Chapter 9

Equipping the Next Generation of Technicians: Navigating School Infrastructure and Technical Knowledge in the Age of AI Integration

Larry C. Gantalao
Cebu Technological University, Philippines

Jeffrey G. Dela Calzada
Cebu Technological University, Philippines

Dennis L. Capuyan
https://orcid.org/0000-0002-7443-8959
Cebu Technological University, Philippines

Bernabe C. Lumantas
Cebu Technological University, Philippines

Dharel P. Acut
https://orcid.org/0000-0002-9608-1292
Cebu Technological University, Philippines

Manuel B. Garcia
https://orcid.org/0000-0003-2615-422X
FEU Institute of Technology, Philippines

ABSTRACT

As artificial intelligence (AI) continues to transform the demands of the global workforce, technical education must evolve to meet these emerging challenges. This chapter examines the integration of AI in technical education with an emphasis on the critical need for modern infrastructure and technical expertise. It highlights the importance of investing in facilities such as AI-equipped laboratories, reliable internet, and educator training programs to foster innovation and personalized learning. Collaboration between educational institutions and industry is explored as a means to bridge the gap between academic theory and real-world applications. Additionally, the chapter advocates revising curricula to combine AI literacy with technical skills, alongside critical thinking and adaptability, to meet evolving workforce demands. It concludes with a call for educators, policymakers, and institutions to prioritize inclusive, forward-thinking strategies to modernize technical education and ensure equity in access and opportunities.

DOI: 10.4018/979-8-3373-0122-8.ch009

INTRODUCTION

The rapid integration of artificial intelligence (AI) in various sectors has significantly transformed education, particularly in technical and vocational training programs. AI technologies are now reshaping the landscape of teaching and learning, offering unprecedented opportunities to enhance the skillsets of students (Ciavaldini-Cartaut et al., 2024; Windelband, 2023). As industries increasingly rely on AI-driven tools and systems, the demand for workers proficient in these technologies is rising. This shift necessitates that technical education institutions adapt to these changes by incorporating AI into their curricula to prepare future technicians for a highly digital and automated workforce (Rott et al., 2022). However, achieving this requires a robust framework that emphasizes both the acquisition of technical knowledge and the development of adequate school infrastructure to support AI-driven learning environments.

In technical and vocational education, technical knowledge remains at the heart of the curriculum, equipping students with the practical skills needed to thrive in fields such as engineering, manufacturing, and information technology (Cai & Kosaka, 2024). As industries evolve, the ability of future technicians to work with AI-powered systems, such as automated production lines or machine learning algorithms, becomes essential. The development of these competencies not only enhances their employability but also contributes to the overall competitiveness of the national workforce (McGrath & Yamada, 2023). Therefore, the successful integration of AI into technical education hinges on ensuring that students are equipped with relevant and up-to-date technical knowledge (Acut, Gamusa, et al., 2025; Hasanah et al., 2025). Equally important to technical knowledge is the role of school infrastructure in supporting learning. Educational institutions must provide students with access to state-of-the-art facilities, tools, and technologies to fully harness the potential of AI integration (Walter, 2024). Adequate infrastructure—including access to high-speed internet, AI-enabled labs, and advanced machinery—ensures that students can engage in hands-on, practical experiences that mirror real-world industry applications (Rintala & Nokelainen, 2019). In the absence of such infrastructure, the ability of technical institutions to effectively integrate AI into their curricula may be severely limited, thus impeding students' readiness for the AI-driven workforce.

MAIN FOCUS OF THE CHAPTER

This chapter explores how technical and vocational education can effectively address the challenges posed by AI integration, particularly in preventing skill obsolescence and ensuring infrastructure readiness. As AI transforms industries, technical programs must evolve to equip students with both foundational and emerging technological skills. The focus here is on ensuring that technical education institutions maintain essential, hands-on technical knowledge that prevents over-dependence on AI systems. A key part of this involves examining the role of school infrastructure in facilitating meaningful learning experiences. The chapter emphasizes the critical need for advanced tools, facilities, and AI-enabled environments that enable students to practice real-world applications of AI without undermining their fundamental technical capabilities. This approach helps mitigate one of the main concerns in AI education—the risk of technicians being trained on systems they do not fully understand, potentially leading to skill degradation. The scope of this chapter addresses the broader risks of how inadequate infrastructure and over-reliance on AI can exacerbate inequality in technical education. It explores the potential for AI to contribute to job displacement if educational programs fail to balance AI-centric skills with core technical competencies. Inadequate infrastructure can lead to inequities in access to AI tools, marginalizing students who lack the necessary resources to fully engage with the technology. Insights are provided into how institutions can develop a balanced curriculum that integrates AI while still emphasizing essential technical skills, contributing to the larger discourse on the responsible and equitable integration of AI into educational systems.

UNDERSTANDING SCHOOL INFRASTRUCTURE

Definition and Components of School Infrastructure

School infrastructure encompasses the physical, technological, and environmental resources necessary to support effective teaching and learning. It includes physical facilities such as classrooms, laboratories, workshops, and libraries, which provide foundational spaces for instruction (Barrett et al., 2018). These physical components are particularly vital in technical education, where hands-on practice with machinery and tools plays a significant role in developing students' skills. Technological resources, including computers, high-speed internet, and AI-enabled devices, are now integral to modern educational infrastructure. These tools enhance learning by facilitating access to digital content, enabling simulations, and fostering collaboration (Haleem et al., 2022). Equally important are learning environments designed to be flexible, inclusive, and conducive to active engagement (Garcia, Goi, et al., 2025). A well-planned environment considers factors such as lighting, acoustics, ventilation, and ergonomic furniture, which collectively influence student concentration, comfort, and participation (Latip et al., 2024).

The Impact of Infrastructure on Educational Outcomes

Infrastructure quality plays a pivotal role in shaping educational outcomes, as it directly affects students' academic performance, teachers' instructional methods, and the overall learning environment (Agyei et al., 2024). Schools equipped with modern laboratories, advanced machinery, and digital tools enable students to gain hands-on experience in their respective fields, a critical component of technical education. Studies indicate that students in such schools consistently outperform their peers in institutions lacking these resources, as access to advanced tools enhances both theoretical understanding and practical skill acquisition (Bernhard, 2018; Pandita & Kiran, 2023). Moreover, adequate infrastructure fosters an environment where students can engage more deeply with their studies, develop problem-solving abilities, and prepare for the demands of a competitive workforce (Hanaysha et al., 2023).

Teachers also benefit from high-quality infrastructure, which enables them to implement innovative teaching approaches and integrate technology into their pedagogy effectively (Akram et al., 2022). Access to resources such as smart classrooms, AI-enabled systems, and collaborative learning spaces allows educators to diversify instructional methods, making lessons more interactive and engaging (Backfisch et al., 2021). Additionally, a well-maintained physical environment promotes student safety, comfort, and accessibility, reducing distractions and minimizing absenteeism. These factors collectively contribute to improved student engagement, motivation, and academic outcomes, underscoring the importance of investing in infrastructure as a foundational element for educational success (Yangambi, 2023).

Current Challenges in School Infrastructure for Technical Education

Despite its importance, many institutions face significant challenges in providing adequate infrastructure for technical education. Resource constraints, particularly in low- and middle-income regions, lead to outdated equipment, limited access to advanced technologies, and overcrowded learning spaces (Mhlongo et al., 2023). Rapid advancements in AI and other emerging technologies exacerbate this gap, as many schools struggle to keep pace with the industry's technological requirements. Additionally, disparities in infrastructure quality between urban and rural schools further deepen educational inequities, leaving students in underserved areas at a distinct disadvantage (Sanfo, 2023). Addressing these challenges requires an approach that includes increased investment in infrastructure, strategic partnerships with industries, and policies that promote equitable access to resources. Strengthening school infrastructure ensures that all students, regardless of their socio-economic background, have the opportunity to develop the technical competencies needed for an AI-driven workforce.

THE SIGNIFICANCE OF TECHNICAL KNOWLEDGE

Definition of Technical Knowledge

Technical knowledge refers to the specialized understanding and skills necessary to perform specific tasks or solve problems within a particular field or industry. It encompasses both theoretical and practical competencies, including understanding engineering principles, expertise in operating machinery, and applying digital tools in problem-solving contexts (Banse & Grunwald, 2009). In technical education, this knowledge forms the foundation for preparing students to meet industry standards and adapt to technological advancements. Beyond mechanical or engineering disciplines, technical knowledge increasingly incorporates familiarity with emerging technologies such as AI, data analytics, and automation (Stolpe & Hallström, 2024).

