

THE UTILIZATION OF ARTIFICIAL INTELLIGENCE AS A VIRTUAL TUTOR IN BASIC PROGRAMMING LEARNING

Helmiyadi^{1,*}, Rifki¹, Mawardi¹, T. Muntazar¹

¹Universitas Bumi Persada, Lhokseumawe, Indonesia

*Corresponding Author Email: helmiyadi.kalam@gmail.com

Abstract: This study aims to analyze the use of Artificial Intelligence (AI) as a virtual tutor for basic programming instruction at Bumi Persada University. The research was conducted in January 2025, involving 27 students from the Informatics Education study program. A descriptive qualitative approach, combined with pre- and post-test measurements, was employed. Data were collected through tests, observations, and interviews. The results showed that the use of AI as a virtual tutor improved students' understanding of algorithm logic, programming structures, and problem-solving skills. Additionally, students experienced higher learning motivation due to the interactive and adaptive nature of the learning process. Challenges identified included limited device infrastructure and the tendency of some students to become overly dependent on solutions provided by AI. This research contributes to the understanding of AI integration in informatics education and provides practical insights for implementing AI-based virtual tutors to enhance the quality of basic programming instruction.

Keywords: Artificial Intelligence, Basic Programming, Informatics Education, Virtual Tutor

INTRODUCTION

The rapid development of digital technology, particularly in the field of Artificial Intelligence, has given rise to a new paradigm in education. AI is no longer merely positioned as a technological tool but has evolved into a pedagogical instrument capable of revolutionizing the learning process. The integration of AI in education enables the creation of more dynamic, adaptive, and interactive learning environments. Collaboration between education and artificial intelligence can enhance teacher understanding, encourage student engagement, and equip students with the necessary future skills (Hajar et al., 2025). One of the main advantages of AI is its ability to provide instant feedback and deliver personalized learning experiences tailored to the individual needs of each student (Zawacki-Richter et al., 2019). Thus, AI has the potential to overcome the limitations of conventional learning systems that tend to be uniform and less

capable of meeting diverse learning needs.

In higher education environments, particularly within Informatics Education study programs, mastery of basic programming constitutes an essential competency that cannot be overlooked. Basic programming is regarded as the main foundation for students to understand the broader discipline of informatics, encompassing software development, algorithm analysis, and information systems engineering. However, in reality, learning programming often presents significant challenges for students. The complexity of the material, which demands logical thinking skills, understanding of algorithmic structures, and precision in syntax writing, causes many students to experience difficulties. These obstacles are further exacerbated by limited lecture time, relatively large class sizes, and high student-to-lecturer ratios, which reduce the intensity of individual guidance.

It is within this context that artificial intelligence, particularly through the application of AI-based virtual tutors, emerges as an alternative solution. Virtual tutors are capable of acting as responsive and adaptive learning companions. Through AI-based systems, students can receive real-time corrections for syntax and logic errors in the programs they write, receive suggestions for improvement, and learn from more varied and contextual examples of code implementation. This provides students with the opportunity to learn independently and continuously, without having to always wait for direct guidance from the lecturer.

Furthermore, the utilization of AI as a virtual tutor in basic programming learning not only provides practical benefits in terms of time efficiency and improved quality of feedback but also has the potential to foster learning motivation. Students are encouraged to experiment with various solutions, explore algorithms, and develop problem-solving skills independently. Thus, AI plays a dual role: as a learning facilitator and as a medium for strengthening 21st-century skills, such as critical thinking, creativity, collaboration, and digital literacy.

Based on this urgency, this research focuses on examining the effectiveness of using AI as a virtual tutor in basic programming learning at Bumi Persada University. This study is expected to contribute theoretically to the literature on AI integration in informatics education, as well as practically by providing an implementation model that can support the improvement of learning quality, particularly in basic programming courses.

LITERATURE REVIEW

Artificial Intelligence in the field of education has demonstrated enormous potential in supporting technology-based learning transformation. The presence of AI enables the creation of more flexible, interactive, and adaptive

learning systems compared to conventional approaches. Holmes, Bialik, and Fadel (2021) emphasize that one of the main advantages of AI is its ability to provide personalized learning according to the individual needs of students and deliver instant feedback. Personalization is important because each student has different learning speeds, styles, and preferences. With intelligent systems capable of adjusting the difficulty level of materials, presentation styles, and exercise formats, the learning process becomes more effective and student-centered.

