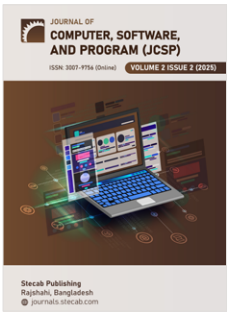

Journal of Computer, Software, and Program (JCSP)

ISSN: 3007-9756 (Online)

Volume 2 Issue 2, (2025)

https://doi.org/10.69739/jcsp.v2i2.934

https://journals.stecab.com/jcsp

Published by
Stecab Publishing

Review Article

Integration of Artificial Intelligence in Industrial Education: A Review of Current Trends and Future Directions

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About Article

Article History

Submission: July 22, 2025
Acceptance : August 27, 2025
Publication : August 31, 2025

Keywords

Machine Learning, Technology in Industrial Education, Vocational Education and Training, Workplace Training

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ABSTRACT

Digital revolution and the resultant emergence of Industry 4.0 has driven the incorporation of Artificial intelligence (AI) in Industrial education to enhance skills development in the industry. However, there is a lack of adequate empirical evidence on the integration of Artificial intelligence in industrial education. To fill this gap, this study reviewed previous studies on the adoption of AI in Industrial education and examined the frequency of occurrence of variables obtained in the studies reviewed. Relevant literature was screened and reviewed to find empirical evidence to support findings. A systematic review of 14 studies provided insights into the current applications, benefit and challenges of AI integration in industrial education. The study found that the most cited applications of AI is Adaptive and personalised learning systems, which customise workers/learners' information based on their interaction with learning content. Other applications are augmented simulators for real-time feedback, virtual mentors, and intelligent tutoring systems which replicate real-life interaction with professionals among others. Majority of the studies found increased engagement and improved learning outcomes and skills development as benefit of AI integration in Industrial education. Other benefits are promotion of early identification of learning challenges and timely intervention and feedback, improvement in administrative efficiency and support, personalisation of learning. Notable challenges were skills and capacity gaps, lack of infrastructure and AI resources, curriculum issues and difficulty in integrating AI into current curriculum, ethical and privacy concerns among others. Based on the findings of the study, it was recommended that the skill gap should be filled with training in AI applications and use, investment in AI infrastructural development should be explored, industry collaboration and partnership in the area of needs should be considered, AI marketing and literacy should be adopted in industries, all AI intervention should be a continuing and lifelong process to ensure sustainability.

Citation Style:

Momoh, A. M., Olajide, F. O., Ogundipe, R. O., & Adesina, A. D. (2025). Integration of Artificial Intelligence in Industrial Education: A Review of Current Trends and Future Directions. *Journal of Computer, Software, and Program, 2*(2), 1-9. https://doi.org/10.69739/jcsp.v2i2.934

1. INTRODUCTION

Industrial education is as old as industries themselves. Early industrial education came in the form of informal apprenticeship training which is as old as man itself. Industrial education as a formal system originated in late 18th century to mid 19th century when industrial expansion created the need for skilled labourers. Technical schools and mechanics institute were established by countries like Germany and England to combine apprenticeships and classroom teaching. Through the apprenticeship training, workers were able to acquire the needed skills and knowledge in specific fields. Overtime, industrial education expanded to incorporate modern technologies as well as adapting to the demands of the ever-changing work environment. Industrial education in Nigeria was introduced during the colonial era initially to focus on technical skills but nowadays it has evolved to align with global standards especially through the integration of Science, technology, engineering and Mathematics (STEM) into vocational and technical education. Industrial Education is essentially education for productivity and development. Uduafemhe *et al.* (2023) noted that TVET as an aspect of education in Nigeria evolved from informal learning system to structured formal education that is geared towards eradicating unemployment, economic stability, and the rapid technological changes impacting the workforce.

