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Artificial Intelligence Technology Embedded in High School Science Learning: A Study of Teacher Perception

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ABSTRACT

This study examines teachers' perceptions and acceptance of using artificial intelligence (AI) technology in the teaching of Sciences (IPA) in Vocational High Schools (SMK). Based on quantitative and qualitative data, the results indicate that the understanding and use of AI in teaching are still limited. Quantitative data were collected through a structured questionnaire to assess teachers' knowledge, confidence, and AI usage frequency, while qualitative data were obtained through in-depth interviews exploring their views and challenges. Although some teachers see the great potential of AI in enhancing student engagement and learning outcomes, various obstacles such as lack of training and technological infrastructure hinder optimal implementation. This articles also offers strategic recommendations for integrating AI into the science curriculum in vocational schools. Although AI has significant potential in vocational science education, its effective implementation is hindered by limited teacher training and infrastructure, necessitating strategic improvements to fully leverage AI's benefits in schools.

Introduction

In the digital era, the advancement of Artificial Intelligence (AI) technology presents new opportunities to enhance learning and teaching processes (Pedro *et al*., 2019). AI facilitates more personalized and adaptive approaches, contributing to increased efficiency and effectiveness in education (Abimanto & Mahendro, 2023). This is particularly relevant for vocational high schools (SMK), where providing students with competencies that align with industry needs is critical (Dahar, 1996). This study explores teachers' perceptions of integrating AI in science education at SMK, aiming to understand the potential benefits and challenges of using AI to support and adapt science learning in vocational settings.

Despite the extensive research on AI technology in the field of education (Astutik *et al*., 2023), there is still limited exploration of teachers' perceptions regarding its use in science learning at vocational schools. This study aims to fill this gap by examining teachers' acceptance, identifying the challenges, and evaluating the potential benefits of AI integration in science education. AI has the potential to personalize learning experiences, which aligns

with the goals of inclusive education (Frank, 2024). However, achieving widespread acceptance among teachers remains a significant obstacle (Mambu *et al*., 2023).

In high school science education, artificial intelligence (AI) provides significant opportunities for personalized learning and student engagement, particularly in enhancing complex problem-solving skills. However, teachers often encounter obstacles in implementing those media effectively (Pastuti & Iskandar, 2023), primarily due to insufficient resources and training. Research indicates that to harness the full potential of AI, educators need ongoing professional development (Nurlaila & Destianti, 2022), access to technological infrastructure (Suryanti *et al*, 2022), and support systems that foster the enhancement of their pedagogical skills.

Moreover, the integration of AI in education aligns with the Technological Pedagogical Content Knowledge (TPACK) framework (Kasi *et al*, 2022), emphasizing the necessity for teachers to develop both technological and pedagogical competencies. This approach highlights the importance of continuous professional growth and support, enabling educators to incorporate AI seamlessly into their teaching practices and effectively enhance student learning outcomes.

The study also investigates various factors that influence the acceptance of AI technology, including technological capabilities, institutional support, availability of resources, and teacher readiness. By providing a comprehensive understanding of these elements, this research aspires to contribute positively to the advancement of science education in vocational schools. The findings can inform the development of curricula and teaching methods that are more adaptive and responsive to students' needs and can serve as a foundation for further research in the intersection of education and artificial intelligence technology.

This study offers a novel perspective by specifically focusing on the integration of AI technology in science learning at vocational high schools, a context that has been largely overlooked in existing research. While previous studies have explored the use of AI in general education, few have examined its application in the specialized context of vocational schools and the unique challenges faced by these institutions. This research contributes to the literature by providing a detailed understanding of teachers' perceptions, highlighting both the potential benefits and barriers of AI implementation, and offering strategic recommendations tailored to vocational education settings.

The research is guided by two primary questions: (1) How do teachers perceive the effectiveness of using artificial intelligence (AI) in adapting science learning for Vocational High School (SMK) students? and (2) What challenges do teachers face in implementing AI technology in science learning for vocational school students? These questions aim to explore educators' perspectives on the potential benefits of AI in enhancing science education and to identify the obstacles that hinder its effective use in the classroom. Understanding these aspects is crucial for developing strategies that support teachers in integrating AI into their teaching practices, thereby improving the overall quality of education in vocational high schools.

