

TRÍ TUỆ NHÂN TẠO: ĐỘNG LỰC THúc ĐẨY GIÁO DỤC BỀN VỮNG
VÀ NÂNG CAO CHẤT LƯỢNG HỌC TẬP

Lê Ngọc Trân, Đặng Thị Triệu Vy, Dương Thanh Linh*
Phân hiệu trường Đại học Bình Dương tại Cà Mau, tỉnh Cà Mau, Việt Nam
* Tác giả liên hệ: dtlinh.cm@bdu.edu.vn

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TỪ KHÓA

Trí tuệ nhân tạo;
Phát triển bền vững;
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Đào tạo nguồn nhân lực.

TÓM TẮT

Trí tuệ nhân tạo (AI) đang ngày càng đóng vai trò trung tâm trong việc tái cấu trúc các lĩnh vực công nghiệp, kinh tế và đời sống xã hội, tác động trực tiếp đến nền tảng của phát triển bền vững cũng như hệ thống giáo dục. Việc áp dụng AI vào nhiều ngành nghề đã tạo ra những bước tiến vượt bậc trong hiệu suất làm việc và quá trình ra quyết định. Tuy nhiên, song hành với những lợi ích đó là những quan ngại về các hệ quả đạo đức, xã hội và môi trường mà công nghệ này có thể mang lại. Bài viết này phân tích cách AI có thể được khai thác như một công cụ hỗ trợ thực hiện các Mục tiêu Phát triển Bền vững (SDGs) do Liên Hợp Quốc đề xướng, với trọng tâm là lĩnh vực giáo dục. Thông qua ba ví dụ điển hình, bài viết xem xét vai trò lưỡng diện của AI – vừa là động lực cho đổi mới sáng tạo, vừa là nguồn phát sinh những thách thức mới – từ đó đưa ra những nhận định liên quan đến hoạch định chính sách, định hướng thương mại và đào tạo nguồn nhân lực. Kết luận chỉ ra rằng, với sự định hướng phù hợp, AI hoàn toàn có thể trở thành nhân tố then chốt thúc đẩy tiến trình phát triển bền vững toàn cầu và đóng góp đáng kể vào việc cải tổ giáo dục, giúp người học sẵn sàng thích nghi với một thế giới liên tục thay đổi.

ARTIFICIAL INTELLIGENCE: A CATALYST FOR SUSTAINABLE
EDUCATION AND ENHANCED LEARNING QUALITY

Le Ngọc Tran, Dang Thi Trieu Vy, Duong Thanh Linh*
Binh Duong University – Ca Mau Campus, Ca Mau Province, Vietnam
*Corresponding Author: dtlinh.cm@bdu.edu.vn

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ABSTRACT

Artificial Intelligence (AI) is increasingly playing a central role in reshaping industries, economies, and social life, directly impacting the foundations of sustainable development as well as the education system. The application of AI across various sectors has led to significant advancements in work efficiency and decision-making processes. However, alongside these benefits, there are concerns regarding the ethical, social, and environmental consequences that this technology may bring. This paper analyzes how AI can be leveraged as a tool to support the achievement of the United Nations' Sustainable Development Goals (SDGs), with a focus on the education sector. Through three case studies, the paper examines the dual role of AI – both as a driver of innovation and a source of new challenges – and offers insights into policy-making, trade direction, and workforce training. The conclusion suggests that, with proper guidance, AI can become a key factor in advancing global sustainable development and significantly contribute to the reform of education, preparing learners to adapt to a continuously changing world.

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1. INTRODUCTION

In the past, artificial intelligence (AI) was largely confined to the realm of science fiction, imagined by authors and filmmakers as part of futuristic societies. However, in today's technologically advanced world, AI has transitioned from fiction to reality, becoming an integral part of everyday life. Over time, the definition of AI has evolved significantly. Contemporary interpretations commonly emphasize AI's capacity to address complex cognitive tasks traditionally associated with human intelligence. AI now plays a pivotal role in various domains, including healthcare and mobile technologies, where it contributes to problem identification and the development of innovative solutions that serve both individuals and society. At its core, AI is fundamentally concerned with designing machines capable of mimicking human thought processes [1].

