## INTRODUCING QUANTUM ARTIFICIAL INTELLIGENCE (QAI) IN EDUCATION<sup>1</sup>

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Abstract

Artificial intelligence (AI) solutions for education can offer personalized and adaptable learning programs through the utilization of sophisticated algorithms and large data sets. AI-driven education is challenging traditional teaching strategies and shaping the future of technology use in the field. AI systems can produce insights that enable collaborative decision-making and early intervention techniques by analysing data from many sources, including student performance, attendance records, and behaviour patterns. The nexus of quantum computing and artificial intelligence, or QAI, is a technological synergy that should yield substantial advantages for both fields. In contrast to binary bits, which are used in conventional AI, quantum bits, or qubits, are multi-state entities that can exist simultaneously. This capability makes it possible for quantum AI to solve complex problems with exponential efficiency. Quantum artificial intelligence has the potential to completely alter the educational landscape. Although AI offers the framework for effective and personalized learning, quantum computing has the potential to expand these possibilities. Quantum artificial intelligence integration in education does, however, also bring with it serious privacy, security, and ethical issues, which call for a calculated approach to reduce dangers and responsibly maximize rewards.

Keywords: Artificial intelligence (AI), Quantum Computing, Quantum artificial intelligence (QAI), Education, AI-driven Education.

## **INTRODUCTION**

A logical development of teaching strategies is the integration of modern technologies into the classroom. Because it is practically difficult to imagine developing interesting learning experiences and attracting new students without innovation, the impact of new technology on education makes lecturers and educational institutions re-evaluate their current approaches (Baltezarević & Baltezarević, 2024). According to the data, the market is poised for significant expansion and innovation in the years to come, and the marriage of quantum computing with artificial intelligence holds the potential to unleash hitherto unheard-of problem-solving capabilities (Artsmart, 2024).

In recent years, artificial intelligence has permeated every aspect of contemporary civilization, improving business, communication, and everyone's quality of life (Baltezarević, 2023). The market for quantum artificial intelligence (QAI) was estimated to be worth \$0.2 billion in 2023 and is expected to increase at a compound annual growth rate (CAGR) of 36.6% from 2024 to 2032, reaching \$3.9 billion (Alliedmarketresearch, 2024).

Artificial intelligence (AI) algorithms stand to undergo a radical change as a result of quantum computing's unparalleled processing and optimization capabilities. Quantum computing must be incorporated into AI education since it gives aspiring professionals the skills they need to use these cutting-edge tools efficiently (Restack, 2025). Because of their unmatched computational capacity, quantum computers have the potential to greatly improve education by making it possible to analyse large, complicated data sets quickly. Quantum algorithms, for example, could be used by personalized learning systems to process and instantly adjust to each learner's unique learning preferences. This can result in the creation of highly individualized learning opportunities, guaranteeing that each student gets assistance that is specific to their needs. Furthermore, simulations in disciplines like biology, chemistry, and physics could be improved by quantum computing, giving students a better understanding of intricate scientific processes (Vivatechnology, 2025).

Continuous upskilling is necessary but difficult for educators who are expected to integrate cutting-edge technologies like quantum computing in the classroom. Professional development can be more efficient and widely available with the use of quantum-based teacher training systems that are driven by AI assistants, virtual reality, and multi-format learning materials (Globalacademicforum, 2023). There is a need for skilled workers in several industries as a result of the growing interest in quantum technology. In response, academic institutions are offering graduate and

<sup>&</sup>lt;sup>1</sup> The paper presents findings of a study developed as a part of the research project "Serbia and challenges in international relations in 2025", financed by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, and conducted by Institute of International Politics and Economics, Belgrade during year 2025.





undergraduate quantum computing courses and programs (Hidary, 2019). According to Braxton, online resources and platforms that provide classes on AI algorithms, quantum mechanics, and their intersections can be quite helpful. These platforms may be developed internally or obtained from reputable online learning environments. Expert-led interactive seminars can provide useful insights into the rapidly developing field of quantum artificial intelligence (Braxton, 2023).

Despite the astounding potential of AI and quantum computing, there are still many obstacles to overcome. Since qubit stability and error rates are very low, quantum computers are still in their infancy. Major hurdles remain in scaling quantum systems and dealing with noise and decoherence. A distinct set of difficulties also arises when creating quantum AI algorithms that fully utilize the capabilities of quantum computers. For AI and quantum computing to reach their full potential, cooperation between researchers, engineers, and specialists in both domains is essential to overcoming these obstacles (Nicholas, 2023).

### LITERATURE REVIEW

The use of quantum computing concepts and technology to improve artificial intelligence (AI) procedures is known as quantum AI (QAI). Quantum AI makes use of the special powers of quantum computers, like entanglement and superposition, to solve problems and carry out intricate computations more quickly than traditional computers. Quantum AI seeks to enhance machine learning (ML) algorithms' performance and speed up the training of AI models in a variety of sectors by using qubits rather than conventional binary bits (Alliedmarketresearch, 2024). Numerous effective quantum algorithms that provide exponential speedups over their classical counterparts have been devised. However, great fidelity (low error) performance on huge registers of qubits is required for quantum computers to execute these quantum algorithms correctly (Preskill, 2018). ML algorithms can be implemented in variational quantum circuits, or data can be embedded into high-dimensional Hilbert spaces to achieve speedups in ML methods on quantum computers (Lloyd et al., 2020).