Method

This study employs a mixed-methods approach, integrating both quantitative and qualitative research methods (Matović & Ovesni, 2023) to provide a comprehensive understanding of the use of artificial intelligence in science education at SMKN 12 Kabupaten Tangerang. The research utilizes a cross-sectional design, which involves

collecting data from participants at a single point in time to explore the relationships between various factors.

Data collection methods include a questionnaire survey, which captures quantitative data on teacher and student perceptions of AI use (Kim *et al*., 2020), and in-depth interviews to gather qualitative insights into their experiences and views regarding AI implementation. This combination of methods allows for a more complete and nuanced understanding of how AI is integrated into science learning, offering complementary data that can better illustrate the opportunities and challenges associated with AI adoption in vocational education settings.

The research is designed to be conducted over five months, starting with Planning and Preparation in the first month, which involves formulating the research problem, designing the framework, and establishing collaboration with the school. The next two months are dedicated to Data Collection, where questionnaire surveys, interviews, and classroom observations are conducted to gather information. In the fourth month, the focus shifts to Data Analysis, using statistical software to analyze quantitative and qualitative data. Finally, the last month is allocated for Research Report Preparation, where findings, analyses, and conclusions are compiled into a comprehensive report.

Figure 1. Research steps

The research was carried out at one of vocational school in Tangerang, Banten, Indonesia, chosen due to its willingness to participate and the relevance of its science curriculum. Data collection took place directly in the classroom to obtain accurate and detailed information about the application of AI technology in science education. The findings are expected to reflect a diverse range of perspectives and experiences from both teachers and students, providing valuable insights into the use of AI in various vocational high school settings. This comprehensive representation aims to contribute to a better understanding of AI integration in vocational education, highlighting both the benefits and challenges faced in different contexts.

Results and Discussion

Table 1. Research Results

	Number								
	2A	**2B**	**3A**	**4B**	**5A**	**5B**	**6B**	**8A**	**8B**
Score	19	19	20	23	14	15	21	19	18
Average	2.71	2.71	2.86	3.29	2.00	2.14	3.00	2.71	2.57

	Number								
	2A	**2B**	**3A**	**4B**	**5A**	**5B**	**6B**	**8A**	**8B**
Percentage	54% Not enough	54% Not enough	57% Enough	66% Good	40% Not enough	43% Not enough	60% Enough	54% Not enough	51% Not enough

Introduction to Artificial Intelligence

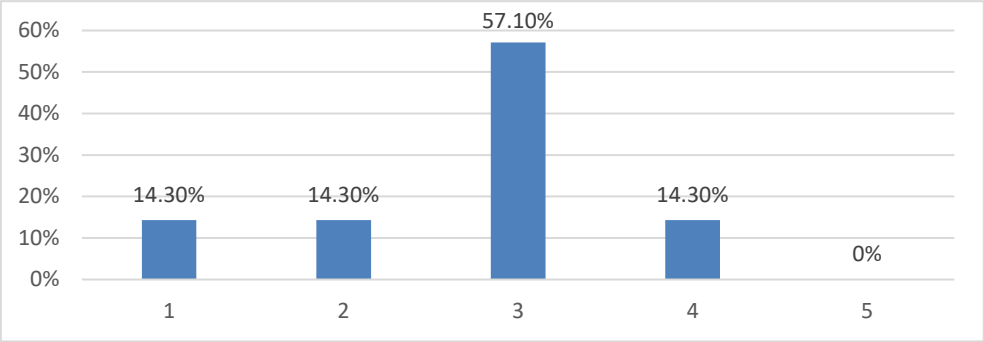

Figure 2. Percentage of adequate understanding of the concept of artificial intelligence

The study revealed that only 14.3% of teachers believed they had an adequate understanding of the concept of artificial intelligence, while 57.1% of teachers felt their understanding was insufficient, and 18.6% indicated they only had a partial grasp of the topic. These findings highlight a significant gap in AI knowledge among educators, emphasizing the need for more targeted training and professional development programs to enhance teachers' understanding and effective use of AI technology in the classroom.