Digital technology is broad and encompasses a variety of tools, services and usage patterns that have grown and are rapidly changing people's lives (Omokhabi, 2023). In addition to social networking sites and the internet digital technology also includes devices such as computers, tablets and smartphones that people enjoy using for digital activities (Omokhabi, 2021). However, according to Omokhabi *et al.* (2025) digital technology like social media is an online tool that enables users to communicate with one another through an online community by exchanging ideas knowledge and other forms of expression. Technology in Industrial education began during the industrial revolution of the 18th & 19th century when mechanisation transformed to manufacturing. By the mid 20th century, the industrial education system was reformed. The digital revolution of the late 20th to 21st century further brought about greater changes in industrial education resulting in the prominence and incorporation of Industry 4.0 technology (Xu *et al.*, 2018). Countries such as Germany, Japan, and South Korea were in the lead of the digital revolution while African countries like South Africa, Egypt, and Kenya began integrating computers, CNC machines, and digital training tools in their technical schools. This trend led to the prominence of Mobile learning and e-training platforms. Nigeria's integration of technology was by 2000s when the National Board for technical education (NBTE) introduced computer based training, and other institutions followed suit.

Many international organisations have taken notice of artificial intelligence (AI) which has created transformative opportunities. In fact UNESCO has held two international conferences on the topic. encompassing the 2019 Beijing International Conference on Artificial Intelligence and Education (Ajiye & Omokhabi, 2025). In recent years artificial intelligence (AI) has emerged as a powerful tool in a variety of industries including healthcare (Omokhabi *et al.*, 2025), education (Ojokheta & Omokhabi, 2023) and now an essential tool for enhancing industrial education and training in the industry. AI has the potential to revolutionalise various industries and as it is, it is undergoing a transformation due to AI integration. AI in Industrial education comes in the form of intelligent tutoring systems, predictive maintenance, simulations, Mobile and adaptive learning platforms, intelligent tutoring systems, robotics, smart automation, predictive analytics, virtual training environment and so on.

AI-powered technologies such as intelligent tutoring systems, adaptive learning platforms, and automated assessments personalised training, are catering to individual learning styles and needs while Virtual reality (VR) and Augmented reality (AR), integrated with AI, provide immersive and interactive simulations, allowing learners to develop hands-on expertise in a controlled environment (Aswini *et al.*, 2025). AI offers personalised learning experience, provides innovative solutions that enhances learning experiences and streamline administrative processes in the industry. AI-driven data analytics help educators refine curricula and predict workforce trends, ensuring that training programmes remain relevant to industry requirements (Aswini *et al.*, 2025). However, the effectiveness of AI in Industrial education may be constrained by Infrastructure issues, skill gap and so on.

Previous studies have explored AI integration in general education but few focuses on AI in Industrial education. This systematic literature review addresses this gap by synthesising empirical studies on AI integration in Industrial Education as well as synthesis of empirical findings. This paper therefore seeks to examine the current trends and future directions in AI integration in Industrial Education. Additionally, it will examine the current applications of AI in Industrial Education, the ways by which AI can enhance teaching and learning as well as the challenges and limitations of AI in industrial education. The future of AI depends on the ability of AI to bridge the skill gap while ensuring equitable access. This paper explores AI transformative potential in Industrial education, analyses implementation challenges, and future areas of research.

1.1. Research questions

i. What are the current applications of AI in Industrial education?

ii. How can AI enhance teaching and learning in industrial education?

iii. What are the challenges and limitations of using AI in industrial education?

2. LITERATURE REVIEW

2.1. AI applications in industrial education

AI tools can be applied in Industrial education in different ways. The following areas of application were identified in studies reviewed. They include:

2.2. AI-augmented simulations, extended reality(XR) and Virtual Reality (VR) for Hands-on skills development

i. AI augmented simulators and extended Reality (XR) systems is used for the delivery of real-time feedback on practical abilities and evaluation of welding techniques (Lee, 2021).

ii. AI-Powered Simulations (VR/AR) is used to facilitate hands

on skills acquisition & interactive and immersive practical training (Aswini *et al*., 2025).

iii. Chowdhury *et al.* (2025), Use of Virtual reality to immersive, experiential instruction in domains where practical experience is crucial, such as technical or safety Training.

2.3. Adaptive learning systems and personalised learning

i. Adaptive learning system that customise learning based on the performance metrics of students in Vocational education and adjust question difficulty leading to a more personalised learning experience (Zhao *et al*., 2024).

ii. Personalised Learning and Adaptive Platforms, Real-Time Feedback, and Simulations (Ejjami, 2024).

iii. Personalised and Adaptive Learning Paths including Adaptive Learning Platforms (Aswini *et al*., 2025).

iv. Chowdhury *et al.* (2025) – Adaptive learning methodology to customise information based on workers interaction with training modules or performance metrics, AI to promote effective administration of training modules and the application of algorithms to monitor workers' learning patterns & tailor information to their preferences to facilitate a more individualised training experience, machine learning analyses data to forecast the most advantageous information for workers as informed by their historical learning practices to facilitate the customisation of training materials.

