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Usability and Effectiveness of AI TVET Robotics Trainer for Enhancing Learning in Robotics and AI

Muhammad Ridzuan Idris[1], Shaifol Ifrad Ibrahim[2] & Noorolpadzilah Mohd Zan[3]

[1,2,3]Politeknik Ungku Omar, 31400, Ipoh Malaysia

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Abstract

This study evaluates the usability and effectiveness of the AI TVET Robotics Trainer in enhancing students' understanding and engagement in robotics and artificial intelligence (AI). A survey was conducted among students to assess their perceptions of the trainer's impact on comprehension, confidence, ease of use, engagement, applicability to real-world projects, motivation, and skill improvement. The findings indicate that the AI TVET Robotics Trainer significantly contributes to improved learning outcomes, with high ratings in understanding concepts, confidence, and applicability to projects. This study highlights the need for integrating AI-driven training kits in technical and vocational education (TVET) to align with Industry 4.0 demands. The research further explores the challenges faced in implementing AI robotics trainers and provides recommendations for improving their effectiveness in TVET institutions.

Keywords: Effectiveness, Usability, Robotics, Artificial Intelligence (Ai), TVET

Introduction

The rapid evolution of automation and artificial intelligence (AI) has significantly transformed various industries, increasing the demand for a workforce equipped with advanced robotics and AI skills. As industries transition toward Industry 4.0, there is a growing necessity for innovative educational tools that enhance learning outcomes and ensure students are adequately prepared for these emerging fields (Hetmanczyk, 2024). However, traditional teaching methods often struggle to keep pace with these rapid technological advancements, leading to gaps in skill acquisition and industry preparedness.

AI-driven training kits have emerged as a transformative solution, offering an interactive, hands-on approach that simplifies complex concepts and makes learning more engaging and effective for students (Chaka, 2023). These AI-based learning tools provide real-time feedback, adaptive learning pathways, and immersive experiences that cater to diverse learning needs, ensuring a more dynamic and personalized educational experience. Unlike conventional pedagogical approaches, which may lack interactivity and immediate applicability, AI-driven robotics trainers equip students with practical skills directly relevant to industry requirements.

In Technical and Vocational Education and Training (TVET) settings, the adoption of AI-driven robotics trainers is particularly crucial. These tools play a vital role in equipping students with the necessary skills in automation, AI, and robotics, ensuring that graduates are well-prepared to meet industry demands and contribute effectively to technological advancements (Kamalov et al., 2023). By integrating AI-based training kits into the curriculum, TVET institutions can bridge the gap between theoretical knowledge and practical application, fostering a more competency-based, industry-aligned learning environment. Furthermore, the use of AI in robotics training enhances students' problem-solving abilities, critical thinking, and adaptability—key competencies for the future workforce.

This study aims to assess the usability and effectiveness of the AI TVET Robotics Trainer in facilitating robotics and AI education within a TVET framework. Specifically, the research examines key factors such as student engagement, confidence levels, and the practical application of acquired skills in real-world environments. By evaluating these aspects, the study seeks to determine the extent to which AI-driven educational tools enhance learning experiences and prepare students for careers in advanced automation and intelligent systems. The findings from this research will provide valuable insights into the integration of AI-based learning tools in TVET settings, offering recommendations for future curriculum development and pedagogical strategies to further enhance technical education.

Moreover, this study contributes to the broader discussion on the role of AI in education by identifying best practices for implementing AI-driven training tools in vocational learning environments. The results will benefit educators, policymakers, and industry stakeholders by informing the development of more effective training programs that align with industry needs. Ultimately, this research highlights the necessity of leveraging AI-driven robotics trainers to build a technologically adept workforce, ensuring that students are not only proficient in theoretical knowledge but also capable of applying their skills to real-world industrial challenges.

Literature Review

Previous studies emphasize the importance of hands-on learning in robotics and AI education. AI-based learning kits have been found to significantly improve cognitive retention and skill acquisition (Pan et al., 2024). Integrating AI-driven training tools in TVET settings aligns with modern industrial needs, bridging the gap between theoretical knowledge and practical application (Crompton & Burke, 2023). The constructivist learning theory suggests that students learn best when actively engaging with educational content, making AI robotics trainers an ideal solution for technical education (Piaget, 1950). Studies indicate that hands-on training in robotics and AI enhances problem-solving abilities, critical thinking, and practical skills necessary for employment in high-tech industries (Amnuaysin et al., 2023). Furthermore, research has highlighted that AI-based educational tools foster a more personalized learning experience, adapting to the student's pace and ability, thus improving overall retention rates and comprehension (Qolamani & Mohammed, 2023).

Methodology

Research Method

A structured questionnaire was distributed to 30 students enrolled in TVET robotics and AI-related courses who had experience using the AI TVET Robotics Trainer. The survey employed

a Likert scale (1-5) to measure students' perceptions of the trainer's usability and impact on their learning experience. Key areas of assessment included understanding of robotics concepts, confidence in AI and robotics, ease of use, engagement, practical application, motivation, and skill enhancement.

The collected data were analyzed using descriptive statistics to determine the overall effectiveness of the AI robotics trainer. The sample of 30 students ensured that respondents had prior exposure to robotics training kits, providing a relevant and reliable dataset for evaluating the learning tool's impact.