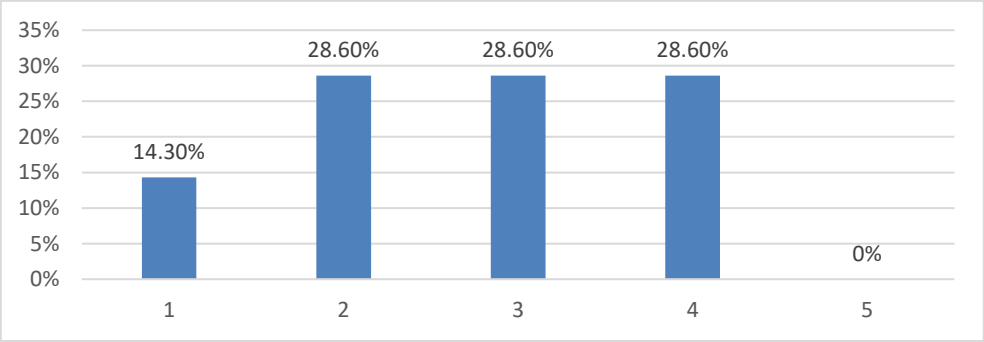

Figure 3. Percentage of use of artificial intelligence technology in science learning

The study found varying levels of AI technology use in science learning. Only 28.6% of teachers reported using AI frequently, while another 28.6% used it occasionally, and 28.6% used it rarely. Additionally, 14.3% of teachers had never utilized AI in their teaching. These results suggest that despite some level of adoption, the overall intensity and frequency of AI use in science education remain low, indicating a need for more consistent integration and support for educators to effectively incorporate AI technology in their classrooms.

Acceptance of the Use of Artificial Intelligence (AI) in Science Learning

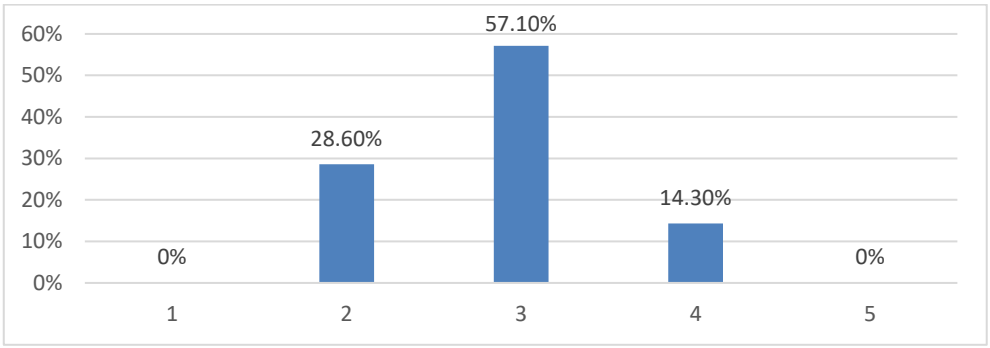

Figure 4. Percentage of your confidence in the use of Artificial Intelligence in science learning

The study shows that only 14.3% of teachers feel confident about using artificial intelligence in science learning. In contrast, 28.6% of teachers express uncertainty or strong doubts about using AI, while the remaining 57.1% are neutral. This indicates a general lack of confidence among teachers in implementing AI, underscoring the need for further training and support to boost their confidence and proficiency in utilizing AI tools effectively in science education.

Description of the basis for your belief in the use of Artificial Intelligence in science learning

The belief in using artificial intelligence (AI) in science learning is rooted in its potential to enhance students' understanding of scientific concepts and their real-world applications through interactive and engaging methods. AI offers quick access to up-to-date information, enriching the learning experience with diverse resources. Educators who adopt AI find that it simplifies the creation of multimedia content, such as videos and images, which accelerates the delivery of complex material (Pedro *et al*., 2019).

In the context of today's digital and globalized era, AI fosters educational innovations that make learning more adaptive and responsive to current demands (Ejjami, 2024). It helps create a dynamic environment where students can build critical skills needed for the future, positioning AI as a valuable tool to support an evolving and student-centered education system (George, 2023).

Perception of the Benefits of Using Artificial Intelligence

Teachers recognize several key benefits of using AI in science education. Specifically, 14.3% of teachers believe that AI enhances student engagement, improves learning effectiveness, and allows for personalized learning experiences, each citing these aspects as significant advantages. Moreover, a substantial 85.7% of teachers see AI as a valuable opportunity for learning innovation. Only 14.3% of teachers expressed uncertainty regarding the benefits of integrating AI into their teaching practices. This indicates a strong overall belief among educators in the positive impact of AI on science learning, particularly in fostering engagement and innovation.

