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Enhancing Technological Literacy of Students and Teachers through Robotics and Introduction to Artificial Intelligence

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ABSTRACT
Background: Robotics technology has evolved from merely representing technological progress to becoming an essential component of modern learning, supporting students' creativity and logical reasoning. However, SMAN 8 Seluma faces limitations in its facilities and infrastructure, which prevent the integration of robotics and artificial intelligence (AI) into the learning environment.
Purpose of the Study: To overcome this issue, a community service program was conducted to provide robotics training and AI introduction to 25 students and 3 teachers.
Methods: The methods employed included the introduction of robot components, robot assembly practice, sensor development, and AI fundamentals.
Results: From the activities, the participant groups successfully assembled a fully functional robot. The questionnaire results indicated a clear increase in students' knowledge before and after the program. The pre-test results showed that 10% of participants were not familiar with robotics. Following the training sessions, this proportion improved to 100%, indicating that all participants had acquired an understanding of robotics. A similar pattern was observed for artificial intelligence (AI), where 30% of participants were initially unfamiliar with the technology; however, after the program, 100% of participants demonstrated an understanding of AI concepts)

Keywords
SMAN 8 Seluma; Robotics; Artificial Intelligence (AI); Microcontroller; Education.

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Introduction

The Technological advancements in the era of Industry 4.0 have brought significant changes across various aspects of life, including education. The utilization of technologies based on Artificial Intelligence (AI) and robotics has become a strategic means of enhancing students' competencies in accordance with the development of knowledge and 21st-century skills (Rizal et al., 2023). In Indonesia, the integration of these technologies has begun to be implemented at various educational levels as an effort to cultivate a generation that is adaptive, innovative, and globally competitive (Yusufadz & Rosyidin, 2022). However, a gap remains between urban schools, which have access to advanced technologies, and remote schools with limited access and supporting facilities.

Robotics is one of the fields with great potential to strengthen science and technology literacy among students. According to Alfiyah et al. (2024) extracurricular robotics activities can foster discipline, creativity, and teamwork among students while instilling scientific values through hands-on practice. Meanwhile, Dharmawan et al. (2024) emphasize that Arduino-based microcontroller robotics education can effectively improve understanding of electronics concepts and programming logic through practical approaches. Mastery of these fundamental concepts is crucial for developing computational thinking skills essential in the digital era. Santika et al. (2020) further note that the integration of STEM (Science, Technology, Engineering, and Mathematics) concepts in learning can cultivate scientific skills and problem-solving abilities from an early age. Through project-based activities, students not only learn theory but also experience real processes connecting scientific concepts with technological applications, including robotics and artificial intelligence.

From a technical perspective, developing simple robotic systems requires an understanding of mechanical principles and actuators. As stated by Adinugraha et al. (2023) the Independent Drive Independent Steering design provides high efficiency and flexibility in robotic control systems. These control and actuation concepts can be combined with microcontroller-based sensor technologies to create responsive automated systems (Samsugi et al., 2020). In the educational context, such technologies can be adapted for experiment- and simulation-based learning, which has been shown to increase students' interest in technology (Widiyanto et al., 2022).

The application of AI also plays an important role in shaping digital thinking among students. According to Farwati et al. (2023) artificial intelligence not only changes the way humans interact with technology but also requires adequate digital literacy from an early school age. Marlon et al. (2020) explain that integrating AI into robotic systems enhances machine efficiency and adaptive capabilities to environmental changes. Similarly, Natasya (2023) notes that AI serves as a key pillar in modern technological transformation, highlighting the need to introduce it at the secondary education level.

Other studies further reinforce the importance of introducing robotics in schools. Jamal (2024) successfully developed a line-following robot trainer learning media based on STM32 to enhance the technical skills of teachers and students. Tamam (2023) also demonstrated that using microcontrollers in an automatic cleaning system promotes practical understanding of control logic and sensor applications. Meanwhile, Najmurrokhman et al. (2019) highlight that PID-controlled robots can serve as effective learning media for understanding system stability principles.

SMAN 8 Seluma is located in Talang Kabu Village, Ilir Talo District, Seluma Regency, approximately 90 km from the city center of Bengkulu. Access to the school remains limited because of inadequate road infrastructure, which hampers interaction with modern educational centers and technology-based activities. The school has approximately 290 students and 23 teachers, but only one laboratory is available and used alternately, limiting the effectiveness of practical sessions. These limitations in facilities and access to information have led to students and

teachers lacking fundamental competencies in robotics and artificial intelligence (AI). These technologies have not been applied in classroom learning or extracurricular activities, unlike urban schools where robotics has already become a medium for learning and achievement. This situation creates a digital skills gap between schools in remote areas and those in urban regions.

Based on these challenges, robotics training and the introduction of artificial intelligence are crucial to implement at SMAN 8 Seluma. This program aims to enhance teachers' and students' competencies in technology, foster interest in science and innovation, and create opportunities for collaboration between higher education institutions and secondary schools in remote areas to promote equitable technology-based education. Consequently, this activity represents a concrete implementation of previous research findings and theories while serving as an initial step toward digital literacy equity in the region (Widiyanto et al., 2022).