Skills Required in the Modern Workforce

The modern workforce demands a harmonious integration of traditional technical skills and advanced digital literacy to navigate the complexities of an AI-driven economy. Core competencies such as troubleshooting, system analysis, and project management continue to serve as foundational pillars across technical fields. However, these must now be augmented by digital-age proficiencies like coding, data interpretation, and AI tool proficiency to remain relevant in increasingly automated industries (Autor, 2015). These skills not only enable professionals to operate cutting-edge technologies but also to analyze and optimize their functionalities, making them indispensable in sectors such as manufacturing, IT, and engineering.

Beyond technical capabilities, soft skills such as critical thinking, creativity, and adaptability have emerged as equally critical in the face of rapidly evolving technologies. These skills empower individuals to address complex, unfamiliar challenges and to integrate new innovations seamlessly into existing workflows (Poláková et al., 2023). For example, adaptability is key to embracing advancements in AI, while creativity fosters innovative problem-solving, particularly in areas where AI tools may provide unprecedented opportunities. In response to these demands, technical education must prioritize the alignment of curriculum design with these evolving skill requirements. Incorporating interdisciplinary approaches and real-world applications ensures that students are well-prepared to excel in dynamic professional environments. This strategy aligns educational practices with current industry standards while fostering adaptability to future technological advancements (Haleem et al., 2022).

Relationship between Technical Knowledge and Employability

Technical knowledge plays a pivotal role in employability, acting as a primary indicator of an individual's readiness to succeed in the competitive labor market. Employers consistently prioritize candidates who possess not only technical expertise but also the capacity to adapt to evolving technological landscapes (Montero Guerra et al., 2023). Proficiency in specialized tools, machinery, and software—coupled with hands-on experience—enhances an applicant's appeal, signaling their potential to contribute effectively from the outset. For example, industries such as manufacturing, IT, and engineering often require familiarity with advanced systems and protocols, making technical proficiency a crucial asset in securing employment (Garcia, 2022).

Beyond immediate job prospects, technical knowledge also supports long-term career growth by fostering continuous learning and adaptability (Shiri et al., 2023). In sectors where technological advancements rapidly redefine job roles, the ability to learn new skills ensures sustained relevance in the workforce. This underscores the critical role of educational institutions in aligning their programs with the dynamic needs of industry (Akhtar et al., 2024). Integrating current technologies and practical applications into curricula allows schools and training centers to bridge the gap between academic preparation and professional demands. This approach enhances employability by aligning educational experiences with industry requirements, ensuring students acquire the skills needed to succeed in competitive job markets (Cheng et al., 2021).

SCHOOL INFRASTRUCTURE AND TECHNICAL KNOWLEDGE

How Infrastructure Facilitates Technical Learning

Infrastructure serves as the backbone of effective technical education, providing the tools and environments needed to develop essential skills. Access to modern equipment and technology is critical for fostering hands-on learning experiences. For example, laboratories equipped with advanced machinery, robotics, and AI-enabled systems allow students to practice industry-relevant tasks and gain familiarity with cutting-edge tools (Elahi et al., 2023). Without access to such resources, students may face significant skill gaps that hinder their competitiveness in the workforce (see Figure 1). Collaborative learning spaces also play a pivotal role in technical education. These environments are designed to encourage teamwork, problem-solving, and innovation by integrating technology into group activities (Mangubat et al., 2025). For instance, makerspaces and innovation labs create opportunities for students to work on projects collectively, fostering interdisciplinary thinking and creativity (Soomro et al., 2023).

Examples of Effective Infrastructure Supporting Technical Education

Examples of effective infrastructure in technical education highlight the transformative impact of well-resourced facilities. Globally, institutions with specialized facilities set benchmarks for integrating practical and theoretical knowledge. For instance, Germany's dual education system seamlessly combines state-of-the-art workshops with classroom learning, giving students hands-on experience in sectors like automotive engineering, robotics, and renewable energy technologies (Delcker & Ifenthaler, 2022). Similarly, technical colleges in Singapore prioritize the integration of smart technologies, such as AI-powered manufacturing systems and Internet of Things (IoT) labs, to prepare students for careers in automation and data analytics (UNESCO, 2023b). These examples demonstrate how targeted infrastructure investments align education with industry demands, ensuring students graduate with relevant, high-level skills.

In the Philippines, innovative infrastructure initiatives are emerging to support technical education despite resource challenges. For example, the Technical Education and Skills Development Authority (TESDA) operates various technical-vocational institutions equipped with modern tools for automotive servicing, electronics, and welding. These facilities enable students to acquire National Certification (NC) credentials, boosting their employability locally and internationally (Asian Development Bank, 2021). Additionally, institutions like Cebu Technological University have established technology hubs where students can experiment with renewable energy systems, drones, and other emerging technologies.

Another noteworthy example is the partnership-driven approach to infrastructure development in the Philippines. Programs like the Dual Training System (DTS) encourage collaboration between schools and industry stakeholders to provide access to real-world facilities, such as manufacturing plants and IT centers, for on-the-job training (TESDA, 2010). Furthermore, organizations such as the Philippine Business for Social Progress (PBSP) have initiated projects to equip rural schools with computer laboratories and internet connectivity, bridging the digital divide and fostering inclusive technical education (PBSP, 2022).

These case studies underscore the importance of contextually adaptive strategies in building infrastructure for technical education. Learning from global examples and leveraging local resources and partnerships allows countries like the Philippines to address infrastructure gaps and enhance their readiness for an AI-driven workforce. This dual approach combines proven strategies from international best practices with contextually relevant solutions, ensuring that infrastructure development is both effective and sustainable.

Role of AI Tools in Enhancing Technical Knowledge

AI tools have significantly transformed technical education by offering personalized learning experiences, real-time feedback, and hands-on training through advanced simulations. These innovations bridge the gap between theoretical knowledge and practical application, making learning more efficient and engaging. Adaptive learning platforms powered by AI assess student performance, identify specific areas for improvement, and dynamically adjust instructional content to match individual learning needs (Garcia, Rosak-Szyrocka, et al., 2025; Kabudi et al., 2021). For instance, AI-driven platforms like Squirrel AI (Singh et al., 2025) and Century Tech (UNESCO, 2023a) utilized machine learning algorithms to create customized learning pathways, allowing students to focus on mastering competencies essential to their career trajectories. These platforms also track student progress, offering targeted interventions that enhance skill development and retention. Beyond personalized learning, AI-driven simulation tools play a crucial role in technical training by enabling students to practice complex tasks in a risk-free virtual environment (Elahi et al., 2023). In fields like manufacturing and engineering, AI-powered software such as Siemens' NX CAM Virtual Machine provides a highly realistic training environment where learners can refine machining techniques without using raw materials or damaging equipment (Gallagher, 2024). Similarly, AI-enhanced welding training systems, such as Soldamatic, leverage augmented reality (AR) to allow students to practice welding techniques with real-time feedback on accuracy, speed, and efficiency (Weld Australia, 2025). These tools not only improve technical skills but also reduce training costs and enhance safety.

AI's growing presence in technical industries has led to significant shifts in workforce demands. Traditional roles have become increasingly automated, leading to job displacement in certain sectors (Soori et al., 2024). However, this shift has also created new roles requiring AI proficiency, such as AI-assisted robotics technicians and predictive maintenance specialists (Rožman et al., 2023). Institutions that integrate AI into their technical curricula help bridge this gap, ensuring that students are equipped with skills relevant to evolving industry standards. Despite its benefits, AI integration in technical education is not without challenges. Some institutions struggle with infrastructure limitations, preventing them from fully leveraging AI tools. For example, underfunded schools may lack the necessary high-speed internet, computing power, or faculty training required to implement AI-driven learning (Ali et al., 2024). Additionally, AI-based assessment tools have been found to reinforce biases, disproportionately affecting students from diverse backgrounds if not carefully designed (Ferrara, 2023). Addressing these issues requires strategic investments in infrastructure and AI literacy training for educators.