2.4. AI enhanced teaching and training environment and learning management system (LMS)

i. AI driven teaching factory (Wahjusaputri *et al.,* 2024).

ii. AI enhanced Learning Management system for vocational education delivery (Mohd Fahimey *et al.,* 2024).

iii. AI driven Learning management systems (LMS) functionalities, Virtual mentors, and intelligent tutoring systems for training programmes, natural Language Processing (NLP) in chatbots and Virtual assistants enabling workers to pose inquiries and get prompt replies for educational experience augmentation, AI-driven gamification features, such as quizzes and simulations to enhance engagement for dynamism and gratification, (Chowdhury *et al.,* 2025).

2.5. Intelligent tutoring systems and virtual mentors

i. Intelligent Tutoring Systems, Real-Time Performance Tracking & Feedback (Aswini *et al*., 2025).

ii. Virtual mentors, designed to replicate real-life interactions with seasoned professionals and to provide mentoring and career guidance (Chowdhury *et al.,* 2025).

2.6. AI driven content development, feedback and assessment

i. AI-driven assessments for improving educational outcomes in Vocational secondary school (Budiman *et al*., 2025).

ii. Lee (2021), real time feedback in simulations.

iii. Automated Assessments & Feedback, AI-Assisted Content Development (Aswini *et al*., 2025).

iv. AI-driven training feedback techniques included into programmes which encompass real-time progress monitoring, performance statistics, and automated questionnaires, AI automated administrative functions, customised learning trajectories to provide content specifically designed for individuals' requirements (Chowdhury *et al*., 2025).

2.7. AI powered learning analytics and data driven decision making

i. Predictive Analytics & Data-Driven Decision-Making (Aswini *et al*., 2025).

ii. AI-driven learning analytics which have been essential in assisting HR Professionals in making data-informed choices on employee training and enables HR executives to perpetually enhance and improve training programmes, AI-driven Learning analytics which provides critical insights into the efficacy of certain training elements, this enabling HR teams to discern which aspects of the training program need modification to enhance its effectiveness (Chowdhury *et al*., 2025).

2.8. Benefits of AI in industrial education

The benefits of AI integration in Industrial education as cited in studies reviewed are:

Improved learning outcomes and skills development.

i. Trainees using this system demonstrated notably improved welding accuracy and accelerated learning curves compared to those receiving traditional instruction or participating in non-AI VR training (Lee *et al*., 2021).

ii. Student trade skills development through a simulated production line with AI assistance resulted in significant gains in students' technical skills and efficiency, as well as an increased perception of their readiness for the industry (Wahjusaputri *et al.,* 2024).

iii. AI Personalised learning experience significantly enhanced both academic achievement and engagement (Zhao *et al*., 2024).

iv. AI enhanced student performance and learning effectiveness with real time feedback and predictive technology (Budiman *et al*., 2025).

v. AI improved learning outcomes and promotes efficiency in skill mastery (Aswini *et al*., 2025).

vi. AI improves knowledge retention and application, influences the efficacy of staff training programmes, AI-augmented training led to heightened production and skill enhancement (Chowdhury *et al*., 2025).

2.9. Increased learner engagement and satisfaction

i. The use of Generative AI applications by students led to positive effects on their comprehension of technical concepts and their overall learning engagement (Ab Hamid *et al.,* 2023).

ii. AI promotes user engagement and satisfaction (Mohd Fahimey *et al.,* 2024).

iii. Improved engagement, enhanced assessment, increased access to education and improved teacher training are some of the impacts of AI in TVET (Ndom-Uchendu & Nwokike, 2024).

iv. AI enhanced student engagement and satisfaction (Budiman *et al*., 2025).

v. Aswini *et al.* (2025) records higher engagement and Satisfaction through AI.

vi. AI enhances employee engagement, involvement and support by delivering appropriate material at optimal times (Chowdhury *et al*., 2025).

2.10. Personalisation and adaptive learning

i. AI Personalised learning experience based on student data (Zhao *et al.*, 2024).

ii. AI promotes personalised learning (Ndom-Uchendu and Nwokike, 2024).

iii. AI provides real-time feedback and predictive technology for enhanced personalised experience, addresses student weakness (Budiman *et al.*, 2025).

iv. AI provides adaptive learning for personalised learning experience (Aswini *et al.*, 2025).

v. AI ensures material customisation based on workers needs and performance (Chowdhury *et al.*, 2025).