A number of QAI algorithms have been developed thus far that have potential applications across several industries. For example, quantum ML has been effectively applied to identify cyberattacks on automobiles (Caivano et al., 2022). To execute their quantum equivalents, the majority of QML algorithms modify conventional ML methods (Havlíček et al., 2019). Quantum AI encompasses a wide range of subfields of AI, including quantum agents and multiagent systems (QMAS), quantum natural language processing (QNLP), quantum computer vision (QCV), quantum reasoning, and quantum automated planning and scheduling (QPS) (Görz et al., 2021). Although AI and quantum computers work on separate tenets, they complement one another and potentially enhance one another's potential. Through the optimization of computational models and the speedy processing of massive data sets, quantum computers can improve AI systems. On the other side, AI can help with algorithm creation, error correction, and deciphering the output produced by quantum systems, all of which can support quantum computing (Nicholas, 2023). One example of a set of tools that blends quantum modelling and ML methods is Google's TensorFlow Quantum (TFQ), an open-source framework for quantum ML. The goal of TFQ is to give people the tools they need to model and control artificial or natural quantum systems (Dilmegani, 2025).

In order to foster holistic growth and improve a person's cognitive and emotional abilities, quantum learning aims to stimulate all of the brain's neural networks. This constitutes a paradigm change in educational approaches (Swan & dos Santos, 2023). Quantum learning environments could be significantly improved by artificial intelligence, which can analyse enormous volumes of data, spot trends, and offer individualized learning experiences (Rane et al., 2023). The relationship between artificial intelligence (AI) and education has attracted a lot of scholarly interest, especially in light of its potential effects on security and privacy. Although this problem is frequently discussed globally, it appears that cybercriminals are constantly coming up with inventive ways to get around security measures and continue their illegal activities (Baltezarević & Baltezarević, 2021).

By giving students the means to interact directly with quantum algorithms and systems, we are cultivating a new generation of innovators who will propel quantum technology forward. The potential for quantum research, teaching, and learning is endless as more educational institutions include quantum computing in their curricula. By funding quantum education now, we can equip students to succeed in tomorrow's quantum-driven society (Spinquanta, 2025). AI and quantum computing together have the potential to completely transform all research. Researchers will have to become



proficient with these new technologies, more thorough investigations may be conducted, and results may be published sooner (Fernandes, 2024).

Quantum-powered education platforms may create personalized learning experiences based on individuals' interests, strengths, and preferred learning modalities, eschewing the one-size-fits-all approach. This could promote greater involvement and greatly speed up students' academic advancement (Globalacademicforum, 2023). However, despite its great promise, quantum computing is still in its infancy; to get quantum advantage, one must show a notable increase in speed or performance for particular jobs. Quantum-AI hybridization provides a strong and long-lasting way forward, for the present and the future, as opposed to a band-aid fix for today's problems. Combining the distinct advantages of AI, high-performance classical computing (HPC), and quantum computing allows us to more successfully address challenging issues in a variety of fields. The long-term, synergistic approach offered by this trio of technologies enables more effective and scalable solutions because each element strengthens and complements the others (Pasqal, 2024).

# CONCLUSION

More than just a technological promise, the combination of artificial intelligence (AI) with quantum computing holds the potential to revolutionize important fields and change the way we approach scientific research and difficult global issues. This potent combination, though yet in its infancy, pushes the limits of existing technology paradigms and provides multifaceted possibilities. The education industry is poised for revolutionary upheaval as the world embraces the combination of artificial intelligence and quantum computing. The way we teach and learn could be completely transformed by these developments. Their combination, however, brings up significant issues regarding the limitations of automation and the use of technology in education.

The development of quantum computing has the ability to completely transform AI's potential in education by resolving challenging issues at previously unheard-of speeds, opening the door to individualized instruction and cuttingedge research. Learning will soon become a highly personalized, continuously monitored experience thanks to robot teachers, AI tutors, and quantum computers. In addition to having access to a limitless amount of information, students will also have to contend with the fact that an all-seeing algorithm will monitor, evaluate, and score every academic decision they make. The potential for quantum artificial intelligence (QAI) to improve educational systems and enhance the learning experiences of future generations is enormous. To fully utilize QAI's potential, however, enabling infrastructure development, student accessibility, cultural acceptance, visionary leadership, multi-stakeholder coordination, and ethical oversight are all crucial.

#### 5. BİLSEL INTERNATIONAL KORYKOS SCIENTIFIC RESEARCHES AND INNOVATION CONGRESS, 26-27 APRIL, 2025

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