In the context of programming learning, AI has a significant contribution as a virtual tutor. Students often face challenges in understanding syntax structures, algorithm logic, and detecting code errors. AI-based virtual tutors can provide quick and precise guidance by identifying syntax errors, offering improvement suggestions, and providing logical explanations for various alternative solutions. Thus, AI not only functions as an error checker but also as a facilitator that helps students understand the computational thinking process behind each line of code.

Furthermore, according to Dwivedi et al. (2023), the utilization of AI in learning contributes to increasing student learning independence. With access to virtual tutors, students can explore materials more broadly outside formal lecture hours. This opens opportunities for students to develop independent learning habits, increase academic initiative, and deepen conceptual understanding through repeated practice without having to wait for the lecturer's presence.

Additionally, Almahasees and Qassem (2023) affirm that AI-based learning applications also play an important role in encouraging critical thinking skills. This is made possible through the provision of various example variations, interactive simulations, and problem-solving scenarios that require in-depth analysis and evaluation. Thus,

AI not only enriches students' learning experiences but also strengthens higher-order cognitive competencies essential in informatics education.

However, the adoption of AI in learning is not without challenges. Kasneci et al. (2023) warn of the risk of excessive dependence on AI. Some students tend to use AI as a source of instant answers without going through critical and reflective thinking processes. This dependency risks fostering superficial learning, where students produce polished answers without a deep understanding of the underlying concepts (Mawardi et al., 2025). This condition has the potential to reduce creativity, hinder the development of original ideas, and diminish independent problem-solving abilities. Therefore, although AI provides great opportunities to increase learning effectiveness, its use needs to be accompanied by pedagogical strategies that emphasize the balance between technological support and the development of students' cognitive abilities.

Thus, AI in education, particularly in programming learning, can be viewed as both a promising and challenging instrument. Its potential lies in its ability to strengthen personalization, increase learning independence, and foster critical thinking skills. However, for its utilization to be optimal, policies, regulations, and pedagogical interventions that encourage students to use AI as a learning support tool, not as a substitute for creative and analytical thinking processes, are necessary.

METHOD

Research Design

This research was designed using a descriptive qualitative approach combined with a pre-test and post-test design. The descriptive qualitative approach was chosen because this research focuses on understanding phenomena in depth through the depiction of empirical realities occurring in the field without strict variable manipulation. This method is considered

appropriate for examining how students interact with AI-based virtual tutors in the basic programming learning process, including perceptions, experiences, and responses that emerge.

Meanwhile, the pre-test and post-test design was used to provide simple quantitative measurements regarding the effectiveness of the intervention. The pre-test was conducted to determine students' initial abilities, while the post-test was carried out to identify any improvement in abilities after they used AI as a virtual tutor. With this combination, the research obtained a more comprehensive picture: both from the perspective of measurable learning outcomes and from the perspective of students' subjective experiences.

Research Subjects

The research subjects were 27 students from the Informatics Education Study Program at Bumi Persada University who were enrolled in the Basic Programming course. The selection of these subjects was carried out purposively because the Basic Programming course is the main foundation for students to master subsequent informatics concepts. Additionally, students at this level are generally still in the early stages of mastering algorithm logic and programming syntax, so they are considered representative of seeing the extent to which AI can function as a learning companion.

The number of 27 students was also considered adequate to provide data variation, both quantitatively and qualitatively. Thus, this research can capture both general overviews and in-depth details regarding the effectiveness of AI utilization in real classroom learning contexts.

Research Procedure

In the initial stage, students were given a diagnostic test to measure basic abilities in programming logic and simple code writing. This test included questions related to basic algorithm

structures, the use of branching, loops, and simple syntax writing in the programming language used in the course. The pre-test results were used as baseline data to identify students' initial difficulties.

The intervention stage was the core of the research, where students were introduced to and directed to use AI-based virtual tutor applications. These applications provided interactive exercises on algorithm concepts, branching structures, loops, and debugging. In this process, students were encouraged to actively experiment, analyze instant feedback from AI, and correct errors independently. The lecturer's role was more focused as a facilitator, ensuring that AI was used appropriately, not merely as a provider of instant answers.