2.11. Administrative efficiency and support

i. AI improves administrative efficiency in vocational education delivery (Mohd Fahimey *et al.* 2024).

ii. It offers important insights into workers' capabilities and areas needing improvement, alleviate the administrative workload for HR Personnel, enhance flexibility, efficiency, and effectiveness (Chowdhury *et al.*, 2025)

2.12. Early Identification, feedback and Intervention

i. AI promotes early identification of learning challenges and timely intervention (Budiman *et al.*, 2025).

ii. AI facilitates the identification of skills deficiencies with prompt and effective remediation, enhance interactivity and relevance in training, enhance participatory and dynamic learning by motivating workers to participate more effectively in their professional growth, promotes rapid feedback (Chowdhury *et al.*, 2025).

2.13. Challenges and limitations of AI adoption in industrial education

AI integration in Industrial education and training faces diverse challenges despite it benefits and potentials. The following challenges were identified in studies reviewed:

Infrastructure and Resource limitations

i. Lack of infrastructure and resources needed to implement AI (Shuaibu, 2024).

ii. Infrastructure limitations like internet connectivity, outdated equipment, and a lack of adequate computing resources, particularly for resource-heavy applications such as AI simulators and XR environments, issue of cost of AI implementation (Zary & Zary, 2025).

iii. Limited infrastructure, high cost of AI tools and software, lack of sufficient AI tools (Ukala & Iheukwumere, 2025).

iv. Substantial obstacles is identifying the initial expenses and resource allocation required for the implementation of AI technologies, technological Barriers/challenges like system integration problems, high initial costs, maintenance and updates, data discrepancies (Chowdhury *et al.*, 2025).

2.13. Skills and capacity gaps

i. Ambiguous and superficial understanding of AI (Egloffstein *et al.* 2024).

ii. AI Skill gap that requires substantial upskilling (Wahjusaputri *et al.*, 2024).

iii. Shortage of qualified trainers and AI experts (Shuaibu, 2024).

iv. Training and capacity issues (Zary & Zary, 2025).

v. Shortage of skilled AI educators and technicians (Ukala & Iheukwumere, 2025).

vi. Lack of AI Literacy and technical abilities, need for training of learners in AI use and insufficient AI competence within HR Departments were identified as obstacles (Chowdhury *et al.*, 2025).

2.14. Curriculum and integration challenges

i. Need for extensive curriculum restructuring and guaranteeing the long-term viability of AI projects (Ejjami, 2024).

ii. Difficulties in incorporating AI into current curricula and insufficient institutional support structures (Zary & Zary, 2025).

iii. Inefficient integration of AI tools, resistance to technological change (Ukala & Iheukwumere, 2025).

iv. Difficulties in integrating AI with existing Systems, lack of Familiarity, resistance to change (Chowdhury *et al.*, 2025).

2.15. Ethical and privacy issues

i. There is concerns about ethical implications of AI (Shuaibu, 2024).

ii. Resolving data privacy issues (Ejjami, 2024).

iii. Data Privacy concerns (Chowdhury *et al.*, 2025).

2.16. Future directions

Further studies on AI integration in Industrial Education should be conducted using the following lens:

Development and testing of impartial and ethical AI systems

i. Future research should prioritise developing and testing impartial AI systems to guarantee fair educational outcomes (Ejjami, 2024).

ii. Investigation should be done on ethical implications of AI adoption in vocational training, data privacy, algorithmic bias, and responsible AI usage (Aswini *et al.*, 2025).

iii. Future studies should expand upon the results of this study to create impartial AI algorithms, evaluate the lasting effects, explore the growth potential, and improve the education of teachers in AI technologies (Ejjami, 2024).

2.17. Longitudinal and impact studies

i. Longitudinal studies that monitor skill retention and employment outcomes beyond immediate post-training periods would help overcome current temporal limitations (Zary & Zary, 2025). This implies that most studies conducted gave short term impact.

ii. Longitudinal studies can offer valuable insights into the impact of AI-driven educational technologies on students' career paths and their capacity to adapt to the labor market, research on long time efficacy of AI in vocational training (Ejjami, 2024).