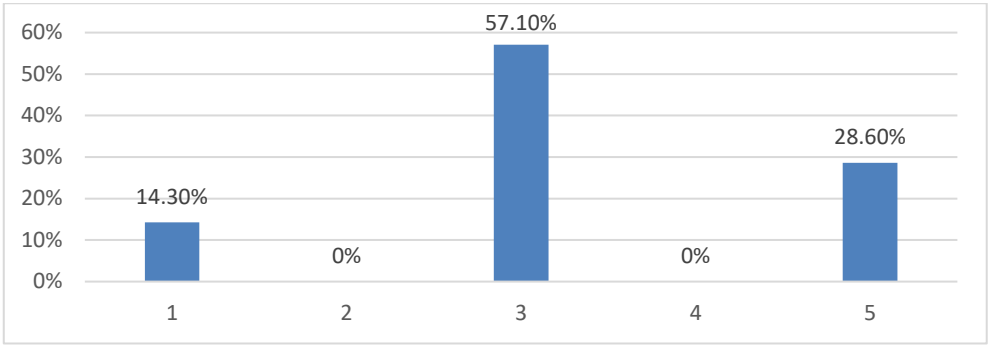

Figure 5. Percentage of teachers' belief that the use of artificial intelligence technology can improve student learning outcomes.

The results indicated that 28.6% of teachers felt very confident that the use of artificial intelligence technology would enhance student learning outcomes. Conversely, 14.3% of teachers expressed uncertainty or strong doubts about the effectiveness of AI in improving learning results, while the remaining 57.1% maintained a neutral stance. This suggests that while a portion of educators is optimistic about the potential benefits of AI, there remains a significant segment that is either unsure or indifferent, highlighting the need for further evidence and support to build confidence in AI's role in education.

Concerns about the Use of Artificial Intelligence

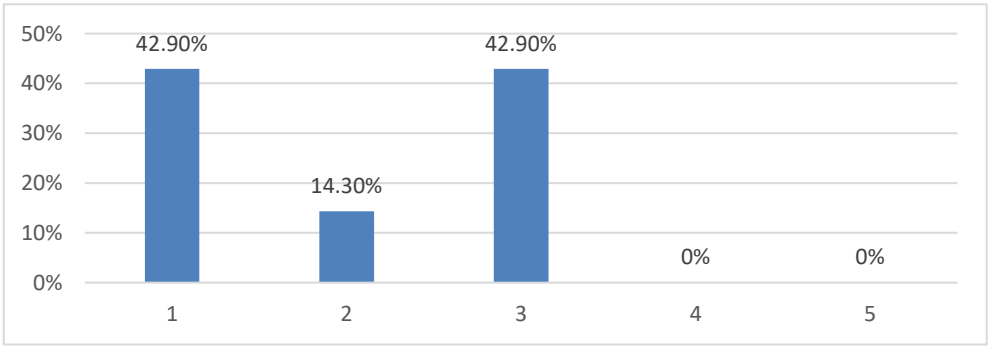

Figure 6. Percentage of concerns regarding the replacement of teachers' roles by AI technology

The findings revealed that 14.3% of teachers disagreed with the concern that AI technology could replace their roles. In contrast, a significant 42.9% strongly disagreed with this notion, while another 42.9% remained neutral on the matter. This indicates that a considerable number of educators do not view AI as a threat to their positions, suggesting a level of comfort with the technology's integration into the educational landscape. However, the neutrality expressed by nearly half of the teachers points to a need for ongoing discussions about the evolving roles of educators in an AI-enhanced learning environment. The use of artificial intelligence at classroom could promoting the learning transformation in school with positive direction (Liua *et al*., 2021).