In addition to the quantitative approach, qualitative feedback was gathered from students to identify specific areas for improvement in the AI robotics trainer. Observational studies were also conducted to analyze students' engagement levels and practical application of knowledge during laboratory sessions using the AI robotics trainer. This mixed-method approach provided a comprehensive understanding of the trainer's effectiveness in enhancing students' learning experience and skill development (Patton, 2021).

Results and Discussions

Quantitative Results

The analysis of survey responses revealed positive feedback across all measured criteria. The following table summarizes the key findings:

Table 1

Students' Perceptions of the AI TVET Robotics Trainer

Assessment Criteria	Average Rating (1-5)
Understanding Robotics Concepts	4.6
Confidence in AI and Robotics	4.5
Ease of Use	4.4
Engagement in Learning	4.5
Applicability to Real-World Projects	4.4
Motivation and Skill Improvement	4.5

Detailed Analysis

- **Understanding Robotics Concepts:** The majority of students (average rating: 4.6) reported improved comprehension of fundamental robotics principles. This suggests that AI robotics trainers effectively simplify complex concepts and provide real-time feedback, reinforcing theoretical knowledge through practical application (Cai et al., 2022).
- **Confidence in AI and Robotics:** The trainer enhanced students' confidence in learning AI and robotics, with an average rating of 4.5. The interactive approach allowed students to

experiment and solve problems autonomously, fostering self-efficacy and critical thinking skills (Li & Wang, 2020).

- **Ease of Use:** The user-friendly design of the trainer contributed to a positive learning experience (average rating: 4.4). Students highlighted the intuitive interface and structured learning modules as key factors in making the learning process smoother (Johnson, 2021).
- **Engagement in Learning:** The trainer provided an interactive experience that increased student engagement (average rating: 4.5). The integration of gamification elements, such as task-based challenges and real-time problem-solving, further encouraged active participation (Kim, 2023).
- **Applicability to Real-World Projects:** Students acknowledged the relevance of their learning experience to practical applications (average rating: 4.4). They expressed confidence in applying their knowledge to industry projects and real-world AI applications (Martinez, 2022).
- **Motivation and Skill Improvement:** The AI TVET Robotics Trainer was reported to boost motivation (average rating: 4.5) and skill proficiency (average rating: 4.4). The hands-on approach allowed students to develop industry-relevant competencies, including coding, hardware integration, and AI-driven automation (Bishop, 2022)

Qualitative Feedback

In addition to the quantitative data, students provided qualitative feedback that further illustrates the impact of the AI TVET Robotics Trainer:

- "The AI TVET Robotics Trainer made complex concepts much easier to understand. I felt more confident in my ability to apply what I learned in real-world scenarios." (Student A)
- "The interactive nature of the trainer kept me engaged throughout the learning process. I found myself looking forward to each session." (Student B)
- "I appreciated the ease of use and the structured modules. It made learning robotics and AI less intimidating." (Student C)
- "After using the AI TVET Robotics Trainer, I felt more motivated to pursue a career in robotics. It gave me the skills and confidence I needed." (Student D)

Statistical Analysis

To further validate the findings, statistical analysis was conducted. The results showed a significant positive correlation between the use of the AI TVET Robotics Trainer and improved learning outcomes. Specifically, the correlation coefficients for understanding concepts, confidence, and skill improvement were found to be statistically significant ($p < 0.05$).

Table 2
Statistical Analysis of AI TVET Robotics Trainer

Assessment Criteria	p-value	Significance
Understanding Robotics Concepts	6.97×10^{-20}	Significant
Confidence in AI and Robotics	6.97×10^{-20}	Significant
Ease of Use	5.13×10^{-19}	Significant
Engagement in Learning	5.50×10^{-21}	Significant
Applicability to Real-World Projects	5.13×10^{-19}	Significant
Motivation for Learning Robotics and AI	2.44×10^{-18}	Significant
Skill Enhancement in Robotics and AI	7.84×10^{-18}	Significant
Overall Recommendation to Peers	5.13×10^{-19}	Significant

Challenges and Recommendations

Despite the positive feedback, students also identified several challenges:

- **Technical Issues:** Some students reported occasional technical glitches that interrupted the learning process.
- **Resource Limitations:** A few students noted that access to additional resources and supplementary materials would enhance their learning experience.
- **Training Duration:** Some students suggested that extending the duration of the training sessions would allow for deeper exploration of the topics.

Based on these findings, the following recommendations are proposed:

- **Enhanced Technical Support:** Providing robust technical support to address and resolve any issues promptly.
- **Supplementary Materials:** Offering additional resources, such as online tutorials and reference materials, to support self-paced learning.
- **Extended Training Sessions:** Increasing the duration of training sessions to allow for more comprehensive coverage of the material.

Conclusion

The AI TVET Robotics Trainer has demonstrated its effectiveness as an educational tool in improving students' comprehension, confidence, and practical application of robotics and AI concepts. These findings highlight the importance of broader adoption of AI-driven training kits in TVET institutions to better equip students with industry-relevant skills. By addressing existing challenges and implementing recommended enhancements, the effectiveness of AI-driven training kits can be further optimized. Future research should investigate the long-term impact on competency development, career preparedness, and industry integration of AI-trained graduates.

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