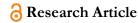
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Impact of Artificial Intelligence in TVET and STEM Education among Higher Learning Students in Malaysia

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Abstract

The advancement of Technologies such as Artificial Intelligence (AI) tools are widely used and help in education such as in Technical and Vocational Education and Training (TVET), as well as Science, Technology, Engineering and Mathematics (STEM). This qualitative study is to identify the impact of AI on students in higher learning settings of TVET and STEM programs in Malaysia. From among science and engineering students, this study aimed to identify in what ways the tools and technologies impact on these learners' experiences, impact their learning, their academic performance, and preparedness for their careers in the future. This study uses a thematic analysis research design. The sample will consist of 10 participants selected based on varying experiences and views. The research method chosen is an in-depth interview, meaning that it will go into details about the benefits and challenges of AI use in education as they are perceived by students. The initial findings will provide an insight into crucial themes enhancement in learning efficiency, development of critical thinking skills, and challenges resulting from the adoption of new technologies. In addition, this research also identifies possible application areas of AI for improving educational outcomes in TVET and STEM and possible barriers for effective implementation. Findings will provide an overview of the knowledge base at the present time about the adoption of AI in the higher learning sector, with associated meaning for educators, and institutions that are considering embedding AI into curricula. The outcome will further realize how AI could be applied to narrow the gap between traditional ways of educating people regarding the demands of an increasingly digitalized workforce, hence significantly improving the employability of TVET and STEM graduates in Malaysia.

Keywords: Artificial Intelligence, Higher Learning, STEM, TVET

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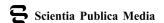
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1. INTRODUCTION

Considering the uses of this technology, the integration of AI into educational settings has spurred significant interest and debate among educators, policymakers, and researchers (Janius et al., 2024). More specifically, the potential for transformative change that AI holds is most evident within the ambit of higher learning, where it is used to innovate teaching and learning, streamline administrative processes, and ultimately better prepare students for careers in an increasing digital world. The increase in AI within STEM programs and TVET represents a paradigm shift in the way knowledge is dispensed and acquired (Popenici & Kerr, 2017). Recent studies have explored various aspects of how AI will influence higher education, from personalizing learning experiences to impacting curriculum design and assessment practices. AIdriven tools, such as intelligent tutoring systems, adaptive learning platforms, and automated grading systems, have been shown to dramatically improve learning outcomes by catering to the needs of individual students and optimizing instructional efficiency. There is a strong possibility that AI in STEM education will transform how students engage with complex technical themes, empowering them to comprehend and retain more from the learning process (Nagaraj et al., 2023). Additionally, recent advancements in AI tools have shown significant potential in enhancing learning experiences in Malaysia's TVET sector using



adaptive learning algorithms and virtual simulations, although challenges such as ethical concerns and digital inequality persist (Amdan et al., 2024). Furthermore, the efficiency of AI tools in revolutionizing STEM education through personalized instruction and intelligent tutoring has been highlighted as a crucial factor for improving student outcomes (Amdan et al., 2024).

1.1. Problem Statement

Although research into the integration of AI in higher education has increased, there is a substantial gap in understanding the effects of AI on student outcomes in relation to Malaysian TVET and STEM programs (Fadel et.al, 2022). Most of the existing studies focus on the general benefits of AI, such as personalized learning, administrative efficiency, and curriculum optimization, but there is very little focused research detailing how AI tools impact the learning experiences of students, their academic performance, and career preparedness in Malaysia, a country rapidly transitioning into a digital economy (Popenici & Kerr, 2017). While AI's potential to enhance STEM education, particularly in terms of engaging students with complex technical content, is widely recognized, few studies have seriously examined its specific applications and outcomes within Malaysian TVET programs (Nagaraj et al., 2023)