Method

The technology literacy enhancement program through robotics training and the introduction of artificial intelligence (AI) at SMAN 8 Seluma was implemented in several stages, as illustrated in Figure 1. The preparation stage began with coordination with SMAN 8 Seluma regarding the implementation schedule, the number of participants involved in the program, the availability of school facilities that could be used, as well as the preparation of robot components and questionnaires for the participants. The participants in this program consisted of 28 individuals, including 25 students and 3 teachers, who were actively involved in all stages of the activity. The robot components were selected according to the types of robots to be developed. In this community service program, three types of robots were constructed: an obstacle-avoidance robot, a line-following robot, and a control robot, with three units of each type. The questionnaire was also prepared to assess participants' knowledge levels related to the topics to be delivered. This questionnaire was administered at both the beginning and the end of the program.

The pre-test and post-test questionnaire consisted of 12 items, including both closed-ended and open-ended questions. The questionnaire covered several aspects, including participants' prior familiarity with robotics, sources of information about robotics, understanding of the function of robots in daily life, knowledge of artificial intelligence (AI), differences between robotics and AI, and examples of AI applications. In addition, multiple-choice questions were included to assess participants' conceptual understanding of robotics definitions, AI concepts, examples of AI-based technologies, and the function of sensors in robotic systems. The questionnaire also explored participants' prior experience in robotics or AI training, their level of interest, and their expectations after participating in the program.

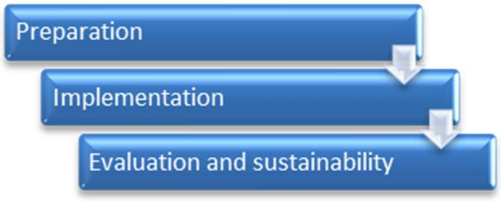


Figure 1. Stage of the Community Service Program

The subsequent stage was the implementation of the community service program, which was conducted directly at SMAN 8 Seluma. The activity began with an introduction to the fundamental concepts of robotics and Artificial Intelligence (AI), followed by an introduction to the Arduino microcontroller as the primary control unit of the robot. After the theoretical session, students were given the opportunity to engage in hands-on practice by assembling and programming simple robots.

The final stage was the evaluation phase. The evaluation was conducted through several methods to ensure the effectiveness of the training. First, direct observation was carried out during the students' robot assembly and programming sessions to assess their ability to apply the acquired knowledge. In addition, a short quiz was administered to measure students' understanding of the basic concepts of robotics and artificial intelligence (AI). Furthermore, pre- and post-assessments were conducted to compare the improvement in both students' and teachers' competencies throughout the training process.

Result

The community service program was carried out at SMAN 8 Seluma, involving 28 participants consisting of 25 students and 3 teachers (n = 28). The participants were divided into 4 groups, and the training was conducted approximately 5 hours with an attendance rate of 100%. Following an agreement between the community service team and the school, a schedule for the implementation of the program was established. The team prepared training modules, robotic kits, and supporting instructional materials.

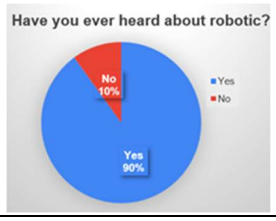
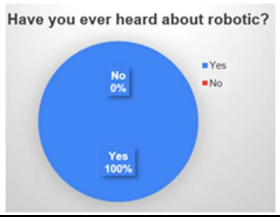
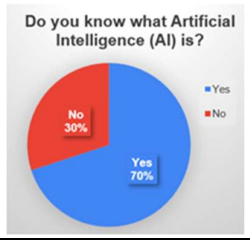
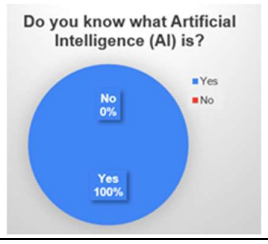
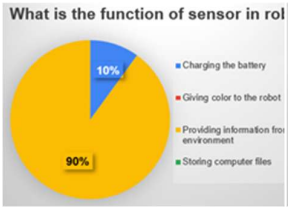
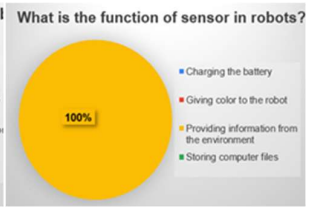
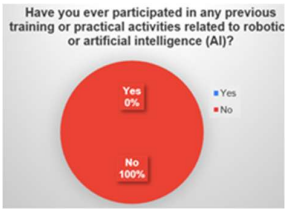
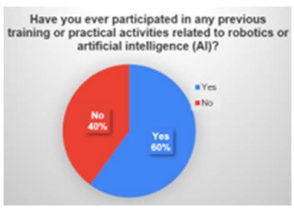
During the implementation, the activity was officially opened by representatives of the school and the community service team through an introduction and a presentation of the program's objectives. All participants were then given questionnaires, as shown in Figure 2, which they completed based on their prior understanding.