Figure 1. Synergy of infrastructure, technical knowledge, and AI

Furthermore, AI-based intelligent tutoring systems, like Carnegie Learning's MATHia and AutoTutor, support technical education by providing real-time explanations, hints, and assessments tailored to individual student needs (Gyonyoru, 2024). These systems employ natural language processing (NLP) and deep learning to simulate human-like tutoring, ensuring that learners receive immediate assistance in complex problem-solving scenarios. In healthcare-related technical fields, AI-powered virtual patients, such as those used in the Body Interact platform, allow students in medical and nursing programs to diagnose and treat patients in simulated clinical settings, improving their decision-making skills and preparedness for real-world medical challenges. As AI continues to evolve, its integration into technical education will further enhance the learning experience, equipping students with both theoretical knowledge and practical expertise. These tools ensure that learners are well-prepared to navigate and operate sophisticated technologies, ultimately making them more competent and job-ready in AI-driven industries (Ponce et al., 2024). However, for AI to be a truly transformative force, institutions must address existing challenges, invest in equitable AI implementation, and prepare students for the rapidly changing workforce. Figure 1 illustrates the synergy between school infrastructure, technical knowledge, and AI, emphasizing their collective role in equipping the next generation of technicians for the challenges and opportunities presented by AI integration in education.

CHALLENGES AND PITFALLS OF AI INTEGRATION

Potential Misuse of AI in Education

AI tools are increasingly used in education to automate processes, enhance personalized learning, and provide real-time feedback. However, their misuse can lead to unintended consequences when implemented without a thorough understanding of their limitations (Acut, Malabago, et al., 2025). A notable example is the use of AI-based grading systems, which assess student writing based on linguistic patterns rather than content depth or creativity (Malik et al., 2023). This has resulted in cases where students using innovative problem-solving approaches receive lower scores, discouraging creative thinking. Over-reliance on AI for assessments also risks deskilling educators, reducing their ability to provide qualitative evaluations that account for nuances AI may overlook. AI-driven surveillance in education presents another significant challenge. In some institutions, AI-powered monitoring systems intended to prevent cheating have sparked controversy over privacy violations and psychological stress among students (Giannakos et al., 2024). For instance, AI proctoring software has been criticized for falsely flagging students due to factors like involuntary movements, poor lighting, or connectivity issues, disproportionately affecting students with disabilities or those from low-income backgrounds. These concerns underscore the need for hybrid approaches where human oversight complements AI decision-making, ensuring fairness and accountability (Coghlan et al., 2021).

Issues of Skill Obsolescence and Degradation

The integration of AI in technical education and vocational training presents a dual challenge: while AI-driven tools enhance learning, they may also contribute to skill degradation. Automated systems now perform many routine tasks (e.g., troubleshooting machinery) that once required manual execution (Filippi et al., 2023). Without active engagement in these foundational skills, students risk becoming overly reliant on AI, which could limit their adaptability in dynamic work environments. A real-world example of this issue is evident in the automotive and manufacturing industries, where AI-powered diagnostic tools have streamlined troubleshooting processes (Malik et al., 2023). While these advancements increase efficiency, they also reduce the hands-on problem-solving experience students gain during training. If educational programs neglect fundamental skill development, future technicians may struggle when AI-driven tools fail or require human intervention for complex issues (Walter, 2024).

Beyond individual competencies, AI-driven automation raises concerns about job displacement. Historical patterns show that technological shifts have rendered certain skill sets obsolete, requiring workers to reskill continually (Zirar et al., 2023). The challenge for educational institutions is to embed adaptability and lifelong learning strategies into technical programs. This includes offering courses on AI ethics, human-AI collaboration, and emerging technologies, preparing students for evolving labor market demands (Bobitan et al., 2024).

Bias and Equity Concerns in AI-Driven Learning Environments

AI-driven educational tools rely on large datasets to analyze student performance and personalize learning experiences (Revano & Garcia, 2021). However, biases in these datasets can reinforce systemic inequalities, disproportionately disadvantaging marginalized student groups. For example, facial recognition software has been found to misidentify students from underrepresented backgrounds at higher rates due to a lack of diversity in training datasets (Chen, 2023). Similarly, AI-powered grading algorithms have been documented to unfairly penalize non-native English speakers, students from low-income schools, and learners with non-traditional educational backgrounds (Salazar et al., 2024). A major instance of AI bias occurred in the UK during the 2020 COVID-19 pandemic, when an AI-based grading algorithm disproportionately downgraded students from disadvantaged schools (Shead, 2020). The model, designed to standardize scores in the absence of traditional exams, prioritized historical school performance over individual merit, systematically favoring students from elite institutions. Public outcry forced the government to abandon the system, highlighting the risks of unchecked AI decision-making in education. Similar failures have been reported elsewhere; for instance, AI-driven admission tools used in U.S. universities may unintentionally favor specific candidate profiles due to biased data patterns in historical admissions records (Stivers, 2018).

Beyond algorithmic bias, unequal access to AI-driven tools perpetuates educational disparities. Underfunded schools often lack the necessary infrastructure—such as high-speed internet, updated hardware, and digital literacy training—limiting students' ability to fully engage with AI-enhanced learning (Kamalov et al., 2023). This digital divide is particularly stark in developing nations, where insufficient technological infrastructure has led to the failure of several AI-driven education initiatives. For example, in India, various EdTech initiatives have faced challenges due to inconsistent digital infrastructure (Kumar, 2023), while a large-scale AI-powered adaptive learning program launched in Bangladesh failed due to unreliable electricity and internet access, rendering the technology largely unusable in classrooms (Tarafdar et al., 2025). Without targeted interventions, AI-driven education risks deepening the gap between high- and low-resource institutions rather than bridging it. Industry-driven AI adoption in education presents another challenge, as commercial interests sometimes take precedence over student learning. Some EdTech companies develop proprietary AI-powered platforms that limit schools' ability to customize learning pathways or integrate alternative educational tools. In extreme cases, corporate-led AI initiatives have locked schools into expensive subscription models, forcing budget-constrained institutions to abandon AI-driven education entirely (Kamalov et al., 2023). Additionally, concerns have been raised over student data privacy, as some AI learning platforms collect extensive user data without clear regulations on how it is stored, shared, or monetized.

To address these challenges, policymakers must ensure that AI tools are built on diverse, representative datasets to minimize bias and promote fairer educational outcomes. Targeted funding should be allocated to schools in underserved communities to improve infrastructure and technological readiness. Moreover, training programs must equip educators with the skills to identify and mitigate AI biases while fostering digital literacy among students. Finally, governments and educational institutions must critically evaluate industry partnerships to ensure that AI adoption aligns with long-term educational equity goals rather than short-term commercial interests. Strengthening regulatory frameworks around AI use in schools—such as mandating transparent algorithmic audits and enforcing ethical AI guidelines—will be crucial in mitigating risks while maximizing the benefits of AI-driven learning.

Impact on School Infrastructure

The successful integration of AI in education is heavily dependent on robust school infrastructure. However, many institutions—especially in low-income regions—lack the fundamental resources necessary for AI-driven learning. Poor internet connectivity, outdated hardware, and unreliable electricity can severely limit AI's effectiveness, creating disparities in educational outcomes (Ali et al., 2024). A report from UNESCO (2024) highlights that the integration of generative artificial intelligence in education presents both opportunities and challenges in the Asia-Pacific region. However, disparities in school infrastructure significantly impact its effectiveness. Schools with limited internet access and outdated facilities struggle to implement AI-powered learning tools, leading to frequent system failures and underutilization. In contrast, well-funded institutions with high-speed internet and modern classrooms can fully leverage AI, further widening the educational divide. Addressing these infrastructure gaps is crucial to ensuring equitable access to AI-driven education across the region.

Beyond technical limitations, the financial burden of AI integration is a significant challenge. Infrastructure upgrades require substantial investments in cybersecurity, AI-compatible lab spaces, and continuous teacher training. Many schools, particularly in developing regions, struggle to secure funding for these upgrades, resulting in delayed or failed AI initiatives. In addition, experts continue to debate the role of AI in education while schools grapple with its implementation. However, despite the discussions, progress remains slow. Many of the challenges surrounding AI integration—such as high costs, security concerns, and the need for specialized IT knowledge—mirror longstanding issues in educational technology. Yet, AI introduces a new dimension to these persistent obstacles that reshape the conversation on EdTech adoption (Bozkurt et al., 2024; Xiao et al., 2025). Additionally, the financial burden of AI-powered grading systems presents a significant challenge for educators and institutions. A case involving an adjunct university professor highlights these cost implications (Kumar, 2023). After filling out the AI grading service's requested information form, the professor received a price quote that required allocating a substantial portion of their income toward grading student papers. The service demanded a valid credit card, charging a base fee in addition to per-use costs. Even if the cost could be offset through an institutional account, available funds would still fall short, and prices were likely to increase over time, with unclear cancellation policies that could incur significant fees. These financial burdens extend beyond individual users, as many educational institutions with limited budgets struggle to afford commercial AI grading services.