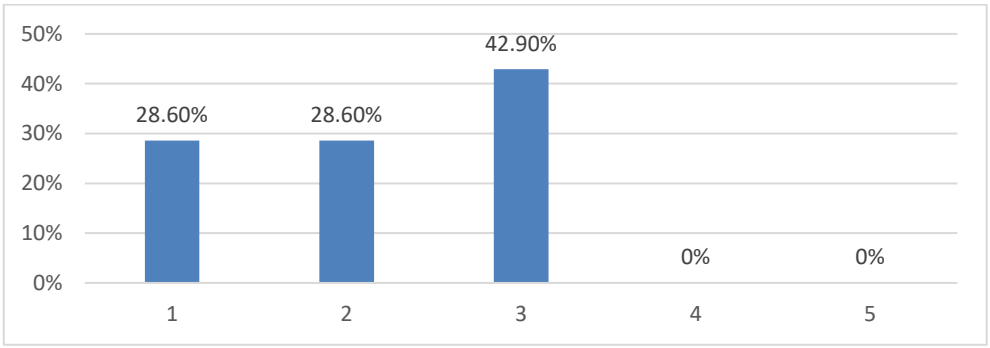

Figure 7. Percentage of concerns about difficulties in adopting and using AI technology

Concerns regarding the difficulties of adopting and using AI technology were distributed relatively evenly among teachers. Notably, 0% of teachers agreed or strongly agreed that they had concerns about these challenges. Meanwhile, 42.9% remained neutral, suggesting ambivalence on the issue. Additionally, 28.6% of teachers disagreed with the concern, and another 28.6% strongly disagreed. This distribution indicates that a majority of educators do not view the adoption of AI technology as particularly challenging, reflecting a degree of optimism regarding its implementation in educational settings.

Potential Benefits of Using AI Technology in Science Learning

The integration of artificial intelligence (AI) in science education presents several significant benefits. Firstly, AI enhances the effectiveness of learning materials by providing interactive and engaging content that boosts student interest and participation (Ait *et al*., 2024). This technology streamlines the learning process, enabling teachers to manage their classrooms more efficiently and dedicate more time to direct interaction with students.

Even teachers who have yet to use AI can recognize its positive impacts in areas such as problem-solving, analysis, and the swift creation of images and videos, all of which can be produced more quickly and accurately. Additionally, AI fosters critical and creative thinking among students, facilitating the development of innovative approaches to learning and allowing for deeper exploration of scientific concepts (Ruiz *et al*., 2024). This focus on higher-order thinking skills not only enriches the educational experience but also prepares students for future challenges. Overall, AI emerges as a valuable tool that significantly enhances the teaching and learning experience in science education.

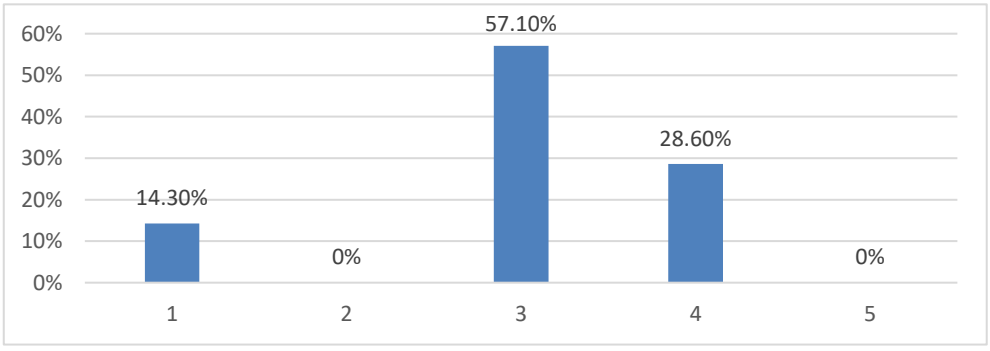

Figure 8. Percentage of potential improvement in student learning outcomes through the use of Artificial Intelligence

The findings indicate that 57.1% of teachers believe that student learning outcomes are likely or definitely to improve with the implementation of AI technology, depending on how it is integrated into the educational process. Additionally, 28.6% of teachers think that

learning outcomes will most likely enhance with AI usage. In contrast, only 14.3% of teachers feel that there will be no improvement. This suggests a strong belief among educators in the potential of AI to positively influence student learning outcomes, contingent upon effective implementation strategies.

Supporting and Inhibiting Factors

Teachers' Perceptions of Supporting Factors in Integrating AI Technology in Learning.

Several key factors support the integration of artificial intelligence (AI) technology in education. Firstly, the availability of increasingly sophisticated and affordable devices enhances access for both teachers and students to utilize AI-based applications effectively. Additionally, robust internet connectivity and adequate technological infrastructure are essential for ensuring seamless implementation of AI in school environments.