2.18. Standardization and comparative research

i. Future academics should also explore the potential for AI implementations to be scaled up in various educational environments (Ejjami, 2024).

ii. Research should focus on Developing Standardized

assessment frameworks that allow for cross-study comparisons of vocational competencies and support more comprehensive meta-analyses, replicating effective interventions in various geographic and economic contexts would enhance the understanding of generalizability as well as context-specific factors (Zary & Zary, 2025). Comparative studies on AI deployment across various vocational domains and skill types would clarify where AI interventions yield the greatest advantages (Zary & Zary, 2025).

iii. Studies that designs standardized AI-based evaluation systems that provide more accurate assessments of student competencies and readiness for the workforce should be carried out (Aswini *et al.*, 2025).

2.19. Teacher and instructor professional development in AI

i. Investigation should be done on several professional development initiatives, such as seminars, certification courses, and partnerships with technology firms, to assess their efficacy in improving instructors' AI skills, investigate the execution and results of the suggested specialised positions, such as the Vocational AI Curriculum Developer (VACD), Vocational AI Data Protection Specialist (VAIDPS), and Vocational AI Sustainability Facilitator (VAISF) (Ejjami, 2024).

ii. Testing different approaches to teacher professional development would tackle the significant issue of educator preparedness (Zary & Zary, 2025).

iii. Further studies are needed to explore AI's impact on lifelong learning and continuous professional development in vocational fields, enhancing AI Algorithms to create even more adaptive and personalized learning experiences that cater to individual Student needs and learning styles (Aswini *et al.*, 2025).

iv. Further research can be conducted on improving AI education for teachers and building capacity in vocational training institutes (Ejjami, 2024; Aswini *et al.*, 2025).

2.20. AI accessibility and integration with emerging technologies

i. Integration of AI with Emerging Technologies, ways to improve access to AI-driven Vocational training for students in remote or underprivileged areas, ensuring inclusivity and equal learning opportunities (Aswini *et al.*, 2025).

Based on the empirical literature reviewed, it was discovered that there should be more longitudinal studies on specific aspects of AI, Studies should be conducted on effective interventions in different contexts, cross sectional studies and comparative studies on AI integration in various vocational domains should be explored, AI assessibility and integration with emerging technologies should also be explored. Also, there should be more of studies that test impartial AI systems and less of perception studies as these have been conducted.

These findings are supported by recent literature on AI which suggests that AI's role in vocational education will continue to expand, with future research focusing on cost-effective and scalable AI solutions (Garcia & Thomas, 2023). This is further supported by Singh & Zhao (2022) who commented that the integration of AI with blockchain technology for secure certification and skill verification is an emerging area of interest.

3. METHODOLOGY

A systematic search of major databases, journals and other empirical sources was conducted in 2025. Keywords used for the search includes "Artificial Intelligence/Machine learning, Industrial education/Vocational training/Technical education, workplace training". The initial search yielded over 30 publications from which the researcher selected relevant ones that meets the inclusion criteria. After removing the duplicate, the researcher screened titles and abstract individually for relevance. The studies that were reviewed needed to involve the keywords mentioned earlier and report at least one or more quantitative or mixed-method outcome within the Industrial education jurisdiction. Only the findings were extracted from the studies. 14 publications satisfied all the inclusion criteria and was used for the study. The inclusion criteria for the study is as follows:

The study only included peer review articles published between (2020 and 2025) in English and focusing on AI applications in Industrial education especially in vocational schools, training institutes, apprenticeships, or technical colleges. The included studies designs varied from controlled experiments to mixed-method evaluations to synthesis of empirical findings. The following studies were excluded:

The study excluded Non-peer review articles published from 2019 and below. Non-English papers and Non-educational AI applications were excluded.

3.1. Expected outcomes

This review aims to provide a comprehensive understanding of the role of AI in Industrial education. The findings will inform the development of AI powered industrial education systems and tools. This study will reveal interventions that will be used to strengthen the field of industrial education

3.2. Implications

This study would be relevant to educators, policy makers and industrial stakeholders working in industries. This study would reveal the current state of AI adoption in Industrial education. Findings from the study would show the relevance of AI in Industrial education while also pointing out the limitations to it use in Industrial education. This study would also contribute to the growing body of literature on AI in education and workforce development.