Where discussions on integration challenges exist such as ethical considerations, data privacy concerns, and the risks associated with over-reliance on technology there is scarce empirical evidence on how these challenges are being addressed in developing countries like Malaysia (Slimi, 2023). The literature often overlooks the practical challenges in the real-world implementation of AI in classrooms, such as the need for adequate teacher training, securing institutional support, and aligning AI tools with local educational objectives (Chen et al., 2020). Moreover, a significant research gap exists in understanding how AI-powered tools can bridge the gap between traditional educational practices and the demands of a rapidly digitalizing workforce, particularly within the Malaysian context (Onyango & Kelonye, 2022). This is crucial for TVET programs, which equip students with technical skills relevant to Industry 4.0 but are often slow in adopting cutting-edge technologies like AI. Although there is well-documented evidence of AI's potential to enhance learning outcomes through personalized learning experiences or intelligent tutoring systems, little has been explored on how such benefits truly translate into improved employability and job readiness for TVET and STEM graduates in Malaysia (Janius et al., 2023).

1.2. Research Objectives:

- 1. To identify in what ways the tools and technologies impact on the learners' experiences.
- 2. To identify the impact of the AI tools in learning and academic performance among the students.
- 3. To identify the preparedness of the students using AI-tools for their careers in the future.

1.3. Literature Review

Artificial Intelligence application in the education sector, particularly regarding Science, Technology, Engineering, and Mathematics, together with Technical and Vocational Education and Training, has been keenly pursued nowadays. (Janius et al., 2024). The literature review investigates AI's influence on STEM and TVET education, with an emphasis on how AI technologies reframe experiences of learning, academic performance, and career readiness. (Janius et al., 2023)

1.3.1. The Role of AI in Enhancing Educational Outcomes

AI's power in education is well acknowledged, having the capabilities to provide personalized learning experiences for people and automate time-consuming administration tasks. (Janius et. al, 2024) According to Chen et al. (2020), AI has dramatically altered education through its intelligent tutoring systems, adaptive learning platforms, and automatic grading systems that are all grounded on robust and consistent evidence of improved instructional efficiency and learning outcomes. On the other hand, Kamalov et al. (2023) emphasized that AI is capable of revolutionizing learning environments for promotive learning, giving tailored feedback, and raising moral concerns about its implementation in educational institutions.

1.3.2. Impact of AI on STEM and TVET Education

On this front, AI impacts STEM and TVET education in Malaysia. Ahmad and Ghapar, (2019), discussed issues and advantages that surround the integration of AI in Malaysian higher education settings using self-exploration education through concrete mixed reality learning systems. From this study's results, it emerged that AI is prominent in facilitating more interactive student participation, improving learning outcomes, and developing digital economy skills. (Janius. N et al., 2024).

This is also supported by (Janius. N et al., 2023), by his research in learning mathematics and playing at the same time to enhance the academic performance for a young child this will related to the AI technologies in games such KAHOOT etc. Review results showed that AI technologies enhance students' attitudes toward learning and their motivation in learning, especially in STEM and TVET education. (Hassan et al., 2018)

1.3.3. Challenges and Ethical Considerations

Notwithstanding the associated benefits, the adoption of AI in education has had to contend with the challenges brought about by ethical concerns and sufficient training of the teaching base. (Amdan et al., 2024) elaborated on how AI could further exacerbate problems like digital accessibility and teacher shortages that already stand in the way of fairness in distributing educational resources. Furthermore, according to Chun and Elkins (2023), a curriculum related to teaching ethical concerns ought to be developed and promote diversity in the teaching of AI. Zhang (2023) studied deeper into the transformative power of AI in higher learning, opining that institutions must adjust themselves to the influence of AI on teaching methods, learning processes, and theories of education. That requires transformation not only the technological adoption level but also in educational paradigms to make the students fit for an AI-driven workplace.