Addressing these challenges requires a multi-stakeholder approach involving policymakers, educators, and industry leaders. Public-private partnerships can play a crucial role in equipping schools with sustainable AI infrastructure, ensuring long-term support rather than short-term interventions. Moreover, initiatives such as open-access AI tools and low-cost digital solutions can help bridge the gap between high- and low-resource schools, ensuring that AI integration benefits all students equitably. Table 1 presents a summary of the key challenges and pitfalls associated with AI integration in education, highlighting infrastructural, technical, and ethical concerns that impact its effective implementation.

Table 1. Summary of challenges and pitfalls in AI integration in education

Challenge	Description	Examples	Proposed Solutions
Potential Misuse of AI	Misapplication of AI tools in assessment, monitoring, and prediction leading to ethical concerns and ineffective outcomes.	AI grading prioritizing linguistic patterns over creativity; Surveillance systems infringing on privacy.	Implement ethical guidelines; combine human judgment with AI outputs; train educators on responsible AI use.
Skill Obsolescence and Degradation	Over-reliance on AI reducing manual skills and rendering some competencies obsolete.	Automation replacing routine tasks like basic coding; AI reducing manual problem-solving opportunities.	Balance foundational skills with AI-based learning; embed lifelong learning and adaptability into curricula.
Bias and Equity Concerns	Algorithmic biases and unequal access to AI tools creating disparities in learning opportunities.	Biased grading algorithms disadvantaging minority groups; Digital divide excluding students in low-income regions.	Use diverse datasets; invest in digital infrastructure; develop open-access tools to bridge the digital divide.
Impact on School Infrastructure	Inadequate resources and high costs limiting effective AI implementation in schools.	Lack of internet connectivity, outdated hardware, insufficient electricity in schools, and high maintenance costs for AI-compatible tools.	Invest in infrastructure upgrades; allocate budgets for AI labs and cybersecurity; promote public-private partnerships.

STRATEGIES FOR IMPROVEMENT

Enhancing School Infrastructure for Technical Education

For AI to be effectively integrated into technical education, schools must first address infrastructure limitations that hinder the seamless adoption of AI-driven technologies. Investment in modern laboratories, AI-equipped classrooms, and reliable power supply is essential to ensure that students have access to the tools needed to develop AI literacy and technical proficiency (Kamalov et al., 2023). Additionally, high-speed internet, cloud computing capabilities, and AI-compatible software and hardware must be prioritized to support AI-powered learning environments. Schools in developing regions, particularly those in rural areas, must receive targeted funding for infrastructure upgrades to bridge the digital divide and ensure equitable access to AI-driven education (Haleem et al., 2022). However, the financial burden of upgrading school infrastructure remains a critical challenge. Many educational institutions, particularly in low-income regions, struggle to secure funding for AI-ready facilities. For example, AI deployment in the education sector across Africa faces significant hurdles, particularly due to infrastructural limitations that contribute to digital literacy gaps. The integration of AI in education also increases power consumption, further straining school budgets and making it challenging to sustain long-term implementation. Similarly, logistical issues—such as lack of maintenance personnel or inadequate training for teachers—have led to AI tools being abandoned or underutilized in some institutions. In contrast, Singapore's Ministry of

Education successfully integrated AI-driven learning tools by ensuring sustained investment in digital infrastructure, teacher training, and cybersecurity measures. Their strategic approach enabled widespread AI adoption without exacerbating educational inequalities.

Cybersecurity and data privacy measures are equally crucial. AI-powered platforms collect vast amounts of student data, and without robust security protocols, this data could be vulnerable to breaches or misuse. Institutions must implement secure cloud storage, encryption mechanisms, and strict access controls to protect sensitive student information while complying with international data protection standards (ISO/IEC 27001). However, cybersecurity implementation can be costly and requires skilled personnel, which many schools lack, further complicating AI adoption. A case from India highlights the risks of poor cybersecurity planning: an AI-powered online examination system experienced data leaks, exposing thousands of student records due to weak encryption protocols (Dayal, 2023). The success of AI integration also relies on teacher preparedness. Educators must be equipped with the skills necessary to leverage AI tools for instruction, assessment, and student engagement. Professional development programs—including workshops, AI boot camps, and partnerships with AI experts—should be prioritized to help teachers navigate AI platforms and integrate them effectively into their pedagogical practices (Chan, 2023). Without proper training, teachers may resist AI adoption due to unfamiliarity or concerns about job displacement. Some schools have reported cases where AI-powered grading and tutoring systems were abandoned after initial implementation due to low teacher confidence and lack of ongoing technical support (Kim et al., 2022). In contrast, Finland's AI in Education Initiative successfully trained teachers through national AI literacy programs, ensuring sustained adoption and pedagogical integration (Moraitis, 2025). To ensure sustainable AI integration, institutions must strategically plan investments, secure long-term funding, and provide ongoing technical and professional development support. Public-private partnerships, government subsidies, and open-access AI tools can help lower costs and facilitate broader adoption, ensuring that AI benefits all students equitably rather than exacerbating existing educational disparities.

Strengthening Collaboration Between Educational Institutions and Industry

A stronger partnership between academia and industry is crucial for aligning AI education with real-world applications. Collaborations with technology firms, research institutions, and industry leaders can provide students with access to cutting-edge AI tools, industry-relevant datasets, and internship opportunities that enhance their practical skills (Ahmed et al., 2022). For instance, partnerships between educational institutions and AI-driven companies in Japan have led to the development of AI-powered smart manufacturing training centers, equipping students with hands-on experience in robotics, automation, and machine learning applications in industrial settings. However, financial constraints and regulatory barriers often limit the scalability of such collaborations. Many educational institutions, particularly in developing regions, lack the funding necessary to establish sustained industry partnerships. In some cases, government regulations on data privacy and intellectual property rights create additional hurdles, making it difficult for schools to access proprietary AI technologies or industry datasets. For example, in the European Union, strict General Data Protection Regulation (GDPR) policies have complicated data-sharing agreements between universities and AI companies (Sartor & Lagioia, 2020).

In the Philippines, collaborations such as the University of the Philippines' Center for Intelligent Systems and industry-led AI boot camps have facilitated joint research projects and innovation hubs focused on AI development (Celdran, 2024). These initiatives bridge the gap between academic learning and workforce demands by ensuring that curricula remain up-to-date with emerging AI trends and industry needs. However, sustaining these partnerships remains a challenge, as industry stakeholders may prioritize short-term projects over long-term academic collaborations. Some universities have struggled to maintain corporate partnerships due to shifting industry interests, leading to inconsistent access to AI tools and mentorship programs. While industry collaborations have largely benefited AI education, some unintended consequences have emerged. In certain cases, commercial interests have overridden educational priorities, resulting in conflicts of interest. For example, In the United States, certain corporate-sponsored AI training programs have faced criticism for emphasizing proprietary software over open-source alternatives. Meta's Llama AI models have been labeled as “open-source,” but the Open Source Initiative (OSI) argues that this characterization is misleading, as Meta restricts competitor use under its license and lacks full transparency regarding training data (Waters, 2024). Similarly, in India, collaborations between major technology companies and educational institutions have sometimes resulted in AI certification programs that predominantly focus on the company's own products. For example, TalentSprint, an EdTech firm, partners with universities to deliver certification programs in AI and other technologies (Bhattacharyya, 2021). While these programs aim to enhance employability, there is a concern that they may limit students' ability to work with diverse AI frameworks by concentrating on specific corporate technologies. These scenarios highlight the risk of industry partnerships shaping AI education in ways that primarily serve corporate agendas rather than academic and student needs.