AI is increasingly permeating business and industrial sectors, with the potential to fundamentally transform the way individuals learn, live, work, and communicate. Moreover, it is expected to exert a profound influence on both economic systems and societal structures. As the world moves into the era of Sustainable Development, guided by the 17 Sustainable Development Goals (SDGs), AI is poised to shape national development trajectories on a global scale [2]. Furthermore, AI is expanding its influence on corporate governance, public policy, and organizational practices. Machines empowered with deep learning algorithms have demonstrated the ability to solve intricate cognitive problems, shedding light on the mechanisms of human cognition, learning processes, and expertise development.



Figure 1. The central role of AI in supporting the achievement of Sustainable Development Goals (SDGs) related to education, innovation, equality, and climate action.

Figure 1 highlights the pivotal role of Artificial Intelligence (AI) in advancing key Sustainable Development Goals (SDGs), including SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 13 (Climate Action). The illustration demonstrates that AI is not merely a technological tool but also a transformative enabler capable of addressing global challenges and fostering a more sustainable future.

As AI continues to deliver higher efficiency, improved outcomes, and more accurate predictions, it is gradually assuming roles traditionally held by humans in various research and operational domains. Nevertheless, this replacement is not expected to be immediate; rather, it will occur progressively as humans become increasingly integrated with intelligent systems and robotic technologies [3]. Notably, the benefits of AI advancement will not be evenly distributed. Some cities and countries are likely to gain substantial economic and intellectual advantages, while others may struggle to keep pace. The rapid acceleration of AI innovation has, in many cases, outstripped the development and enforcement of appropriate regulatory mechanisms and legal frameworks [4].

Recent technological advances in fields such as computer vision, robotics, and speech recognition have prompted growing concern among scientists, entrepreneurs, policymakers, and political leaders regarding the potential adverse effects of AI. One prominent apprehension is the possibility that AI may surpass human intelligence, leading to undesirable outcomes such as the automation of warfare and widespread job displacement. In response to such concerns, Dr. Eric Horvitz, a Microsoft research scientist and former president of the Association for the Advancement of AI, initiated and financially supported the “One Hundred Year Study of AI” a long-term research initiative aimed at examining the societal implications of AI in a systematic and sustained manner. Despite these concerns, Dr. Horvitz maintains a balanced perspective, emphasizing that technological advancements, including AI, are capable of producing both beneficial and detrimental outcomes for society [5].

While AI holds immense potential for fostering innovation and societal progress, its widespread and unregulated deployment poses significant social and ethical challenges that warrant thorough examination. In high-income countries, fears surrounding AI-induced unemployment are prevalent; however, in contrast, AI also has the capacity to foster socioeconomic development in low-income regions by generating new opportunities and helping to break entrenched cycles of poverty [6].

As such, education plays a pivotal role in preparing future leaders—both in business and government—to navigate the complexities of an AI-driven world. It is imperative that students are equipped with a critical understanding of AI, encompassing both its potential benefits and its associated risks. Only through comprehensive education can the next generation effectively engage with the technological realities of today and the rapidly evolving challenges of tomorrow.

This research paper explores the transformative potential of AI across various crucial domains. Following this introduction, we will delve into a detailed analysis of AI's specific applications within education, highlighting both the promising opportunities it offers and the inherent challenges that warrant careful consideration. Subsequently, the paper will present illustrative case

studies showcasing the tangible impact of AI in diverse sectors such as education itself, water management, and agriculture. The emphasis in this section will be on extracting valuable insights from these varied applications that can be meaningfully applied to the advancement of sustainable education practices. Finally, the paper will synthesize the key findings emerging from this exploration, propose practical recommendations for stakeholders, and outline promising directions for future research in this rapidly evolving field.

2. USING AI IN EDUCATION TO REVOLUTIONIZE TEACHING AND LEARNING

The integration of AI into the educational domain is catalyzing a transformative shift in both teaching and learning paradigms. AI has emerged as a powerful enabler of innovation, with the capacity to significantly enhance educational experiences through personalized learning pathways, improved instructional efficiency, and increased pedagogical effectiveness. By leveraging AI's data-processing capabilities, educators can analyze extensive datasets to derive actionable insights into individual learner profiles, enabling the design of customized instructional strategies that address diverse learning needs. This transformation is being propelled by AI-powered educational technologies—such as adaptive learning systems, intelligent tutoring platforms, and educational chatbots—which are increasingly recognized for their role in improving learning outcomes and fostering student engagement.