1.3.4. Applications and Future Directions

AI practical applications in education are endless, from increasing student engagement to automatization of complex administrative tasks. Kornyo (2021) tested AI systems within the context of STEM classrooms in 2021, pointing out the potential use of these technologies for the enhancement of pedagogical content knowledge and students' perceptions related to AI technologies. Similarly, Cox (2021) created design fictions of future scenarios in which AI and robotics make significant impacts on higher education, working to open discussion of their ethical and practical implications in the associated writing. In relation to the enhancing of career preparedness, Khalid (2020) showed that AI learning greatly improved entrepreneurial performance among students at Malaysian universities. This forms a basis for ensuring that the curriculum is tailored to meet demands within a changing world of work. (Janius et al., 2023).

Artificial intelligence infused into STEM and TVET education opens numerous learning opportunities, thus enhancing learning experiences and improving the academic performance of students in setting them up for careers ahead. Advancement poses additional challenges that need critical reflection, especially when considering the ethical dimensions of their use and the need for comprehensive training of teachers. With the continuous evolution of AI, it becomes incumbent on the part of the educational institutions to change themselves by developing strategies in a way that would use the full potential of AI while combating its challenges. As is quite clear from the studies under review, all these have put in a unified manner that AI has some transformative power in education and requires further research to explore its long-term impacts.

1.4. Theoretical Framework

Perceived Usefulness, Ease of Use and Enjoyment

To the degree a person believes that using a certain system or technology will improve his performance. In relation to AI tools, it describes how much a user believes these tools will improve their work or learning. It refers to the degree to which an individual believes that using a particular system will not require much effort on his or her part. The easier AI tools are to use, the greater their chance of being accepted by users. This factor augments the basic TAM by considering whether the user enjoys or is satisfied with the use of AI tools. Of course, perceived enjoyment could have an effect paramount to the acceptance of technology in general, because users tend to employ more of those tools in which they are engaged.

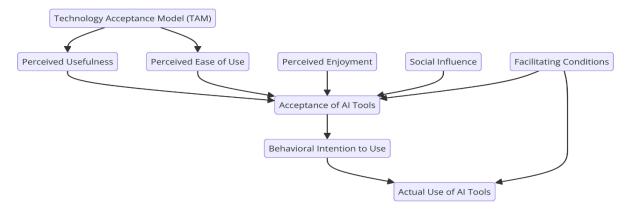


Figure 1. Technology Acceptance Model (TAM)

Social Influence and Facilitation Conditions

Social Influence is the extent to which an individual feels that important others, such as friends, family, teachers, or supervisors, believe they should use AI tools. Social norms and pressures can be very instrumental in adopting new technology. These are the environmental or external factors facilitating the use of AI tools, including the availability of resources, supportive infrastructure, and user guidance or training. If the conditions are favorable, this would increase the likelihood of accepting and using AI tools.

Acceptance of AI Tools

This is the central point where all the influences converge. Acceptance refers to the positive attitude or decision to use AI tools, which is driven by the perceived usefulness, perceived ease of use, perceived enjoyment, perceived social influence, and perceived facilitating conditions.

Behavioral Intention to Use

This intention reflects the likelihood that a user will start using AI tools after forming a positive attitude or acceptance. Behavioral intention is a strong predictor of actual usage.

Actual Use of AI Tools

This is the ultimate outcome of the model, where acceptance and intention of the user integrate into the actual adoption and use of AI tools in daily work or learning activities.

Flow of Influence

Perceived Usefulness and Perceived Ease of Use are directly influenced by the TAM, further influencing Acceptance of AI Tools. Perceived Enjoyment has a direct impact on the Acceptance of AI Tools, and that is the motivational component of the use of the tools. Social Influence and Facilitating Conditions directly impact the Acceptance of AI Tools, underlining the importance of social and environmental context. Ultimately, considering the above-mentioned factors accepted by users, a behavioral intention to use is led, which finally results in the actual use of AI tools.

This study is aligned and related to the TAM model. It explains how educators and institutions could stimulate the adoption of AI tools, depending on the user perceived the usefulness, perceived Ease of Use, Perceived Enjoyment, Social Influence, Acceptance of AI Tools, this appropriation implies that technically successful integration of AI in education must consider both technological and broader social and institutional issues.