While some educators may lack full understanding of AI, the presence of sufficient facilities and infrastructure can create a conducive environment for AI-based learning. The growing availability of free AI applications also allows teachers to access innovative teaching resources without incurring significant costs. Furthermore, the rapid advancement of technology, coupled with a workforce trained in information technology, serves as a critical driver for effectively integrating AI into the learning process (Dwivedi *et al*., 2021). By leveraging these factors, the application of AI in education can proceed more smoothly and yield optimal results for both teachers and students.

Teachers' Perceptions of Key Barriers or Challenges in Adopting AI Technology:

The adoption of artificial intelligence (AI) technology in education faces several significant challenges. One of the primary obstacles is the availability of appropriate devices; not all students and teachers have access to devices capable of supporting AI applications. Additionally, many schools still struggle with limited technological infrastructure, such as stable internet connectivity, which can impede the effective integration of AI into the teaching and learning process.

Another challenge arises from the cost of many effective AI tools and applications. The constraints of School Operational Assistance (BOS) funds often restrict the ability to purchase these resources, leading to limited access for educators. Furthermore, the scarcity of human resources with the necessary skills and knowledge in AI technology presents a major hurdle to implementation (Arslan *et al*., 2022).

Lastly, there is often a lack of interest in collaboration among teachers and educational staff regarding the development and integration of AI technology, which can further slow the adoption process. To overcome these challenges, it is crucial to develop a well-planned strategy that includes adequate support and resources, enabling the effective integration of AI technology into the learning environment.

Support and Training

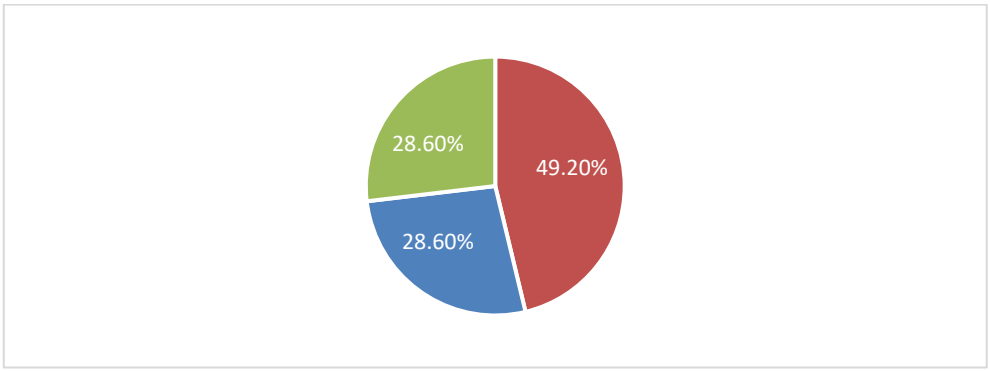

Figure 9. Percentage of teachers who have received adequate training related to the use of artificial intelligence technology in science learning.

Only 28.6% of teachers reported having received adequate training in the use of artificial intelligence technology for science learning. In contrast, 42.9% indicated that they had not received sufficient training, while another 28.6% felt that their training was only partial. These findings highlight a significant gap in professional development related to AI, emphasizing the need for comprehensive training programs to equip educators with the skills and knowledge necessary to effectively integrate AI into their teaching practices.

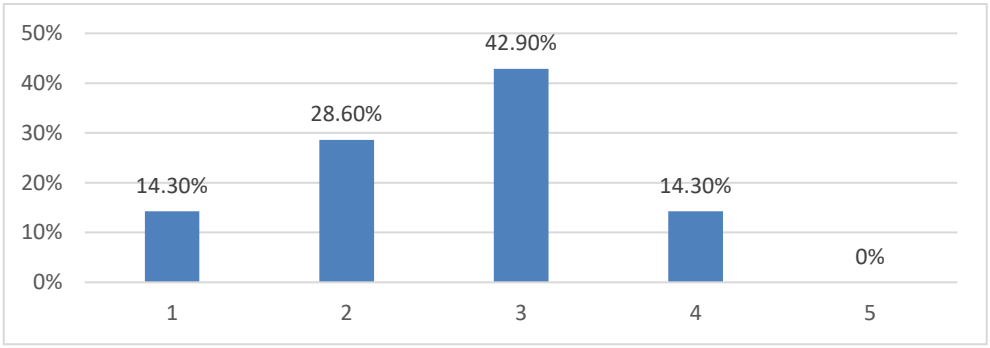

Figure 10. Percentage of teachers receiving sufficient support from schools regarding the implementation of artificial intelligence technology.