In addition to pedagogical enhancements, AI offers the potential to streamline administrative and operational tasks, thereby allowing educators to devote more attention to individualized instruction and student support. Despite these promising developments, the integration of AI into educational settings also raises critical ethical concerns, particularly with respect to data privacy, algorithmic transparency, and the potential for reinforcing existing biases. As such, a nuanced examination of AI's role in education must account for both its transformative potential and its associated risks.

One of the most compelling affordances of AI in education is its ability to personalize the learning experience according to each student's unique preferences, capabilities, and pace. Through the continuous analysis of learning behavior and performance data, AI systems can identify patterns and recommend tailored content and instructional strategies. Adaptive learning platforms, for example, utilize AI algorithms to dynamically adjust the complexity, sequencing, and delivery of instructional materials, thus enabling a more responsive and individualized learning journey.

Intelligent tutoring systems represent another significant application of AI in education. Functioning as virtual instructors, these systems provide learners with immediate feedback, targeted guidance, and real-time remediation. By identifying specific areas of misunderstanding and delivering contextually appropriate interventions, intelligent tutoring systems enhance both comprehension

and knowledge retention. Moreover, AI-driven chatbots have gained traction as supportive tools in educational environments, offering instantaneous responses to student inquiries and facilitating a range of routine administrative functions.

Collectively, these AI-driven innovations are reshaping the educational landscape, offering both opportunities for pedagogical advancement and challenges that require careful consideration. This article explores the evolving role of AI in education, with an emphasis on its potential benefits and the ethical considerations it entails.

At present, there is a marked disparity in how various countries are preparing for the advent of the AI revolution, which could influence their ability to leverage the benefits of this transformative technology. Given the current state of AI infrastructure, it is crucial that future educators are well-versed in both the advantages and potential challenges of AI at both macro and micro levels. The increasing prominence of STEM (science, technology, engineering, and mathematics) education globally underscores the urgency of addressing these disparities. Bridging the digital divide between nations is essential, and this educational focus is central to reducing such gaps [7-9].

The potential applications of AI have already demonstrated considerable promise, as evidenced by the following case studies. These examples illustrate how higher education institutions are adapting to an AI-driven environment, reshaping research methodologies, solution applications, and evaluative practices through AI-enhanced decision-making processes by both academics and students. One notable example is the PlantVillage project, which has developed a neural network aimed at automating plant disease diagnosis through visual identification. In this initiative, students collaborated with researchers to gain practical experience with deep learning and machine learning techniques. Images of both healthy and diseased plants are fed into the neural network, allowing the system to identify patterns in the data and learn to differentiate between plant health statuses. Neural networks, unlike humans, can process, store, compare, and suggest solutions at a much faster pace.

This technology offers significant advantages for farmers, particularly those in remote areas, as it allows them to diagnose plant diseases using smartphones based on remotely gathered data. As an open-source initiative, PlantVillage invites contributions from a global network of researchers, students, and farmers, facilitating the expansion of this knowledge base. This collaborative research model evolves into an ongoing learning experience that not only enhances educational opportunities but also fosters knowledge exchange across borders. The impact of such initiatives extends beyond education, influencing agriculture and the ways in which information is shared globally for mutual benefit. This collaborative learning approach marks a departure from the traditional preventive measures typically employed in higher education, highlighting a shift toward a more dynamic and globalized exchange of knowledge.

It is imperative that educational systems adequately prepare students to utilize AI and other technological tools in various professional contexts. AI plays a pivotal role in the intelligent management of nations, and as such, education professionals bear the responsibility of equipping students with the knowledge and skills necessary to navigate its impact on managerial decision-making. This preparation ensures that students are capable of applying AI-driven insights effectively in their future careers. The accuracy of AI-generated conclusions hinges on the quality of data input, which underscores the need for educators to teach students the importance of providing accurate data for decision-making processes within neural networks. Additionally, students must receive comprehensive training in deep learning, as many future career opportunities will require them to apply advanced AI techniques to complex management decisions.