2. METHODS

2.1. Research Design

The research design for this study is qualitative, involving depth interviews, which help to provide substantial evidence on the impact of AI tools on students pursuing TVET and STEM courses. This

qualitative approach allowed the researchers to explore the experiences, perceptions, and attitudes of students toward AI use in education.

2.2. Participants

The sample size was 10 participants, purposefully sampled from a targeted population from several higher learning institutions in Malaysia. The participants target the second year onwards in their programs in TVET and STEM, respectively. Both male and female demographics are equal, with ages ranging from 20 to 25. Such diversity ensured a different array of perspectives that enriched the depth of this study.

Education Institution Semester **Participant** Background **UNITAR International University** 1 Bachelor of Education Mathematics Major 6 2 **UNITAR International University** Bachelor of Education Statistics 4 3 5 UITM Shah Alam Bachelor of Science (Actuarial Science) 5 4 UITM Shah Alam Bachelor Honor in Science (Physical) 5 UITM Kota Kinabalu Diploma in Business Administration 6 Universiti Sains Malaysia Bachelor of Pure Mechanical Engineering 4 6 7 Universiti Teknologi Malaysia Bachelor of Pure Mechanical Engineering 4 8 Universiti Teknikal Malaysia Bachelors in Technology of Electronic and 6 Computer 9 Politeknik Kota Kinabalu Diploma in Quantity Survey 6 10 Tar UMT Kota Kinabalu Bachelor in Accounting and Finance 2

Table 1. Participants Biography

2.3. Instruments

Data collection was performed through semi-structured interviews that allowed free expression by participants with a focus on certain specific research themes. These interviews were audio-recorded and transcribed using NVivo 14 to code and thematically analyze. The measures of validity included member checking by the participants to confirm the interpretations.

2.4. Data Analysis

Data analysis was done through thematic analysis to find patterns and themes regarding the impact of AI on learning experiences, challenges, and ethical considerations. Coding involved open coding for initial themes, axial coding for the refinement of categories, and selective coding to integrate the themes into broader insights.

3. RESULTS

3.1. Impact of AI on Learning Experience

As one of the participants remarked that using AI tools, such as Excel and Photomath, increased efficiency in learning and, at the same time, further enhanced understanding of concepts in mathematics, as all the solutions were automated and detailed mathematics ways were given. This identifies the objective of research in establishing certain impacts of AI-driven tools.

Participant 3 said AI tools, like ChatGPT and MATHway, should aid in making learning more comfortable by breaking hard problems in mathematics into simpler steps to be learned and approached. Less time consuming to understand the mathematics framework.

Participant 5 commented that for abstract mathematical concepts the video aids which AI tools give and successfully helped. This is important to STEM and TVET students, who often come across daunting mathematical and technical problems in need of being broken down to aid in understanding. Visual aids are very effective for the teaching of abstract and technical concepts that are hard to understand theoretically in STEM and TVET education.

They also always mentioned that the AI tools greatly improved their learning experiences; in the comments, also, the students indicated that they have finally understood certain complex points and that

the process was improved efficiency-wise. This relates to the objective of the study finding out how AI impacts learning experiences. In this sense, a contribution to literature can be considered, addressing the practical benefits in relation to AI and its employment in STEM and TVET education. These are especially appropriate in STEM and TVET programs, as very complex technical and vocational concepts require a detailed explanation.

3.2. The Disadvantages Students Experience When Using AI

Over-reliance on AI tools by way of one major challenge that Participant 2 identified, in the long run, makes a person insufficient in independent problem-solving specially in the practical assignment in the engineering subject that needs them to do a lot of practical work in the workshop or lab.

Participant 4 responded about the accuracy of the answers generated by the computer. There might be possible misinterpretations if they are not cross-checked.

Participant 6 responded to the ethical issues of over-reliance in AI, for that matter, critical thinking. These challenges that the participants bring out underline the need for a balanced approach were AI tools function within education. The key insights of this paper and hence contributions toward gap filling exist in the fact that there is a need to develop better accuracy of the AI tools and strategies to mitigate over-reliance. These problems will have to be cured to fully reap the benefits of AI and minimize the emerging negative impacts.