Figure 2. Opening session of the community service activity and distribution of questionnaire

The results of the pre-test and post-test questionnaires indicate a significant improvement in participants' technological literacy. The improvement can be observed from the comparison of participants' responses before and after the training. The pre-test results showed that only 90% of participants were familiar with robotics, while 30% were not familiar with artificial intelligence (AI). In addition, 10% of participants did not understand the function of sensors in robotic systems, and none of the participants had previously attended robotics or AI training activities.

After the training, the post-test results demonstrated that 100% of participants were familiar with robotics and AI concepts, and all participants were able to understand the function of sensors in robotic systems. This indicates a substantial improvement in both conceptual understanding and technological literacy among participants. The detailed comparison of pre-test and post-test is presented in Table 1.

Table 1: Result of pre test and post test

No	Indicator	Pre test	Post test	Improvement
1	Familiar with robotic	90% 	100% 	10%
2	Familiar with AI concepts	70% 	100% 	30%
3	Understanding of sensor function	90% 	100% 	10%
4	Experience in robotic/ AI training	0% 	60% 	60%

Subsequently, the theoretical session was delivered by the community service team (Figure 3), covering the fundamental concepts of robotics and Artificial Intelligence (AI), and followed by an introduction to the Arduino microcontroller as the main control unit. The basic components of robotics and the utilization of AI in modern technology were presented by the Community Service Team to enhance the participants' knowledge. Microcontrollers, as the 'brain' or controller of an automated system, were introduced to the participants, including their types and various applications. The Arduino microcontroller served as the central control unit for the robotics system introduced during the activity.

Figure 3. The presentation of materials by the community service team

After the theoretical session, participants were given the opportunity to directly practice assembling and programming simple robots. The training was conducted in a classroom setting, complemented by question-and-answer sessions and group practice activities. Through this approach, participants were able to learn actively, collaborate with their peers, and gain a direct understanding of the application of robotics in everyday life.

Figure 4. Activity of assembling and programming a simple robot

Throughout the group work sessions, the participants also engaged in discussions and question-and-answer activities with the community service team regarding the introduced learning media, such as the names of and ways to obtain several supporting materials that were previously unfamiliar to them.

The robotics training, conducted as part of the community service program, was successfully carried out and ran smoothly. This activity provided positive impacts on the participants, both in terms of knowledge and practical skills. Observations indicated that the participant demonstrated strong motivation to learn robotics, as reflected in their active questioning, independent assembly efforts, and completion of the robot construction stages. This shows that the methods employed were appropriate for the participants' practical skill levels. Several participants also expressed that this training was their first experience in directly assembling a robot.

Discussion

The results of this study indicate that the robotics and artificial intelligence (AI) training program was effective in enhancing participants' technological literacy. The improvement from limited initial understanding to 100% comprehension in post-test results suggests that the combination of theoretical explanation and hands-on practice is highly effective in technology-based learning.

This finding is consistent with previous studies that emphasize the importance of experiential learning in robotics education. For example, Dharmawan et al. (2024) reported that Arduino-based robotics training significantly improves students' understanding of programming and electronics concepts. Similarly, Widiyanto et al. (2022) highlighted that project-based learning using technology can increase students' engagement and interest in STEM fields.

Several factors contributed to the success of this program. First, the use of interactive teaching methods allowed participants to actively engage in the learning process. Second, the hands-on approach in assembling and programming robots enabled participants to directly apply theoretical knowledge. Third, the use of simple and accessible technologies, such as Arduino, made the learning process easier to understand, especially for participants with no prior experience.

Despite these positive outcomes, this study has several limitations. The number of participants was relatively small (n = 28), and the duration of the training was limited to a single session. Additionally, no long-term evaluation was conducted to assess knowledge retention or the sustainability of the skills acquired.

Nevertheless, this program demonstrates strong potential for improving technological literacy in schools located in remote areas with limited access to technology. The findings suggest that similar programs can be implemented more broadly to reduce the digital divide between urban and rural schools. Future programs should focus on advanced training, continuous mentoring, and integration of robotics and AI into the school curriculum to ensure long-term impact.

Conclusion

The community service program on robotics training and the introduction of artificial intelligence (AI) was successfully implemented at SMAN 8 Seluma involving 28 participants, consisting of 25 students and 3 teachers. The program achieved its objective of enhancing participants' technological literacy through theoretical explanations and hands-on robot assembly activities. The pre-test and post-test results demonstrated a significant improvement in participants' understanding of robotics and AI concepts. Before the training, only 70% of participants were familiar with robotics and AI concepts, while 10% of participants did not understand the function of sensors in robotic systems. After the training, the post-test results showed that 100% of participants understood basic robotics concepts, AI applications, and sensor functions, and were able to assemble and operate simple robots independently.

In addition to improving conceptual understanding, the program also increased participants' motivation and interest in technology-based learning. Positive responses from both students and teachers indicate that robotics and AI training can effectively improve technological literacy, particularly in schools located in remote areas with limited access to technology. For future programs, advanced robotics and AI training, continuous mentoring, improvement of robotics equipment, and teacher capacity building are recommended to ensure the sustainability of technology-based learning activities in schools.

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Conflicts of Interest

The authors declare no conflict of interest.

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