

# Revolutionizing Education with Industry 5.0: Challenges and Future Research Agendas

**Mostafa Al-Emran<sup>1</sup>, Mohammed A. Al-Sharafi<sup>2,3</sup>**

<sup>1</sup> Faculty of Engineering & IT, The British University in Dubai, Dubai, UAE.

<sup>2</sup> Department of Information Systems, Universiti Teknologi Malaysia, Skudai 81310, Johor, Malaysia.

<sup>3</sup> Department of Business Analytics, Sunway University, Bandar Sunway 47500, Selangor, Malaysia.

*mustafa.n.alemran@gmail.com; mohamed.a.alsharafi@gmail.com*

Article Information	Abstract
<p><b>Article type:</b> Editorial</p> <p><b>Article history:</b></p> <p>Received: December 10, 2022 Accepted: December 30, 2022</p> <hr/> <p><b>Keywords:</b></p> <p>Industry 5.0, Education 5.0, Challenges, Research agenda</p>	<p>Industry 5.0 refers to the collaboration of advanced technologies, such as robotics and intelligent solutions, with humans to improve efficiency and performance. In education, Industry 5.0 refers to the cooperation between these technologies and educators and students to enhance the efficiency and effectiveness of teaching and learning. Industry 5.0 technologies have the potential to revolutionize the way students learn, and teachers teach. This study provides an overview of Industry 5.0 in education and explores several challenges that might face its implementation. The study also presents a number of potential research agendas to help overcome these challenges and promote the successful adoption of Industry 5.0 in education. The research agendas cover large-scale areas, such as pedagogical approaches, technology adoption, technology integration and learning performance, social and emotional development, sustainability, partnerships and collaborations, and personalized learning. This research provides a valuable and timely understanding of Industry 5.0 and its implementation in education, considering the progression of Industry 5.0 technology development.</p>

## I. OVERVIEW OF INDUSTRY 5.0 IN EDUCATION

Industry 4.0 has prioritized automating processes and reducing the need for human intervention, resulting in machines taking over many tasks previously performed by humans. Industry 5.0 seeks to create a balance between human and machine involvement in order to maximize the benefits of their interaction (Andres et al., 2022). Industry 5.0 is a movement focused on revolutionizing the global industrial landscape with the goal of prioritizing human well-being and sustainability. It seeks to use innovative solutions to not only create employment and economic growth, but also to promote the overall prosperity and sustainability of humanity as a whole (Leng et al., 2022). Industry 5.0 brings a number of applications. One key application of Industry 5.0 is the use of IoT-connected devices and sensors to collect data from industrial systems and processes. This data can be analyzed in real-time to identify problems, optimize production, and reduce downtime. Industry 5.0 also involves the use of advanced automation technologies, such as robotics and machine learning to handle tasks that are dangerous, repetitive, or require high precision. Another application is the use of virtual and augmented reality for training, design, and maintenance, as well as the integration of renewable energy sources into industrial operations. In quality control, using Industry 5.0 through IoT sensors and machine learning algorithms can continuously monitor product quality, identifying defects and issues early in the production process and allowing for quick corrective actions.

Education is considered a fundamental necessity and a cornerstone for the progress of any country. It is constantly evolving in response to changes in culture and business, producing the knowledgeable and skilled individuals that businesses

need to thrive. In Industry 4.0, education focused on technology and minimizing human involvement, prioritizing the use of machines. However, with the arrival of Industry 5.0, the goal is to create a balance between autonomous machines and humans. The combination of advanced technology and highly trained specialists leads to more effective, sustainable, and safe production. Industry 5.0 will also bring the role of Lead Robotics Officer, a specialized individual responsible for managing machine-operator interaction and experience in fields, such as robotics and AI (Maddikunta et al., 2022). This position requires the ability to make informed decisions, which can only be achieved through education in the fusion of technology, communication, and leadership skills, also known as Education 5.0.