3.3. Opportunities for Improvement in AI Tools

Participant 7 mentions that the AI tools should give more detailed explanations with step-by-step procedures to increase the better understanding of the rationale behind solutions.

Participant 9 recommended increasing the helpfulness in the correct response from the AI and improvements in guiding the user would foster a feeling of trust and effectiveness.

These would thus be key areas in which AI tools should be enhanced to make learning more effective. By addressing these opportunities, this study can then provide actionable recommendations to be implemented by educators and developers, which is very important for closing the gap on how AI tools are currently used compared to their potential.

3.4. Ethical Considerations and Risks of Using AI in Education

Participant 8 raised ethical concerns for cheating and an overdose on AI that may turn detrimental to learning. Participant 10 supported the same view and added the integration of AI should with caution be made in education since it was subject to ethical issues that might undermine the process of education. What emerges clearly in the responses is an underlying theme of ethical concerns and the AI-related risks in education. These findings imply that succinct guidelines and policies need to be put in place to ensure ethical usage of AI tools, therefore bridging an important lacuna in literature.

3.5. Future Implications and Recommendation

As per Participant 1, AI is going to transform or, rather say, keep on transforming education in the field of STEM particularly, through personalized learning experiences and an enhancement in educational attainment.

Participant 4 proposed that the approach for educators and institutions would be to integrate AI tools in a complimentary manner, without developing to an extent of dependence, to foster independent learning. Participants imagine that AI tools will be the heart of education in future, provided they are introduced with caution. These findings contribute to the research's aim of identifying the wider implications of AI in education and subsequently making recommendations for its future use, thereby filling a crucial gap in the current literature.

3.6. Impact on Learning

AI tools greatly enhance the learning experience of students enrolled in STEM and TVET programs by simplifying complex concepts and ensuring efficiency.

Challenges: The balanced use of AI tools in education is the critical challenge of over-reliance on AI and the accuracy of AI-generated solutions.

Opportunities for Improvement: it is important to take maximum steps towards developing the stepby-step explanation features and accuracy in AI tools for education.

Ethical Issues: Too much dependency on artificial intelligence has its own ethical dangers and must be managed carefully, and many other guidelines must be followed in making sure they are used ethically in school. AI in education will likely grow but must be tempered with traditional methods to keep from becoming too reliant and still allow students to exercise critical thinking.

This empirical gap in the literature is addressed in the above sections by the presented findings: on the specific impacts AI is bringing into education; the raised challenges and a diversity of raised ethical questions; and, on the other hand, the opportunities that exist in the further development of AI tools that can improve the process of nurturing learning outcomes.

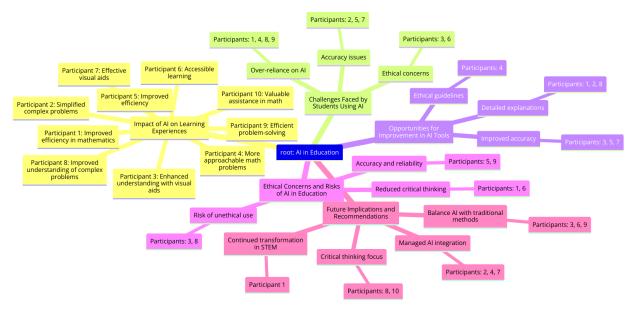


Figure 2. Mind Map for the Result Theme

The theme mind map in Figure 2 is the flow of the data analysis for the research.