4. RESULTS AND DISCUSSION

4.1. RQ1 What are the current applications of AI in Industrial Education?

The current applications of AI in industrial education includes; Adaptive learning systems to customise information based on workers interaction with training modules, personalised learning, AI augmented simulators for real time feedback, Virtual mentors and intelligent tutoring systems to replicate real life interaction with professionals, AI enhanced learning management systems, AI driven assessment or automated assessment, Predictive analytics and data driven decision making, Interactive and immersive practical training, AI assisted content development, AI Automated Administrative functions, AI data forecast, AI administered training modules, Algorithms for monitoring learning patterns, virtual realities,

Natural language processing for question and answer, AI driven gamification. Findings indicate that AI is increasing integrated into nearly all areas of Industrial education and training to simplify the education and training process and this highlights the need for further research to identify additional opportunities for its application and impacts.

The most sited application of AI in Industrial education is adaptive learning and personalised learning which was cited by four different studies indicating that AI is changing the learning process in industrial education. This implies that AI in Industrial education has effectively simplified the learning process for learners, thereby reducing learning difficulties and tailoring instruction to meet individual learning needs.

The findings above are supported by the study of Rana and Chicone (2025) who reported that a significant contribution of AI in training and development is its capacity to provide hyper-personalized learning experiences via adaptive learning Systems. Therefore, AI-driven system can consistently evaluate an employee's strengths, weaknesses and learning habits to provide tailored training modules that Align with their skill level and needs.

In support of the findings above Abedsoltan *et al*., (2024); Emon and Khan (2025b) also affirmed that AI-driven virtual reality simulations allow workers to engage in Real-world events inside a regulated and risk-free setting, enhancing their practical experience and decision-making abilities especially in Aviation, industrial, and healthcare industries who have extensively used AI-driven VR training Systems to improve procedural understanding and safety compliance. Also, that AI has also facilitated the use immersive Technology, like virtual reality (VR) and augmented reality (AR), in staff Training and this has simplified the process of workers training in the industry. Also, Chowdhury (2025), stated that over the next five years, numerous organizations intend to enhance their utilization of AI Technologies, integrating more sophisticated features such as augmented Reality (AR) for training simulations, predictive analytics for forecasting future skill requirements, and greater integration with employee performance management systems. The findings are also in line with research by Chen *et al.* (2022), who indicated that AI-powered tutoring systems enhance student engagement by offering real-time feedback and individualized learning paths, which are particularly useful in vocational settings where students acquire hands-on skills. Furthermore, studies by Johnson and Lee (2021) suggest that AI-powered predictive analytics can assess workforce trends and guide curriculum development to match evolving industry demands. Research by Martinez and Silva (2022) further supports the findings that AI-based career guidance and job-matching platforms help vocational students transition seamlessly into the workforce by connecting them with relevant employment opportunities. Smith and Patel (2020) corroborate this that AI-driven simulations help learners practice complex tasks in fields such as healthcare, engineering, and manufacturing, leading to improved knowledge retention and confidence.

4.2. RQ² How can AI enhance teaching and learning in industrial education?

AI enhances teaching and learning in Industrial education in the following ways;

Increased engagement, promotes learning effectiveness and efficiency in skills development, Promotes early identification of learning challenges or skill gap and timely intervention, promotes personalised learning, provides timely real time feedback, promotes user satisfaction, higher comprehension, increased learners readiness for industry, enhanced academic achievement, increased accuracy, enhance assessment, increase access to education, addresses student weaknesses, improved learning outcomes, improve knowledge retention and applications, promotes efficacy of staff training, enhance interactivity and relevance in training, promotes participatory and dynamic learning, enhance flexibility

The most mentioned benefits of AI integration in Industrial education as discovered by six studies is increased engagement and satisfaction and improved learning outcomes and skill development. This implies that AI result in positive learning outcomes and skills development because of it ability to capture it's audience through personalised and adaptive learning systems which tailors learning to individuals needs and preference. This shows that learners are motivated to learn if their needs and interest is catered for. This therefore has implications for policy makers and programme developers. The implications of this finding to them is that result has shown that in designing any training programme, the focus should be on satisfying learners needs for flexibility, convenience, accessibility, feedback, motivation, support etc. All these must be catered for as it affect learning effectiveness and skills acquisition.

These results are consistent with wider educational studies on AI-enhanced learning, indicating that adaptive technologies can tailor instruction and hasten skill development (Holmes *et al*., 2022). Therefore, AI can be utilised to improve the skill set of workers. Findings are in line with previous studies which showed that personalized learning experiences facilitated by AI can significantly enhance student performance (Kamalov *et al*., 2023). Anuyahong *et al.* (2023) have shown also that AI-based systems can significantly improve student engagement and performance, as they allow for adaptive testing that tailors questions based on a student's current level of understanding.

