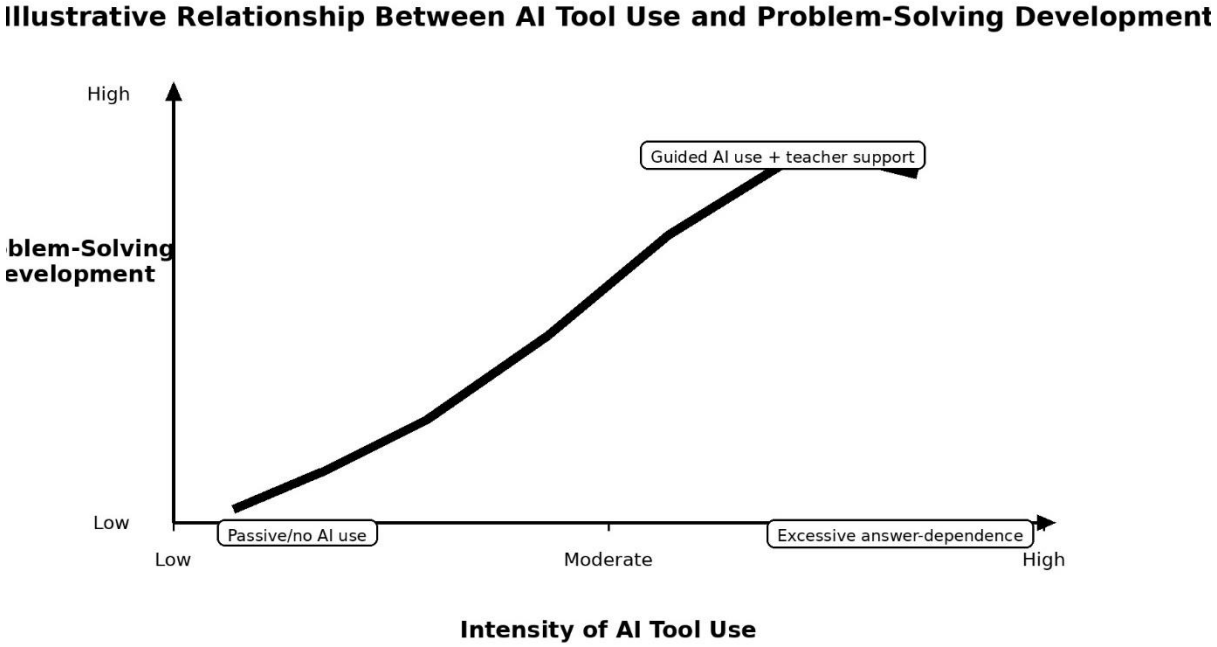
10. Discussion

According to the literature, AI-based learning tools can positively influence the problem-solving ability of students, however, it is conditional and mediated. The conceptual H1 is supported by the fact that AI systems can enhance personalization, feedback and engagement of learners. H2 is also strongly supported since the scaffolding reasoning tools seem to be more helpful than the ones that simply automate final answers. Of particular significance is H3: teacher mediation, task design, and student self-regulation define the difference between AI as a means and end of intellectual development, on the one hand, and AI as a shortcut, undermining effort, on the other hand.

Practically, the problem-solving process is the most effective when students employ AI to pose questions, trial strategies, analyze options, and contemplate mistakes. It becomes least enhanced when students are simply copying AI responses. As such, the pedagogical paradigm of AI is more important than the technology itself. Inquiry-based learning, project work, case analysis and reflective practice should be supported by AI.

11. Conceptual Graph

Figure 1- Illustrative Relationship Between Level of AI Use and Problem-Solving Development



Interpretation: Problem-solving ability tends to improve most under moderate, guided, and reflective AI use, while both minimal support and excessive dependence may reduce learning quality.

12. Implications for Education

Instructional tasks with AI should need reasoning, justification, and reflection to be designed by teachers. Rather than requesting students to have an answer provided by AI, educators need to request students to compare AI generated answers, point out mistakes, clarify why one approach is more robust, or complete an answer. The institutions are also supposed to offer AI literacy training to ensure that students know how to doubt outputs, check evidence and use AI in an ethical manner. Teachers also need to be professionally developed to ensure that the introduction of AI is a pedagogically significant process.

13. Conclusion

The AI-based learning tools are becoming a potent part of modern learning, and there is a distinct possibility of enhancing the problem-solving process of learners. They are strong in adaptive assistance, instant feedback and the possibility of individual guidance. Properly applied, they can make students more aware of issues, select more effective strategies and self-monitor their thought processes. Nevertheless, the same tools may turn out to be dangerous in case they promote passive reliance or take the place of real intellectual work.

The paper will conclude that AI affects the ability of students to solve problems positively but conditionally. The best application of AI is as a scaffold to inquiry, metacognition and strategic thinking. The most unsuccessful application is in case AI is turned into an answer machine that is not related to the pedagogical intent. These hypotheses are to be tested in future empirical research in the context of the age, subjects and types of AI tools. The educational practice must go beyond mere adoption of technology and look to the development of AI-assisted learning scenarios that will produce thoughtful, independent, and capable problem-solvers.

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