4. DISCUSSION

From the result, the researchers can conclude the relation between AI-tools and education, especially in TVET and STEM programs by mentioning a theory called AI-enhanced Adaptive Learning and Ethical Pedagogy (AEL-EP) Theory (Grubaugh et al., 2023). It's a great leap toward integrating Artificial Intelligence into STEM and TVET education. This theory plans the power of adaptive learning technologies with the much-needed ethical sensitivities in educational practices (Silva & Janes, 2020). Key points of the AEL-EP Theory have a framework in recommending the use of AI in adjusting personal learning paths to make it more efficient to goals more efficient, specifically within contexts that put great demand on complex technical skills. It also points out that work must be done to ensure areas of ethical pedagogy within artificial intelligence supported learning environments with respect to approaching problems overdependence on AI, erosion of critical thinking, and the ethical problems that such technologies produce (Zawacki-Richter et al., 2019).

Thus, a test for educators and institutions to adopt AI tools, at the same time with critical implementation in the teaching environment. In this way, attention to both adaptive learning and ethical considerations will ensure that learners not only acquire an ability to use AI technologies but develop a moral capacity and critical thinking to engage with the challenges presented by an ever-growing digital world (Alshehri, 2023). This means that the AEL-EP Theory offers a comprehensive synthesis in today's educational practices, integrating technology innovation with the basic values in teaching.

More practical studies are required to utilize the full potential of the AEL-EP Theory. Further research needs to aim at the empirical validation of the theory in variegated educational contexts, more specifically within STEM and TVET programs. The next steps should involve investigating how best to design AI-driven adaptive learning tools to support the principles for engaging students and learning outcome improvement, with ethical considerations deeply integrated throughout the educational process (Ali & Abdel-Haq, 2021).

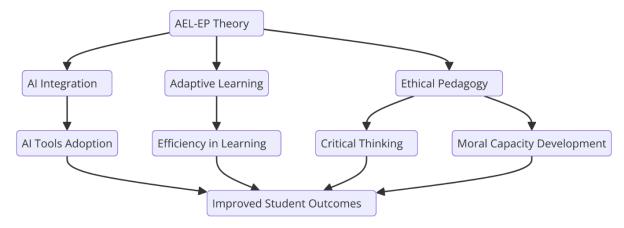


Figure 3. AEL-EP Theory Model

Empirical Studies and deep studies should be done on the impact of AI tools in student learning experiences over time. Special focus must be placed on critical thinking development and problem-solving skills in the environments utilizing the AEL-EP Theory. Further research should be directed toward the creation of a strong ethical framework for AI in education, which is firmly based on the principles laid down by AEL-EP Theory. The resulting framework should incorporate and clarify the guidelines for educators in balancing the potential AI benefits with the arising ethical challenges due to the technology (Kadaruddin, 2023).

Adaptation of the Theory in Cross-Cultural and Contextual Settings: To begin with, the research can investigate the extent to which the AEL-EP Theory can be generalized to different cultural and educational settings. A comparative study could examine how the integration of AI and ethical pedagogy might differ across regions especially in developing countries like Malaysia with huge digital inequalities that may affect the effectiveness of the AI tools. Other areas that deserve research attention are the place of teacher training and institutional support in making the AEL-EP Theory a reality. For example, such studies may evaluate what is placed within such professional development programs set up to prepare educators for the application of the theory in their instructional practices.

Future research into innovative AI technologies should establish pedagogical principles for the AEL-EP Theory to ensure the new tools effectively enhance learning while guaranteeing ethical use and critical engagement by students. Further investigational avenues along this line would be major factors in sharpening and validating the AEL-EP Theory as a landmark for what future education, characterized by sophisticated technological tools, should turn towards for conduct that is virtuous and morally right.

4.1. Enhanced Personalized Learning

The study is greatly contributing to the literature on how AI facilitates personalized learning within TVET and STEM Education in Malaysia. Being in possession of vast capabilities, AI tools enable instruction tailored to individual needs, style, and pace of learning among students (Grubaugh et al., 2023). Such an individual approach goes a long way in teaching technical subjects, where students usually find it difficult to understand theories and concepts involved. AI adaptive algorithms allow learners to work on materials which reflect their current level of mastery and maximizing the effectiveness of learning (Silva & Janes, 2020). The results demonstrated how AI dynamically adapted teaching strategies to individual preferences, hence enhancing performance and comprehension in technical subjects (Alshehri, 2023). AI-powered tools can offer learning at a personalized level, which increases the students' engagement and motivation toward deeper learning (Ali & Abdel-Haq, 2021).