Beyond curriculum enhancements, industry collaborations can facilitate AI resource sharing. Through public-private partnerships, educational institutions can receive access to state-of-the-art AI tools, cloud computing services, and machine learning models that would otherwise be cost-prohibitive. However, funding disparities between institutions can create inequities in access, with well-funded universities benefiting disproportionately from such partnerships while under-resourced schools remain excluded. Additionally, logistical challenges, such as aligning academic calendars with industry project timelines, can hinder the smooth execution of collaborative initiatives. To address these barriers, policymakers must create incentives for long-term industry-education partnerships, such as tax benefits for companies that invest in academic AI programs or government grants to support resource-sharing initiatives. Moreover, establishing standardized frameworks for ethical AI collaborations—including clear guidelines on data usage, intellectual property rights, and student involvement—can help build sustainable partnerships that benefit both academia and industry. Joint certification programs between universities and AI firms can further enhance students' employability (Walter, 2024).

Developing an AI-integrated Technical Education Curriculum

A revised curriculum that integrates AI literacy alongside technical skills is essential for preparing students for the demands of an AI-driven workforce. Traditional technical education programs must evolve to include AI applications in engineering, data analytics, cybersecurity, and smart manufacturing. This involves redesigning courses to incorporate AI-driven problem-solving techniques, machine learning algorithms, and automation principles (Southworth et al., 2023). For example, in technical education fields such as robotics and mechatronics, AI-powered control systems can be embedded into coursework to help students understand predictive maintenance, AI-driven automation, and real-time data analytics (Mishra et al., 2024). Similarly, in computer science and information technology, courses must emphasize AI programming languages (e.g., Python, TensorFlow), neural networks, and natural language processing to align with the increasing demand for AI-skilled professionals. Additionally, the curriculum should foster the development of critical thinking, ethical reasoning, and problem-solving skills. While AI can automate many routine tasks, human oversight remains essential in interpreting AI outputs, mitigating biases, and ensuring ethical AI deployment. Courses on AI ethics, digital literacy, and data governance should be incorporated to help students navigate the societal and ethical challenges of AI technology. Several Philippine universities have already taken steps in this direction with their Data Science and Analytics program, which balances technical AI training with discussions on AI governance and ethical implications (Cacho, 2024).

Establishing AI Literacy and Inclusivity Initiatives

To ensure that AI integration benefits all students equitably, institutions must implement AI literacy programs that cater to diverse learning needs. AI literacy encompasses not only technical skills but also critical thinking skills that help students assess AI-generated content, address ethical concerns, and prevent over-reliance on automated tools (Ali et al., 2024). Without structured AI education, students risk becoming passive consumers of AI outputs rather than active, informed users who understand its limitations. One major risk associated with rapid AI adoption in education is skill obsolescence, particularly in traditional learning domains. Studies have shown that excessive dependence on AI-powered tools for writing, computation, and problem-solving can lead to skill degradation over time. A mixed-methods study by Lee et al. (2024) in South Korea, for instance, found that English language learners (ELLs) recognized both the strengths and weaknesses of various AI-based tools, including the accessibility of translation machine learning and the error-checking capabilities of generative AI. However, interview data analysis indicated that excessive reliance on AI-based writing tools could interfere with ELLs' English writing process. These findings suggest that AI literacy initiatives must incorporate guidelines on responsible AI use to prevent skill erosion in foundational competencies.

Beyond skill obsolescence, AI misuse is another pressing concern. Unregulated AI use in education can reinforce biases, compromise academic integrity, and perpetuate misinformation. A manifesto by Bozkurt et al. (2024) on AI-assisted grading in higher education emphasized that algorithmic biases disproportionately impact students from underrepresented backgrounds, resulting in unfair assessments. Similarly, cases of AI-generated misinformation in academic research have raised concerns about students relying on AI-generated citations, some of which are fabricated or inaccurate (Acut et al., 2024). AI literacy programs must include training on ethical AI use, bias detection, and fact-checking methodologies to equip students with the skills needed to critically evaluate AI-generated outputs. AI-driven education should also incorporate adaptive learning models that personalize instruction based on student needs. AI-powered platforms like IBM Watson and Google's AI for Education can tailor learning materials to students' strengths and weaknesses, promoting inclusive and equitable access to AI-based education. However, access to such tools remains uneven, particularly in low-income regions where digital infrastructure is lacking. A report found that students in rural schools had limited engagement with AI-driven adaptive learning platforms due to poor internet connectivity and lack of teacher training, exacerbating the digital divide (Varsik & Vosberg, 2024). Schools must prioritize financial support programs, AI scholarships, and open-source AI tools to ensure that students from disadvantaged backgrounds can participate in AI-driven learning environments.

To ensure that AI literacy programs are effectively implemented, educational institutions and policymakers must develop AI literacy curricula that integrate technical knowledge with ethical considerations, digital responsibility, and critical thinking. They must also incorporate blended learning approaches that balance AI-assisted learning with traditional skill development to prevent over-reliance. Ensuring access to AI education for marginalized groups through multilingual resources, inclusive AI tools, and financial aid programs is crucial, as is mandating transparency and accountability in AI use by requiring educators to evaluate AI tools for bias, accuracy, and ethical implications. Strengthening teacher training programs will further equip educators with the knowledge and skills needed to integrate AI responsibly into the classroom. Integrating AI literacy into education systems enables institutions to cultivate a generation of learners who are not only skilled in AI but also capable of using it critically, ethically, and adaptively. Table 2 outlines strategies for enhancing AI integration in technical education, focusing on infrastructure development, curriculum adaptation, and capacity-building initiatives.

Table 2. Strategies for improving AI integration in technical education

Strategy	Key Actions	Examples and Insights
Enhancing School Infrastructure	1. Invest in modern laboratories, AI-equipped classrooms, and reliable power supply. 2. Provide high-speed internet and AI-compatible hardware/software. 3. Prioritize infrastructure upgrades in rural areas.	Addressing the digital divide in rural schools. AI-ready classrooms for hands-on learning with cutting-edge tools.
Educator Training for AI Integration	1. Organize teacher training programs for effective AI tool usage. 2. Conduct workshops, seminars, and collaborations with AI experts. 3. Encourage personalized learning through AI platforms.	Continuous professional development ensures educators stay updated. Enables automation of administrative tasks and personalized support for students.
Strengthening Education Institution-Industry Collaboration	1. Partner with technology companies and industry leaders for access to equipment and industry-relevant data. 2. Create internships, apprenticeships, and real-world project opportunities. 3. Establish joint innovation hubs.	University innovation centers focus on AI development. Align curriculum with labor market demands to enhance graduate employability.
Developing AI-Integrated Curriculum	1. Integrate AI tools, data analytics, and machine learning into technical programs. 2. Redesign courses to teach AI-enhanced problem-solving. 3. Incorporate ethics, digital literacy, and governance.	Data Science and Analytics program in several universities prepares students for data and AI-driven industries. Builds both technical and ethical competencies.
Advancing AI Literacy and Inclusion	1. Implement AI literacy programs in technical training. 2. Promote inclusive AI access through government and industry partnerships. 3. Develop ethical AI awareness programs in educational curricula.	AI learning hubs in rural areas and AI ethics workshops in technical education programs to bridge the digital divide and promote responsible AI use.

The successful integration of AI into technical education requires a multi-faceted approach that addresses infrastructure challenges, strengthens industry collaborations, modernizes curricula, and promotes inclusivity (Garcia et al., 2024). Investing in AI-ready facilities, equipping educators with AI competencies, and fostering industry-academic partnerships enable institutions to build a strong AI ecosystem that prepares students for AI-driven careers. A well-rounded curriculum—balancing technical expertise with ethical AI literacy—ensures that graduates not only excel in AI-powered workplaces but also navigate the complexities of AI governance responsibly. With proactive policy interventions, strategic investments, and continuous professional development, technical education institutions can harness the full potential of AI, fostering an innovative and ethically conscious AI-literate workforce for the future.

CONCLUSION

The integration of AI in technical education presents both opportunities and challenges, particularly in enhancing school infrastructure and technical knowledge. While AI-driven learning has the potential to revolutionize education, its successful implementation requires strategic investments in modern facilities and comprehensive educator training. Educational institutions, particularly those in resource-limited settings, must explore cost-effective solutions and industry partnerships to bridge technological gaps and ensure equitable access to AI-enhanced learning. Collaboration among academia, industry, and policymakers plays a crucial role in aligning curricula with evolving workforce demands. Integrating AI literacy and problem-solving skills into technical education ensures that students are better prepared for emerging job markets. Case studies from global and local contexts highlight the importance of adaptive policies and interdisciplinary approaches in overcoming challenges such as the digital divide, ethical concerns, and AI bias in educational content. To maximize the benefits of AI while mitigating its pitfalls, institutions should implement structured AI governance, promote ethical AI use, and adopt a balanced approach that combines human expertise with technological advancements. The transformation of technical education must be a collective effort—one that involves continuous dialogue, research, and innovation. Ensuring an inclusive and future-ready learning environment will allow AI integration to enhance, rather than disrupt, the educational landscape.