Educational technologies play a vital role in education by providing students with access to a wide range of learning resources, making it easier for educators to personalize the learning experience, and providing students with access to advanced learning tools (Al-Emran et al., 2023; Al-Sharafi et al., 2022; Al-Tahitah et al., 2021). These technologies can revolutionize students' learning and lead to a more efficient, personalized, and effective education system (Al-Emran & Mezhuyev, 2019; Al-Nuaimi & Al-Emran, 2021; Mohd Rahim et al., 2022). Industry 5.0 also brought a variety of educational applications. One application of Industry 5.0 in education is the use of smart classrooms and learning environments. These classrooms utilize technologies, such as smart boards, interactive displays, and virtual reality, to enhance the learning experience. For example, students can use virtual reality simulations to learn hands-on skills, such as surgical procedures or automotive repair (Koohang et al., 2023). Another application of Industry 5.0 in education is the use of artificial intelligence and machine learning to personalize the learning experience for each student. This can be made through the use of adaptive learning software, which adjusts the curriculum and difficulty level based on a student's performance and needs. This allows students to learn at their own pace and ensures that they are receiving the best possible education. Big data analytics is also being utilized in education to track student progress and identify areas where they may need additional support. This data can be used by teachers to tailor their lesson plans and instruction methods to better meet the needs of their students. In addition, the use of predictive analytics to identify students at risk of falling behind or dropping out, allowing educators to intervene and provide additional support (Wahdan et al., 2021). The integration of wearable technologies, such as fitness trackers or smartwatches, can be used to track student physical activity and encourage healthy habits (Al-Emran, 2021; Al-Emran et al., 2021, 2022; Arpacı et al., 2020). Additionally, the implementation of AI-based intelligent scheduling systems enables the creation of personalized class schedules for each student based on their academic needs and interests. The use of machine learning algorithms can also help analyze student data and identify patterns and trends that can help educators tailor their teaching strategies.

## **2. CHALLENGES OF INDUSTRY 5.0 IN EDUCATION**

While Industry 5.0 brings many potential benefits, it also presents several challenges for the education sector. One major challenge is the need to prepare students for jobs that do not yet exist. Industry 5.0 technologies are rapidly evolving, and it is difficult to predict exactly which skills and knowledge will be required in the future. This makes it difficult for educators to prepare students for the job market and ensure they can compete in a rapidly changing economy. Another challenge is the need to provide students with the necessary digital skills to thrive in an Industry 5.0 world. As more and more jobs become reliant on advanced technologies, it is crucial that students are proficient in areas, such as coding, data analysis, and machine learning. This requires a significant investment in both teacher training and the development of relevant curricula. Additionally, not all students have the same level of access to technology and digital resources, which can create a divide between those who are able to take advantage of Industry 5.0 opportunities and those who are left behind. This is particularly true in developing countries, where access to education and training may be limited. As intelligent technologies become more sophisticated, there is a risk that they may be used to discriminate against certain groups of people or to perpetuate existing power imbalances. It is important that educators address these ethical issues and ensure that students are aware of the potential risks and responsibilities associated with Industry 5.0 technologies.

One of the main challenges of Industry 5.0 in education is the need to adapt teaching and learning methods to accommodate Industry 5.0 technologies. This may require the development of new pedagogical approaches, as well as the integration of technology into the classroom. It may also require the adoption of new assessment methods to evaluate students' knowledge and skills in this rapidly evolving field. Another challenge is the need to address ethical concerns related to the use of Industry 5.0 technologies. For example, there are concerns about the potential for AI and robotics to

perpetuate biases and perpetuate inequities. There is also a need to consider the potential for these technologies to be used for nefarious purposes, such as surveillance or manipulation. Another challenge of Industry 5.0 in education is the impact on employment and job security. As advanced technologies are integrated into the manufacturing process, there is a risk that many jobs will require high-skilled workers to interact efficiently with machines. This can lead to widespread unemployment and a decline in job security, particularly for workers with low levels of education or training.

### 3. FUTURE RESEARCH AGENDA

Transferring learning into Industry 5.0 is currently in a nascent stage. A review of the existing literature on the topic of Industry 5.0 and education has revealed several potential areas for research. The ultimate goal is to create a more holistic and human-centered approach to learning and skill development that leverages the power of technology to enhance, rather than replace, human capabilities. The research themes and their related research questions that can be explored in future research are listed in Table 1.