4.2. Improved Student Engagement

Another vital contribution of the research has been to identify how AI can contribute to enhancing student engagement in TVET and STEM education. For example, intelligent tutoring systems, adaptive simulations, and virtual labs. It offers a high interactive learning experience for active participation. It has been proved that such instruments make learning more interesting for learners while trying to solve some complex tasks, like math and engineering (Sangarsu, 2023). This is further reinforced by immediate feedback from AI tools, allowing students to correct their mistakes right away and refine their skill, continuing to keep them motivated and invested in the learning process. Even better, AI can personalize content in a manner that is aesthetic and appealing to the students; it takes an idea that might be abstract and reduces it into chunks of information that are more palpable and readable.

4.3. Ethical Concerns and Over-Reliance on AI

Although the study has sketched the benefits of integrating AI, equal emphasis was given to the fact that there would be potential challenges, especially ethical ones, that might arise and lead to over-dependence on the AI tools. The findings also bring out pointedly ethical dilemmas related to data privacy and biases which could be inherent in the AI algorithms. Another important concern is overdependence by the students on these AI tools; they would depend so much on the solutions provided by AI. This displaces problem-solving skills and critical thinking among them. This could reduce a student's capability in independent analyses and thereby generally reduce competence in performing technical activities. The identification of these challenges contributes to a greater discourse on responsible AI use in education that urgently claims the need for balanced integration to support learning without compromising ethical standards and the development of critical thinking. (Amdan et al., 2024)

4.4. Preparation for a Digitalized Workforce

Other important contributions of this study include exploring the potential of AI in preparing students for a digital workforce that is increasingly digitalized. The increasing applications of AI technologies in recent times in various industries have raised demands for graduates with considerable levels of digital literacy and technical competencies. According to the study, AI tools enhance the technical knowledge of students, along with their digital competencies in modern job markets. AI in TVET and STEM programs closes the gap between traditional education and the requirements of Industry 4.0, thus ensuring better preparation of students for eventual work. (Janius et al., 2022) The study contributes to the understanding of AI's role in aligning education with future employment needs by emphasizing the aspect of digital readiness among TVET and STEM graduates.

5. FUTURE RESEARCH DIRECTIONS

5.1. Broader Sample Size

Future studies should be done by increasing the sample size to more varied educational institutions across Malaysia for better representation of student demography and backgrounds. To this end, a more varied and extensive sample would enable researchers to have a broader view of AI influence in diverse settings within both TVET and STEM education (Kim et al., 2020). The broader approach will, therefore, provide deeper insights into the adoption of AI tools and their varying impacts on learning experiences, academic performance, and career readiness across socio-economic backgrounds, geographic locations, and institutional types (Kokku et al., 2018). A larger sample size can also generalize findings more aptly, which, in turn, enhances the robustness and applicability of the results.

5.2. Longitudinal Research

Another significant direction for future research includes longitudinal studies. While the present study gave some initial insights into the short-term effects AI has on learning experiences, there is a need to explore precisely how AI influences students' learning outcomes for an extended period. To this end, longitudinal research may trace changes in students' cognitive and technical skills, critical thinking, and problem-solving abilities while working with AI tools throughout their educational trajectory (Ijirana et al., 2021). By observing the long-term effects, these researchers will know better how the sustained benefits

and possible drawbacks of AI in education can provide more definite proof of the role of AI integration in shaping competencies of students and their readiness for digital careers (Spencer et al., 2021). In addition, such studies help in the identification of how AI adoption evolves over time and offer insight into the effectiveness and adaptability of AI-driven learning tools.