REFERENCES

Acut, D. P., Gamusa, E. V., Pernaa, J., Yuenyong, C., Pantaleon, A. T., Espina, R. C., Sim, M. J. C., & Garcia, M. B. (2025). AI Shaming Among Teacher Education Students: A Reflection on Acceptance and Identity in the Age of Generative Tools. In *Pitfalls of AI Integration in Education: Skill Obsolescence, Misuse, and Bias*. IGI Global., DOI: 10.4018/979-8-3373-0122-8.ch005

Acut, D. P., Malabago, N. K., Malicoban, E. V., Galamiton, N. S., & Garcia, M. B. (2024). "ChatGPT 4.0 Ghosted Us While Conducting Literature Search:" Modeling the Chatbot's Generated Non-Existent References Using Regression Analysis. *Internet Reference Services Quarterly*, •••, 1–26. DOI: 10.1080/10875301.2024.2426793

Acut, D. P., Malabago, N. K., Malicoban, E. V., Galamiton, N. S., & Garcia, M. B. (2025). "ChatGPT 4.0 Ghosted Us While Conducting Literature Search:" Modeling the Chatbot's Generated Non-Existent References Using Regression Analysis. *Internet Reference Services Quarterly*, *29*(1), 27–54. Advance online publication. DOI: 10.1080/10875301.2024.2426793

Agyei, E. A., Annim, S. K., Acquah, B. Y. S., Sebu, J., & Agyei, S. K. (2024). Education Infrastructure Inequality and Academic Performance in Ghana. *Heliyon*, *10*(14), 1–25. DOI: 10.1016/j.heliyon.2024.e34041 PMID: 39108894

Ahmed, F., Fattani, M. T., Ali, S. R., & Enam, R. N. (2022). Strengthening the Bridge Between Academic and the Industry Through the Academia-Industry Collaboration Plan Design Model. *Frontiers in Psychology*, *13*, 1–11. DOI: 10.3389/fpsyg.2022.875940 PMID: 35734456

Akhtar, P., Moazzam, M., Ashraf, A., & Khan, M. N. (2024). The Interdisciplinary Curriculum Alignment to Enhance Graduates' Employability and Universities' Sustainability. *International Journal of Management Education*, *22*(3), 1–17. DOI: 10.1016/j.ijme.2024.101037

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' Perceptions of Technology Integration in Teaching-Learning Practices: A Systematic Review. *Frontiers in Psychology*, *13*, 1–9. DOI: 10.3389/fpsyg.2022.920317 PMID: 35734463

Ali, O., Murray, P. A., Momin, M., Dwivedi, Y. K., & Malik, T. (2024). The Effects of Artificial Intelligence Applications in Educational Settings: Challenges and Strategies. *Technological Forecasting and Social Change*, *199*, 1–18. DOI: 10.1016/j.techfore.2023.123076

Asian Development Bank. (2021). *Technical and Vocational Education and Training in the Philippines in the Age of Industry 4.0*. DOI: 10.22617/TCS210084

Autor, D. H. (2015). Why Are There Still So Many Jobs? The History and Future of Workplace Automation. *The Journal of Economic Perspectives*, *29*(3), 3–30. DOI: 10.1257/jep.29.3.3

Backfisch, I., Lachner, A., Stürmer, K., & Scheiter, K. (2021). Variability of Teachers' Technology Integration in the Classroom: A Matter of Utility! *Computers & Education*, *166*, 1–21. DOI: 10.1016/j.compedu.2021.104159

Banse, G., & Grunwald, A. (2009). *Coherence and Diversity in the Engineering Sciences*. Elsevier., DOI: 10.1016/B978-0-444-51667-1.50010-0

Barrett, P., Treves, A., Shmis, T., Ambasz, D., & Ustinova, M. (2018). *The Impact of School Infrastructure on Learning: A Synthesis of the Evidence*. World Bank., DOI: 10.1596/978-1-4648-1378-8

Bernhard, J. (2018). What Matters for Students' Learning in the Laboratory? Do Not Neglect the Role of Experimental Equipment! *Instructional Science*, *46*(6), 819–846. DOI: 10.1007/s11251-018-9469-x

Bobitan, N., Dumitrescu, D., Popa, A. F., Sahlian, D. N., & Turlea, I. C. (2024). Shaping Tomorrow: Anticipating Skills Requirements Based on the Integration of Artificial Intelligence in Business Organizations—A Foresight Analysis Using the Scenario Method. *Electronics (Basel)*, *13*(11), 1–17. DOI: 10.3390/electronics13112198

Bozkurt, A., Xiao, J., Farrow, R., Bai, J. Y. H., Nerantzi, C., Moore, S., Dron, J., Stracke, C. M., Singh, L., Crompton, H., Koutropoulos, A., Terentev, E., Pazurek, A., Nichols, M., Sidorkin, A. M., Costello, E., Watson, S., Mulligan, D., Honeychurch, S., & Asino, T. I. (2024). The Manifesto for Teaching and Learning in a Time of Generative AI: A Critical Collective Stance to Better Navigate the Future. *Open Praxis*, *16*(4), 487–513. DOI: 10.55982/openpraxis.16.4.777

Cacho, R. (2024). Integrating Generative AI in University Teaching and Learning: A Model for Balanced Guidelines. *Online Learning : the Official Journal of the Online Learning Consortium*, *28*(3), 1–28. DOI: 10.24059/olj.v28i3.4508

Cai, J., & Kosaka, M. (2024). Conceptualizing Technical and Vocational Education and Training as a Service Through Service-Dominant Logic. *SAGE Open*, *14*(2), 1–16. DOI: 10.1177/21582440241240847

Celdran, C. (2024). Establishing the Philippine AI Research Center: Pioneering AI Adoption in a Filipino Context. *CoinGeek*. https://coingeek.com/establishing-the-philippine-ai-research-center-pioneering-ai-adoption-in-a-filipino-context/

Chan, C. K. Y. (2023). A Comprehensive AI Policy Education Framework for University Teaching and Learning. *International Journal of Educational Technology in Higher Education*, *20*(1), 1–25. DOI: 10.1186/s41239-023-00408-3

Chen, Z. (2023). Ethics and Discrimination in Artificial Intelligence-Enabled Recruitment Practices. *Humanities & Social Sciences Communications*, *10*(1), 1–12. DOI: 10.1057/s41599-023-02079-x

Cheng, M., Adekola, O., Albia, J., & Cai, S. (2021). Employability in Higher Education: A Review of Key Stakeholders' Perspectives. *Higher Education Evaluation and Development*, *16*(1), 16–31. DOI: 10.1108/HEED-03-2021-0025

Ciavaldini-Cartaut, S., Métral, J.-F., Olry, P., Guidoni-Stoltz, D., & Gagneur, C.-A. (2024). Artificial Intelligence in Professional and Vocational Training. In *Palgrave Studies in Creativity and Culture* (pp. 145–155). Springer Nature Switzerland.