Furthermore, this study is consistent with the study of Bhalke *et al*., (2024) who affirmed that AI-driven analytics systems monitor employee engagement, assessment outcomes, and Knowledge retention rates to provide HR executives with valuable data about training efficacy

Also, according to Emon and Khan, (2024b), they retracted that AI insights enable firms to detect skill deficiencies, assess training return on investment, and enhance learning tactics to maximize training results. AI-powered chatbots serve as immediate learning aides, addressing employee inquiries, suggesting pertinent educational materials, and offering evaluations on exams (Labadze *et al*., 2023). This implies that AI-driven chatbots and virtual mentors have made employee training easy by offering immediate assistance and tailored coaching throughout the learning process.

In addition, Shu and Gu, (2023) offer empirical evidence and confirm that an intelligent education model, which the Edu-Metaverse empowers, significantly enhances better learning

outcomes for Students compared to traditional education methods. Shu and Gu, (2023) further confirms thatAI help to expand students' active participation in learning and to cultivate an intelligent individual with a better value orientation.

4.3. RQ3 What are the challenges and limitations of using AI in industrial education?

AI skill gap/lack of AI Literacy, lack of infrastructure, difficulty in Integrating AI into current curriculum, shortage of qualified AI expert, high cost of AI tools and software, resistance to change, data privacy issues/concerns, technology barriers, ethical concerns, poor understanding of AI, insufficient institutional support, initial expenses identification issue, issues with long term viability. AI skill gap is the most cited challenge in the reviewed paper and was cited by six publications out of the ones utilised for the study. This is closely followed by Infrastructure and resources limitation which is cited by four publications and so on. The result above implies that skill gap is the major challenge affecting the effective integration of AI into industrial education. AI is also limited by limited infrastructure and other resources. Improving the current situation requires a conscious effort at developing AI skills in all stakeholders especially the instructors, educators and learners. This requires comprehensive investment in upskilling and reskilling programme. Without addressing this gap, AI tools risk being underutilized or misapplied limiting their effectiveness and benefit. In the same vein, judicious investment in AI infrastructure should be embarked upon for full realization of AI potentials.

These findings are in line with Kumar *et al.* (2022) who highlight digital infrastructure limitations, lack of trained educators, and resistance to technological change as barriers to the widespread adoption of AI in vocational training institutions. This finding is further supported by Ukala & Iheukwumere, (2025) who commented that AI tools in TVET programmes in public institutions in Abia state are not sufficient to effectively support students' learning and skill development; and that AI-driven tools are not effectively integrated into the curriculum to address the specific skill needs of students.

5. CONCLUSION

This study investigated the integration of AI in Industrial education with specific reference to the current trends in its integration, the benefits, limitations and future directions. The findings of this study has implications for strategic planning and policy making that will be relevant to the development of interventions for industrial education as a discipline. The benefit of AI shows AI can be used to achieve great feat in the industrial education sector if effectively applied. The challenges in AI integration shows the need for judicious investment in AI learning and development. AI adoption in Industrial education can contribute to a future ready industrial education system that aligns with the demands of the 21st century workforce. With AI organisations can now adapt learning to meet individuals need or use machine learning algorithms to customize training according to the needs of the learners among others.

Suggestions for effective integration of AI in Industrial education

For effective integration of AI in industrial Education it was recommended that

i. Skill Gap should be filled with Training in AI applications and use. Training should be for all stakeholders including the public. This will enable them use and adapt to AI effectively.

ii. Investment in AI infrastructural and resources development should be explored. AI development unit with specialized roles like AI curriculum developers, AI data analyst and specialist should be created in each countries specialised agency for technological development.

iii. Industry collaboration and partnership in the area of needs should be considered. All stakeholders must collaborate to disseminate resources, expertise and best practices in AI development.

iv. AI marketing and literacy should be adopted in industries. AI marketing will reveal the benefits of AI usage to users while AI literacy will make them better equipped to handle AI use.

v. All AI intervention should be a continuing and lifelong process to ensure sustainability. An effective AI enhanced learning system cannot be created at once but overtime with continuous investment of time and resources in its Sustainability.

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