5.3. Contextual Exploration of AI Integration

Future research should also investigate contextual factors that will influence the integration of AI in education. The study postulates that in varying educational contexts, for example, rural and urban schools, the adoption of AI tools will be problematic in different ways. Looking at such contextual variations will reveal how digital equity and access are a factor in AI's impact on learning. In most rural schools, infrastructure, connectivity, and access to sophisticated AI tools may not be well developed, and this limits the effectiveness of AI for improving learning outcomes (Muhaimin et al., 2020). This investigation into the disparities in these areas potentially could mean future studies provide recommendations on how these digital inequalities can be addressed so that AI tools become accessible and useful to students regardless of their geographical locations or socio-economic status (Graves et al., 2021).

6. PRACTICAL RECOMMENDATIONS

6.1. Educator

The findings indicate that while AI tools can significantly enhance learning, educators should complement teaching methodologies with the same, rather than being complete replacements. After all, thoughtful integration will be in line with maintaining the development of critical thinking and problem-solving skills. AI should be used to consolidate concepts and personalized feedback and assist interactive learning experiences. What educators need to strive for is a balance between task efficiency with the help of AI and opportunities for critical and creative thinking among students. By trying to strike a balance between these two stances, educators can enable students to benefit from AI capabilities without relying too heavily on this assistance.

6.2. Institutional

The institution's role is very important and core in facilitating ethics related to the use of AI tools in education. It is, therefore, recommended that institutions develop clear policies with associated training programs on ethical issues related to the use of AI in education, such as data privacy, algorithmic biases, and responsible use. These should then be filtered into the institution's framework to guide educators and students toward ethical and effective usage of AI. Similarly, there is a need for a focus on equal infrastructure in schools concerning the accessibility and availability of AI tools. This would make AI tools accessible by all students with ease, and hence, digital gaps will be minimized, leading to equal opportunities in learning at all spheres of education.

6.3. Policymaker

Policy makers should contribute to elaborating robust regulatory frameworks that answer ethical and practical issues related to integrating AI into education, with regulation particularly called for on data privacy, algorithmic fairness, and equal access to AI tools. By setting guidelines to support more ethical uses of AI, policy makers can help mitigate potential biases and make sure AI is used responsibly in ways that truly benefit education. Policymakers may go further and provide incentives and funding for research and development into AI tools customized for education. The support of such development of AI technologies in response to local needs and values in education would indeed be far more effective in integrating such AI technologies to achieve improvement in educational outcomes in both TVET and STEM programs.

In summary, this study adds to significant knowledge regarding the effects of AI tools in TVET and STEM Education in Malaysia and serves to identify both opportunities and challenges in the application of AI for the enhancement of such sectors. Whereas AI tools will boost personalized learning, increase student engagement, and prepare students for a digital workforce, it also creates ethical problems and risks of over-

reliability. These findings form the basis for further research and recommendations in practice, underlining the importance of seeking a balanced, ethical, and context-sensitive integration of AI in education. If done with these factors in place, AI could improve educational outcomes without sacrificing students' critical thinking, problem-solving, and ethical reasoning. Thus, its insights ought to guide educators and institutions of learning in their quest to align education with the demands this ever-digitizing world brings forth.

7. CONCLUSION

Impacts the profession and applies different findings in various educational settings. Coupled with thoughtful ethical considerations, educators can effectively integrate these tools into teaching, making learning better while managing the potential downsides. As a conclusion, AI can greatly enhance improvements in education for TVET and STEM programs in Malaysia by making learning efficient and relevant to individual needs. AI tools have the potential to make complex learning easier for students to understand and build their preparedness for the digital job market.

However, challenges are viewed in the sense that over-reliance on AI might reduce a student's problem-solving abilities and critical thinking. A lot of ethical concerns regard reliance on AI because it has some issues with the accuracy of the answers given by AI, and it may also lead to over-reliance by students on technology. For AI to be optimally integrated into the curriculum, further developments are needed with the AI tools themselves to ensure that the explanations are clear and accurate. Additionally, guidelines for responsible and equitable use of AI should also be placed in schools. Further study is required to ascertain how this AI conceptual way of learning longways

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