Themes	Research questions
Pedagogical approaches	<ul style="list-style-type: none"> <li>• How can Industry 5.0 technologies, such as virtual and augmented reality, be used to create immersive and interactive learning experiences?</li> <li>• What are the most effective ways to integrate Industry 5.0 technologies, such as Artificial Intelligence, into the classroom and curriculum?</li> <li>• What are the effects of Industry 5.0 technologies on students' critical thinking and problem-solving skills?</li> <li>• How do Industry 5.0 technology-enhanced pedagogical approaches impact students' motivation and engagement?</li> <li>• How does integrating Industry 5.0 technologies in pedagogy change the role of a teacher in the classroom?</li> </ul>
Technology adoption	<ul style="list-style-type: none"> <li>• What factors influence the adoption of Industry 5.0 technologies in education?</li> <li>• How do teacher training and leadership support impact the implementation of Industry 5.0 technologies in the classroom?</li> <li>• How does the availability of resources impact the implementation of Industry 5.0 technologies in education?</li> <li>• How do economic conditions affect the implementation of Industry 5.0 in education?</li> <li>• How does the cost of Industry 5.0 technologies impact their implementation in educational institutions?</li> <li>• What is the return on investment for Industry 5.0 technologies in education?</li> <li>• How do societal expectations and cultural norms affect the implementation and success of Industry 5.0 in education?</li> <li>• How do technological expectations impact the implementation and success of Industry 5.0 in education?</li> <li>• What are the perceptions of students and teachers towards Industry 5.0 in education?</li> <li>• How do organizational and institutional policies impact the implementation and success of Industry 5.0 in education?</li> <li>• How do leadership and governance impact the implementation of Industry 5.0 in education?</li> <li>• How do regulations and standards impact the implementation of Industry 5.0 in education?</li> <li>• What are the ethical considerations for implementing Industry 5.0 technologies in education?</li> <li>• How do data privacy and security impact the implementation of Industry 5.0 in education?</li> </ul>
Technology integration and learning performance	<ul style="list-style-type: none"> <li>• How does using Industry 5.0 technologies for assessment impact student learning and performance?</li> <li>• What is the impact of Industry 5.0-based online learning platforms on student engagement and motivation?</li> <li>• How does integrating Industry 5.0 technologies change how students access and interact with educational content?</li> <li>• How can Industry 5.0-based technologies support different learning styles and adapt to students' needs?</li> <li>• How does the use of AI impact student performance in math and science?</li> <li>• What is the impact of virtual and augmented reality on student performance in language arts and social studies?</li> </ul>

	<ul style="list-style-type: none"> <li>• Does the use of digital tools for assessment improve student performance in all subject areas?</li> <li>• How can Industry 5.0 technologies support collaborative learning, and what is the impact on learning performance?</li> <li>• How can Industry 5.0 technologies be used to create realistic simulations and gamified learning experiences, and what is the impact on learning performance?</li> <li>• How Industry 5.0 improves students' learning outcomes?</li> <li>• How does using Industry 5.0 technologies such as data analytics improve student performance for under-served populations?</li> </ul>
Social and emotional development	<ul style="list-style-type: none"> <li>• How does integrating Industry 5.0 technologies in learning environments impact students' motivation, self-esteem, and emotional intelligence?</li> <li>• What are the most effective ways to promote social and emotional development using Industry 5.0 technologies in learning environments?</li> <li>• How can Industry 5.0 technologies be used to support the development of students' empathy, emotional regulation, and social skills?</li> <li>• How does the integration of Industry 5.0 technologies affect the formation of a student's identity and sense of belonging to a group?</li> <li>• How can Industry 5.0 technologies foster a sense of community in an online learning environment?</li> </ul>
Sustainability	<ul style="list-style-type: none"> <li>• How can Industry 5.0 promote sustainable education by incorporating sustainable values and practices into the curriculum and teaching methods?</li> <li>• How can Industry 5.0 technologies be used to promote sustainable practices in the classroom and throughout the school or institution?</li> <li>• How can Industry 5.0 technologies enhance the accessibility and inclusivity of education?</li> <li>• How can education support sustainable development by preparing students to become responsible citizens and leaders in sustainable practices?</li> <li>• How can Industry 5.0 be used to address environmental and social issues in the context of the local community?</li> <li>• How can education foster a sustainable mindset and behavior in students by incorporating Industry 5.0 technologies and practices?</li> <li>• Can Industry 5.0 technologies be used to educate and raise awareness on sustainability issues to a broader public?</li> <li>• How can Industry 5.0 be used to support sustainable development goals (SDGs)?</li> <li>• How does the implementation of Industry 5.0 affect the well-being of students?</li> <li>• In what ways does Industry 5.0 contribute to sustainable education?</li> <li>• How Industry 5.0 makes education more accessible, particularly to disadvantaged students?</li> </ul>
Partnerships and collaborations	<ul style="list-style-type: none"> <li>• How can new partnerships and collaborations be established between educators, industry, and other stakeholders?</li> <li>• What are the benefits and challenges of industry-academia partnerships for Industry 5.0 education research?</li> <li>• How can collaborations be formed and maintained between educators, researchers, and policymakers to drive the development and adoption of Industry 5.0 technologies and pedagogical approaches?</li> </ul>
Personalized learning	<ul style="list-style-type: none"> <li>• How can Industry 5.0 technologies, such as data analytics, be used to personalize instruction and improve student outcomes?</li> <li>• What are the best practices for personalizing instruction using Industry 5.0 technologies?</li> <li>• How can Industry 5.0 technologies be used to identify and support individualized learning paths for students?</li> <li>• What are the implications of Industry 5.0 technologies for designing and implementing personalized learning in education?</li> <li>• How can Industry 5.0 technologies be used to track student progress and provide real-time feedback?</li> <li>• How can Industry 5.0 technologies be used to create personalized learning experiences for students?</li> </ul>

**Table 1. Proposed research agenda.**

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