Coghlan, S., Miller, T., & Paterson, J. (2021). Good Proctor or "Big Brother"? Ethics of Online Exam Supervision Technologies. *Philosophy & Technology*, *34*(4), 1581–1606. DOI: 10.1007/s13347-021-00476-1 PMID: 34485025

Dayal, D. (2023). Cyber Risks in the Education Sector: Why Cybersecurity Needs to Be Top of the Class. *Digital First Magazine*. https://www.digitalfirstmagazine.com/cyber-risks-in-the-education-sector-why-cybersecurity-needs-to-be-top-of-the-class/

Delcker, J., & Ifenthaler, D. (2022). Digital Distance Learning and the Transformation of Vocational Schools From a Qualitative Perspective. *Frontiers in Education*, *7*, 1–15. DOI: 10.3389/feduc.2022.908046

Elahi, M., Afolaranmi, S. O., Martinez Lastra, J. L., & Perez Garcia, J. A. (2023). A Comprehensive Literature Review of the Applications of AI Techniques Through the Lifecycle of Industrial Equipment. *Discover Artificial Intelligence*, *3*(1), 1–78. DOI: 10.1007/s44163-023-00089-x

Ferrara, E. (2023). Fairness and Bias in Artificial Intelligence: A Brief Survey of Sources, Impacts, and Mitigation Strategies. *Sci*, *6*(1), 1–15. DOI: 10.3390/sci6010003

Filippi, E., Bannò, M., & Trento, S. (2023). Automation Technologies and Their Impact on Employment: A Review, Synthesis and Future Research Agenda. *Technological Forecasting and Social Change*, *191*, 1–21. DOI: 10.1016/j.techfore.2023.122448

Gallagher, K. (2024). Siemens NX CAM Integrates AI-Powered CAM Assist. *Siemens*. https://blogs.sw.siemens.com/nx-manufacturing/the-future-of-ai-cnc-programming-siemens-nx-cam-integrates-ai-powered-cam-assist/

Garcia, M. B. (2022). Hackathons as Extracurricular Activities: Unraveling the Motivational Orientation Behind Student Participation. *Computer Applications in Engineering Education*, *30*(6), 1903–1918. DOI: 10.1002/cae.22564

Garcia, M. B., Arif, Y. M., Khlaif, Z. N., Zhu, M., de Almeida, R. P. P., de Almeida, R. S., & Masters, K. (2024). Effective Integration of Artificial Intelligence in Medical Education: Practical Tips and Actionable Insights. In *Transformative Approaches to Patient Literacy and Healthcare Innovation* (pp. 1-19). IGI Global. DOI: 10.4018/979-8-3693-3661-8.ch001

Garcia, M. B., Goi, C.-L., Shively, K., Maher, D., Rosak-Szyrocka, J., Happonen, A., Bozkurt, A., & Damaševičius, R. (2025). Understanding Student Engagement in AI-Powered Online Learning Platforms: A Narrative Review of Key Theories and Models. In *Cases on Enhancing P-16 Student Engagement With Digital Technologies* (pp. 1-30). IGI Global. DOI: 10.2139/ssrn.5074608

Garcia, M. B., Rosak-Szyrocka, J., Yılmaz, R., Metwally, A. H. S., Acut, D. P., Ofosu-Ampong, K., Erdoğdu, F., Fung, C. Y., & Bozkurt, A. (2025). Rethinking Educational Assessment in the Age of Generative AI: Actionable Strategies to Mitigate Academic Dishonesty. In *Pitfalls of AI Integration in Education: Skill Obsolescence, Misuse, and Bias*. IGI Global., DOI: 10.4018/979-8-3373-0122-8.ch001

Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., Järvelä, S., Mavrikis, M., & Rienties, B. (2024). The Promise and Challenges of Generative AI in Education. *Behaviour & Information Technology*, •••, 1–27. DOI: 10.1080/0144929X.2024.2394886

Gyonyoru, K. I. K. (2024). The Role of AI-Based Adaptive Learning Systems in Digital Education. *Journal of Applied Technical and Educational Sciences*, *14*(2), 1–12. DOI: 10.24368/jates380

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the Role of Digital Technologies in Education: A Review. *Sustainable Operations and Computers*, *3*, 275–285. DOI: 10.1016/j.susoc.2022.05.004

Hanaysha, J. R., Shriedeh, F. B., & In'airat, M. (2023). Impact of Classroom Environment, Teacher Competency, Information and Communication Technology Resources, and University Facilities on Student Engagement and Academic Performance. *International Journal of Information Management Data Insights*, *3*(2), 1–12. DOI: 10.1016/j.jjimei.2023.100188

Hasanah, N. A., Aziza, M. R., Junikhah, A., Arif, Y. M., & Garcia, M. B. (2025). Navigating the Use of AI in Engineering Education Through a Systematic Review of Technology, Regulations, and Challenges. In *Pitfalls of AI Integration in Education: Skill Obsolescence, Misuse, and Bias*. IGI Global., DOI: 10.4018/979-8-3373-0122-8.ch016

Kabudi, T., Pappas, I., & Olsen, D. H. (2021). Ai-Enabled Adaptive Learning Systems: A Systematic Mapping of the Literature. *Computers and Education: Artificial Intelligence*, *2*, 1–12. DOI: 10.1016/j.caeai.2021.100017

Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New Era of Artificial Intelligence in Education: Towards a Sustainable Multifaceted Revolution. *Sustainability (Basel)*, *15*(16), 1–27. DOI: 10.3390/su151612451

Kim, J., Lee, H., & Cho, Y. H. (2022). Learning Design to Support Student-Ai Collaboration: Perspectives of Leading Teachers for AI in Education. *Education and Information Technologies*, *27*(5), 6069–6104. DOI: 10.1007/s10639-021-10831-6

Kumar, R. (2023). Faculty Members' Use of Artificial Intelligence to Grade Student Papers: A Case of Implications. *International Journal for Educational Integrity*, *19*(1), 1–10. DOI: 10.1007/s40979-023-00130-7

Latip, M. S. A., Latip, S. N. N. A., Tamrin, M., & Rahim, F. A. (2024). Modelling Physical Ergonomics And student Performance in Higher Education: The Mediating Effect Of student Motivation. *Journal of Applied Research in Higher Education*. Advance online publication. DOI: 10.1108/JARHE-01-2024-0052

Lee, Y.-J., Davis, R. O., & Lee, S. O. (2024). University Students' Perceptions of Artificial Intelligence-Based Tools for English Writing Courses. *Online Journal of Communication and Media Technologies*, *14*(1), 1–11. DOI: 10.30935/ojcmt/14195

Malik, A. R., Pratiwi, Y., Andajani, K., Numertayasa, I. W., Suharti, S., Darwis, A., & Marzuki, . (2023). Exploring Artificial Intelligence in Academic Essay: Higher Education Student's Perspective. *International Journal of Educational Research Open*, *5*, 1–11. DOI: 10.1016/j.ijedro.2023.100296

Mangubat, J. C., Mangubat, M. R., Uy, T. B. L., Acut, D. P., & Garcia, M. B. (2025). Safeguarding Educational Innovations Amid AI Disruptions: A Reassessment of Patenting for Sustained Intellectual Property Protection. In *Pitfalls of AI Integration in Education: Skill Obsolescence, Misuse, and Bias*. IGI Global., DOI: 10.4018/979-8-3373-0122-8.ch013

McGrath, S., & Yamada, S. (2023). Skills for Development and Vocational Education and Training: Current and Emergent Trends. *International Journal of Educational Development*, *102*, 1–9. DOI: 10.1016/j.ijedudev.2023.102853

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, Opportunities, and Prospects of Adopting and Using Smart Digital Technologies in Learning Environments: An Iterative Review. *Heliyon*, *9*(6), 1–20. DOI: 10.1016/j.heliyon.2023.e16348 PMID: 37274691

Mishra, N., Garcia, P. S., Habal, B. G. M., & Garcia, M. B. (2024). Harnessing an AI-Driven Analytics Model to Optimize Training and Treatment in Physical Education for Sports Injury Prevention. *Proceedings of the 8th International Conference on Education and Multimedia Technology*, 309-315. DOI: 10.1145/3678726.3678740

Montero Guerra, J. M., Danvila-del-Valle, I., & Méndez-Suárez, M. (2023). The Impact of Digital Transformation on Talent Management. *Technological Forecasting and Social Change*, *188*, 1–10. DOI: 10.1016/j.techfore.2022.122291

Moraitis, V. (2025). Why the Guidelines for AI in Finland's Education System Could Redefine Learning Globally. *The AI Track*. https://theaitrack.com/ai-in-finland-education-global-model/

Pandita, A., & Kiran, R. (2023). The Technology Interface and Student Engagement Are Significant Stimuli in Sustainable Student Satisfaction. *Sustainability (Basel)*, *15*(10), 1–21. DOI: 10.3390/su15107923

PBSP. (2022). Digital and IT equipment for Last Mile Schools. https://www.pbsp.org.ph/news/digital-and-it-equipment-for-last-mile-schools

Poláková, M., Suleimanová, J. H., Madzík, P., Copuš, L., Molnárová, I., & Polednová, J. (2023). Soft Skills and Their Importance in the Labour Market Under the Conditions of Industry 5.0. *Heliyon*, *9*(8), 1–20. DOI: 10.1016/j.heliyon.2023.e18670 PMID: 37593611

Ponce, P., Anthony, B., Bradley, R., Maldonado-Romo, J., Méndez, J. I., Montesinos, L., & Molina, A. (2024). Developing a Virtual Reality and Ai-Based Framework for Advanced Digital Manufacturing and Nearshoring Opportunities in Mexico. *Scientific Reports*, *14*(1), 1–24. DOI: 10.1038/s41598-024-61514-4 PMID: 38755242