After the intervention, students were again given a test with a difficulty level equivalent to the pre-test. The aim was to measure the development of their understanding of basic programming concepts after utilizing the virtual tutor. Comparison of pre-test and post-test results allowed researchers to assess the effectiveness of AI in supporting improved learning outcomes.

To complement the quantitative data, direct observations were conducted during the learning process as well as semi-structured interviews with several students. Observations were directed at seeing student interactions with AI, levels of engagement, and dynamics that emerged in the classroom. Meanwhile, interviews focused on exploring students' learning experiences, motivation, perceptions of the advantages and disadvantages of AI, and the challenges they faced.

Data Analysis

Data analysis in this research was conducted using a mixed approach between simple quantitative analysis and in-depth qualitative analysis. Data from pre-test and post-test were analyzed by calculating the difference in

average scores, distribution of success levels, and percentage of improvement in student learning outcomes. This analysis provides an objective picture of the extent to which AI intervention impacted basic programming abilities.

Observation notes and interview results were analyzed using thematic analysis techniques (Braun & Clarke, 2006). This process involved identifying patterns, grouping themes, and interpreting students' experiences. The themes raised included aspects of learning motivation, perceptions of AI reliability, technical challenges, and the risk of dependence.

By combining these two approaches, this research not only assessed the success of AI intervention in measurably improving students' understanding but also revealed the pedagogical and psychological dimensions that accompany it. The analysis results are expected to provide a richer contribution to the understanding of AI's role as a virtual tutor in informatics education.

RESULTS AND DISCUSSION

The results of this research showed a significant improvement in students' understanding of basic programming concepts after participating in the learning intervention with the assistance of AI-based virtual tutors. Quantitative analysis indicated that in the pre-test stage, only about 30% of students were able to write programs with simple branching structures without syntax or logic errors. This shows that the majority of students still experienced difficulties in applying basic programming concepts, especially in the use of control structures, which are important foundations in algorithms.

However, after the intervention using virtual tutors, there was a significant increase in post-test results, where 81% of students successfully wrote programs correctly. This improvement reflects that the use of AI was able to strengthen students' understanding, particularly in applying

branching and looping concepts that were previously major obstacles. This finding aligns with the statement of Dwivedi et al. (2023) that AI can improve learning quality through the provision of instant feedback and adaptive support for individual needs.

In addition to achievements in terms of learning outcomes, qualitative data obtained through interviews and observations showed that students found learning with AI more interesting and interactive. They felt helped because the virtual tutor was able to provide instant explanations, present relevant code examples, and automatically detect syntax errors. These features made it easier for students to understand programming logic while reducing frustration due to technical errors that often arise during the coding process. This shows that AI not only acts as a solution provider but also as a facilitator that can increase students' learning motivation.

Classroom observations indicated a change in students' learning attitudes. They appeared more confident in trying various programming solution alternatives. This courage emerged because students felt that the errors they made could be immediately addressed with AI assistance without waiting for feedback from the lecturer. This condition strengthens AI's role as a learning medium capable of encouraging exploration and experimentation, which are important elements in informatics education.

However, despite the positive results, this research also found potential risks. Some students admitted that they tended to directly copy solutions offered by AI without conducting critical analysis. This phenomenon indicates a tendency towards excessive dependence on AI, where students prioritize the final result over the algorithmic thinking process. This aligns with the warning of Kasneci et al. (2023) that the use of AI without pedagogical control can reduce creativity and hinder the development of

original thinking. As a result, AI should be utilized alongside human intelligence, not independently (Muntazar & Hajar, 2025).

Therefore, the role of the lecturer remains a very important factor in directing the use of AI in the classroom. Lecturers must ensure that students do not merely accept solutions from AI but also analyze, compare, and reflect on the results obtained. Thus, AI truly functions as a learning companion or scaffolding tool, not as a substitute for students' thinking processes. Appropriate pedagogical interventions, such as analytical assignments, reflective discussions, and project-based case studies, need to be integrated to balance the use of AI with the development of higher-order cognitive skills.

Overall, the results of this research strengthen the argument that AI has great potential in supporting basic programming learning. However, the success of its implementation is not only determined by technological sophistication but also by appropriate pedagogical design. AI can be an effective instrument in improving learning outcomes, motivation, and student confidence, as long as it is used with strategies that prevent students from falling into the trap of dependence and passive thinking.