The study revealed that 14.3% of teachers feel they receive good support from their school regarding the integration of artificial intelligence technology. Conversely, 28.6% of teachers reported that support is lacking, and 14.3% indicated that support is very inadequate. Meanwhile, 42.9% of teachers expressed that the support they receive is sufficient. These results suggest a mixed perception of institutional support among educators, highlighting the need for improved resources and assistance to foster a more effective implementation of AI technology in the classroom.

Integration of Artificial Intelligence Technology in Science Education in Vocational High Schools.

In today's era of rapid technological advancement, ongoing training and professional development for teachers are essential to uphold the quality of education. It is crucial for Vocational High School (SMK) educators to be encouraged and supported in participating in training programs that focus on applying artificial intelligence (AI) in science education. Continuous professional development initiatives must be designed to ensure that teachers' skills remain aligned with the fast-evolving technological landscape.

School principals play a vital role in fostering teacher engagement by providing necessary support and incentives for those proactively enhancing their skills in using AI

technologies. This support could include allocating specific budgets for training and professional development related to AI. Additionally, adequate technological infrastructure is a prerequisite for the successful implementation of AI technologies in schools. Principals should ensure that sufficient hardware is available and develop school policies that guarantee all students have access to devices and stable internet connectivity.

Regarding ethics and privacy, policymakers must establish clear and transparent guidelines for using AI technology in educational contexts. Strong privacy protection policies should be formulated to ensure the security of student data and compliance with data protection regulations. Integrating AI into the science curriculum requires active involvement from both teachers and principals. Educators must incorporate AI content into existing curricula and create teaching materials tailored to students' needs and understanding levels. At the same time, principals should support curriculum development and review to keep pace with the latest AI advancements.

Implementing an integrated monitoring and evaluation system is crucial for assessing the effectiveness of AI technology usage in education. Principals must conduct periodic evaluations and leverage the results to enhance and refine the application of AI in science education continually. Additionally, fostering collaboration and networking among teachers and schools is essential for sharing experiences and best practices in utilizing AI technology. By encouraging collaboration and establishing policies that facilitate the exchange of experiences between institutions, the effective use of AI in science education at vocational schools can be enriched. The adoption of these guidelines and recommendations is expected to offer practical directions for stakeholders, ultimately improving learning effectiveness in the digital age. Hoping that artificial intelligence could improve the teaching and learning quality in vocational school (Hui, 2020).

Conclusion

To effectively enhance the application of artificial intelligence (AI) in science education within vocational high schools (SMK), several key strategies can be implemented. First, it is essential to develop a curriculum that supports the integration of AI. This curriculum should incorporate AI tools and applications within learning activities and provide guidance for teachers on effectively utilizing these resources. Second, investing in teacher training and professional development is crucial to ensure educators possess the necessary skills and knowledge to use and apply AI effectively. Collaboration with universities, research institutions, and technology companies is also vital in creating AI solutions that align with educational needs. This can be achieved through targeted training programs, collaborative projects, and ongoing technical support. Additionally, establishing AI-integrated laboratories can foster an environment conducive to interactive experimentation and learning, allowing students to engage more deeply with the material. It is equally important to set clear assessment criteria related to the use of AI in education to enhance motivation and accountability among both teachers and students. Comprehensive and continuous training, along with regular workshops and seminars, is necessary to keep educators updated on the latest developments and share best practices. Research findings indicate that most teachers view the application of AI in science education positively, recognizing its potential to improve student engagement, learning outcomes, and overall learning efficiency. However, several challenges must be addressed, including the lack of training, concerns about AI replacing teachers, the availability of technology, and ethical issues surrounding AI use. Understanding these challenges is critical for developing policies that facilitate more

effective AI implementation in vocational high school learning environments. By adopting these strategies, the effectiveness of AI in science education can be significantly increased, maximizing benefits for students while effectively tackling existing challenges.

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