Revano, T. F., & Garcia, M. B. (2021). Designing Human-Centered Learning Analytics Dashboard for Higher Education Using a Participatory Design Approach. *2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)*, 1-5. DOI: 10.1109/HNICEM54116.2021.9731917

Rintala, H., & Nokelainen, P. (2019). Vocational Education and Learners' Experienced Workplace Curriculum. *Vocations and Learning*, *13*(1), 113–130. DOI: 10.1007/s12186-019-09229-w

Rott, K. J., Lao, L., Petridou, E., & Schmidt-Hertha, B. (2022). Needs and Requirements for an Additional AI Qualification During Dual Vocational Training: Results from Studies of Apprentices and Teachers. *Computers and Education: Artificial Intelligence*, *3*, 1–10. DOI: 10.1016/j.caeai.2022.100102

Rožman, M., Oreški, D., & Tominc, P. (2023). Artificial-Intelligence-Supported Reduction of Employees' Workload to Increase the Company's Performance in Today's VUCA Environment. *Sustainability (Basel)*, *15*(6), 1–21. DOI: 10.3390/su15065019

Salazar, L. R., Peeples, S. F., & Brooks, M. E. (2024). Generative AI Ethical Considerations and Discriminatory Biases on Diverse Students Within the Classroom. In *Advances in Educational Technologies and Instructional Design* (pp. 191-213). IGI Global. DOI: 10.4018/979-8-3693-0831-8.ch010

Sanfo, J.-B. M. B. (2023). Factors Explaining Rural-Urban Learning Achievement Inequalities in Primary Education in Benin, Burkina Faso, Togo, and Cameroon. *International Journal of Educational Research Open*, *4*, 1–11. DOI: 10.1016/j.ijedro.2023.100234

Sartor, G., & Lagioia, F. (2020). *The Impact of the General Data Protection Regulation (GDPR) on Artificial Intelligence*. European Parliamentary Research Service., DOI: 10.2861/293

Shead, S. (2020). How a Computer Algorithm Caused a Grading Crisis in British Schools. *CNBC*. https://www.cnbc.com/2020/08/21/computer-algorithm-caused-a-grading-crisis-in-british-schools.html

Shiri, R., El-Metwally, A., Sallinen, M., Pöyry, M., Härmä, M., & Toppinen-Tanner, S. (2023). The Role of Continuing Professional Training or Development in Maintaining Current Employment: A Systematic Review. *Health Care*, *11*(21), 1–17. DOI: 10.3390/healthcare11212900 PMID: 37958044

Singh, T. M., Reddy, C. K. K., Murthy, B. V. R., Nag, A., & Doss, S. (2025). AI and Education: Bridging the Gap to Personalized, Efficient, and Accessible Learning. In *Advances in Educational Technologies and Instructional Design* (pp. 131-160). IGI Global. DOI: 10.4018/979-8-3693-8151-9.ch005

Soomro, S. A., Casakin, H., Nanjappan, V., & Georgiev, G. V. (2023). Makerspaces Fostering Creativity: A Systematic Literature Review. *Journal of Science Education and Technology*, *32*(4), 530–548. DOI: 10.1007/s10956-023-10041-4

Soori, M., Jough, F. K. G., Dastres, R., & Arezoo, B. (2024). Robotical Automation in CNC Machine Tools: A Review. *Acta Mechanica et Automatica*, *18*(3), 434–450. DOI: 10.2478/ama-2024-0048

Southworth, J., Migliaccio, K., Glover, J., Glover, J. N., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a Model for AI Across the Curriculum: Transforming the Higher Education Landscape via Innovation in AI Literacy. *Computers and Education: Artificial Intelligence*, *4*, 1–10. DOI: 10.1016/j.caeai.2023.100127

Stivers, S. (2018). AI and Bias in University Admissions. *ISM Insights*. https://www.ism.edu/ism-insights/ai-and-bias-in-university-admissions-3.html

Stolpe, K., & Hallström, J. (2024). Artificial Intelligence Literacy for Technology Education. *Computers and Education Open*, *6*, 1–8. DOI: 10.1016/j.caeo.2024.100159

Tarafdar, S., Afroz, S., & Ashrafuzzaman, M. (2025). Artificial Intelligence and the Future of Education in Bangladesh. In *Advances in Educational Technologies and Instructional Design* (pp. 287-320). IGI Global. DOI: 10.4018/979-8-3693-7949-3.ch011

TESDA. (2010). The Dual Training System in the Philippines. https://tesda.gov.ph/about/tesda/91

UNESCO. (2023a). CENTURY, An AI-Powered Teaching and Learning Platform. https://www.unesco.org/en/articles/century-ai-powered-teaching-and-learning-platform

UNESCO (Ed.). (2023b). *Technology in Education: A Case Study on Singapore*., DOI: 10.54676/HOOV5879

UNESCO. (2024). How Generative AI is Reshaping Education in Asia-Pacific. https://www.unesco.org/en/articles/how-generative-ai-reshaping-education-asia-pacific

Varsik, S., & Vosberg, L. (2024). *The Potential Impact of Artificial Intelligence on Equity and Inclusion in Education*. OECD Artificial Intelligence Papers., DOI: 10.1787/15df715b-

Walter, Y. (2024). Embracing the Future of Artificial Intelligence in the Classroom: The Relevance of Ai Literacy, Prompt Engineering, and Critical Thinking in Modern Education. *International Journal of Educational Technology in Higher Education*, *21*(1), 1–29. DOI: 10.1186/s41239-024-00448-3

Weld Australia. (2025). Soldamatic Augmented Reality Welding Simulators. *Weld Australia*. https://weldaustralia.com.au/welding-technology/soldamatic-augmented-reality-welding-simulators/

Windelband, L. (2023). *Artificial Intelligence and Assistance Systems for Technical Vocational Education and Training – Opportunities and Risks*. Springer International Publishing., DOI: 10.1007/978-3-031-26490-0_12

Xiao, J., Bozkurt, A., Nichols, M., Pazurek, A., Stracke, C. M., Bai, J. Y. H., Farrow, R., Mulligan, D., Nerantzi, C., Sharma, R. C., Singh, L., Frumin, I., Swindell, A., Honeychurch, S., Bond, M., Dron, J., Moore, S., Leng, J., & Slagter van Tryon, P. J.. (2025). Venturing into the Unknown: Critical Insights into Grey Areas and Pioneering Future Directions in Educational Generative AI Research. *TechTrends*, •••, 1–16. DOI: 10.1007/s11528-025-01060-6

Yangambi, M. (2023). Impact of School Infrastructures on Students Learning and Performance: Case of Three Public Schools in a Developing Country. *Creative Education*, *14*(04), 788–809. DOI: 10.4236/ce.2023.144052

Zirar, A., Ali, S. I., & Islam, N. (2023). Worker and Workplace Artificial Intelligence (AI) Coexistence: Emerging Themes and Research Agenda. *Technovation*, *124*, 1–17. DOI: 10.1016/j.technovation.2023.102747

KEY TERMS AND DEFINITIONS

AI Integration: The process of incorporating artificial intelligence into educational environments, particularly in technical education, to enhance learning, automate tasks, and improve efficiency in skill development and assessment.

Artificial Intelligence: The field of computer science that enables machines to perform tasks that typically require human intelligence, such as problem-solving, decision-making, and pattern recognition, with applications in education, automation, and workforce training.

School Infrastructure: The physical and digital resources in educational institutions, including classrooms, laboratories, internet connectivity, and AI-powered tools, which support the effective implementation of AI-driven technical education.

Technical Education: A branch of education focused on equipping students with practical and industry-specific skills in areas such as engineering, information technology, and applied sciences, preparing them for specialized careers.

Technical Knowledge: The specialized understanding and expertise required to operate, troubleshoot, and innovate within technical fields, including familiarity with AI-driven tools, programming, and machine learning applications in various industries.

Technicians: Skilled professionals who apply technical knowledge to install, maintain, and repair systems and machinery, including AI-powered technologies, ensuring their effective operation across industries.

Workforce Readiness: The preparedness of graduates and trainees to enter the labor market with the necessary technical knowledge, problem-solving skills, and adaptability to emerging AI-driven technologies in their respective fields.