The findings of this research also reveal interesting aspects regarding the interaction patterns between students and AI-based virtual tutors. Students who initially had low confidence in their programming abilities showed significant improvement after several sessions of interaction with AI. The presence of AI providing non-judgmental feedback created a safe learning environment where students felt comfortable making mistakes and learning from them. This psychological aspect is important because in traditional classroom settings, some students may feel embarrassed or anxious when making errors in front of their peers or lecturers.

Furthermore, the adaptive nature of AI-based tutors allowed students to learn at their own pace. Students with slower comprehension could repeat materials and exercises without feeling pressured, while faster learners could proceed to more challenging problems. This individualized learning path is difficult to achieve in conventional classroom settings with limited time and resources. The ability of AI to provide differentiated instruction according to each student's needs represents a significant advancement in educational technology.

However, it is important to note that not all students responded equally positively to AI-based learning. A small number of students expressed frustration when AI provided explanations that were too technical or when the system failed to understand their specific questions. This highlights the importance of continuously improving AI systems to better understand and respond to user queries, as well as the need for complementary human support when technology falls short.

The issue of infrastructure also emerged as a significant challenge in this research. Some students reported difficulties accessing AI applications due to limited device specifications or unstable internet connections. This digital divide issue needs to be addressed by educational institutions to ensure equal access to AI-based learning resources for all students, regardless of their socioeconomic background.

CONCLUSION AND RECOMMENDATIONS

Based on the research findings, it can be concluded that the utilization of Artificial Intelligence as a virtual tutor in basic programming learning at Bumi Persada University provides significant positive impacts. AI has been proven capable of improving students' understanding of algorithm logic, developing skills in writing programming code, and

encouraging student learning motivation. These results show that AI not only acts as a technical tool but also as a pedagogical instrument that can enrich students' learning experiences.

Nevertheless, the effectiveness of AI does not automatically make this technology a substitute for the lecturer's role or students' thinking processes. The integration of AI must be balanced with pedagogical strategies designed to stimulate critical, analytical, and creative thinking skills. Without appropriate pedagogical intervention, students have the potential to fall into passive learning practices, such as copying answers from AI without going through reflective and evaluative processes. Therefore, lecturers still have a central role in directing the use of AI to align with learning objectives.

In practice, lecturers are advised to use AI as a supportive tool, not as a substitute. AI can be utilized for independent practice, allowing students to practice writing code outside lecture hours with the guidance of virtual tutors. It can also be used for debugging simulations, where students can learn to recognize syntax and logic errors through instant feedback provided by AI. Additionally, AI can assist in providing syntactic feedback, helping students correct errors directly and understand the necessary improvements.

However, the main emphasis must still be directed towards developing students' analytical and problem-solving skills. AI should function to strengthen active learning processes, not replace them. Project-based learning strategies, reflective discussions, and assignments that require students to analyze and modify solutions provided by AI can be effective approaches to maintaining this balance.

For future research, it is recommended that the scope of the study be expanded with a larger sample size and covering diverse academic backgrounds of students, so that research results are more representative. Additionally, exploration

needs to be conducted regarding the utilization of AI in more advanced levels of programming learning, for example, in courses such as Data Structures, Algorithms, or Software Engineering. Longitudinal research is also needed to assess the impact of AI use on learning patterns, independence, and student creativity.

Furthermore, future research could explore the development of more sophisticated AI tutors specifically designed for programming education, incorporating features such as natural language processing to better understand student questions, adaptive difficulty adjustment based on student performance, and integration with collaborative learning platforms. Research could also investigate the effectiveness of AI tutors compared to other teaching methods, as well as the optimal balance between AI assistance and human instruction.

From a policy perspective, universities need to develop guidelines for the ethical and effective use of AI in education. These guidelines should address issues such as academic integrity, data privacy, and the role of AI in assessment. Faculty development programs should also be established to help lecturers integrate AI into their teaching practice effectively.

Thus, this research not only provides empirical contributions regarding the effectiveness of AI in basic programming learning but also emphasizes the importance of integrating technology with appropriate pedagogical approaches. AI has the potential to become a significant instrument for educational transformation, as long as its use is directed to strengthen higher-order cognitive skills and shape graduates who are adaptive, critical, and innovative in facing the challenges of the digital era. The success of AI integration in education ultimately depends not on the technology itself, but on how it is designed, implemented, and supported within a holistic educational ecosystem

that prioritizes student development and learning outcomes.

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