While AI and emerging technologies offer significant opportunities, they also present substantial challenges. For instance, workers engaged in repetitive tasks without the requisite digital skills may face job displacement or wage volatility. Shifting demands for specific skill sets could exacerbate inequalities across various job categories. Therefore, it is crucial for future business leaders and students to cultivate both the mindset and the competencies necessary to address the challenges posed by AI. Given the inherent uncertainties and the fact that success often involves multiple stages of experimentation and adaptation, this preparedness becomes even more critical. When applied appropriately, AI has the potential to create a positive feedback loop, boosting worker productivity, stimulating economic growth, and promoting environmentally and socially responsible practices. However, even the most well-intentioned AI applications can have unforeseen consequences, which may negatively influence public perceptions and societal responses to new technologies [4].

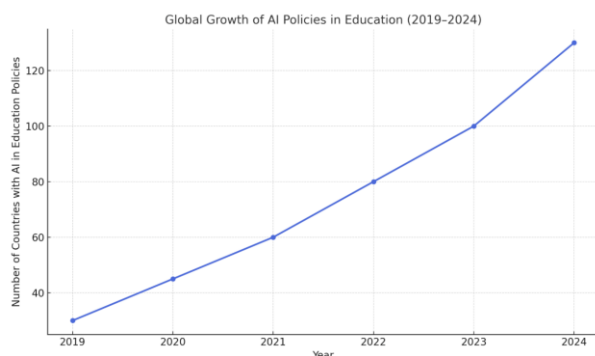


Figure 2. Global Growth of AI Integration Policies in Education (2019–2024)

(Source: UNESCO (2024), World Economic Forum (2024))

The AI revolution holds vast potential for growth and efficiency enhancement, yet it also raises significant concerns regarding inequality and the fair distribution of its benefits. While AI applications have been shown to increase productivity and offer substantial financial advantages, the adoption of AI and technology transfer may disproportionately benefit a small number of businesses,

leaving more pressing issues unaddressed. For developing nations, consistent and strategic support is essential to strengthening their industries, governmental infrastructures, and educational systems in preparation for the future of new energy and the more technologically advanced society that AI promises. To ensure that the benefits of AI adoption are distributed equitably and serve the broader societal good, it is imperative that businesses, governments, and society collaborate effectively.

This chart illustrates the increasing trend of countries worldwide adopting policies to integrate AI into the education sector during the period from 2019 to 2024. Data from UNESCO and the World Economic Forum highlight the global interest and efforts to harness the potential of AI in enhancing education systems. This upward trend reflects a growing awareness of the critical role AI plays in shaping the future of education.

Despite the immense growth potential and efficiency improvements AI offers, its integration also poses challenges, particularly in the realms of inequality, privacy, and security. These challenges are especially relevant to Sustainable Development Goals (SDGs) #10 (Reduced Inequalities) and #12 (Responsible Consumption and Production). The widespread application of AI necessitates management education to equip students with the knowledge and skills needed to understand and engage with AI's role in their personal and professional lives. In the age of AI, understanding these implications is crucial not only for individual success but also for guiding the economic development trajectory of nations.

3. CASE STUDIES

This section presents three case studies illustrating how Artificial Intelligence (AI) is being applied across various sectors to address challenges related to sustainable development. Although not directly focused on education, these examples demonstrate the vast potential of AI in enhancing efficiency, generating innovative solutions, and fostering global collaboration. They offer valuable insights and implications for the application of AI in the context of sustainable education.

3.1 Case study 1: Smart Water Management

Water is a fundamental resource vital to human life and development, serving as a cornerstone for human settlement and civilization throughout history. Access to clean, safe, and reliable water sources is essential for sustainable development. Water and sanitation are central to achieving multiple Sustainable Development Goals (SDGs), including those related to energy, agriculture, infrastructure, and climate [10]. Each day, millions of tons of water are processed to meet household and production demands, with strict adherence to sanitation standards necessary to safeguard health and ensure water quality [11].

In recent years, AI has been increasingly applied to enhance water and sanitation management, providing innovative solutions to optimize infrastructure and promote sustainability [10]. The integration of AI with conventional approaches addresses critical environmental and social challenges, contributing to the advancement of global

SDGs [11]. AI's potential benefits include improved operational efficiency, better protection of water resources, and the provision of precise, data-driven solutions. Nevertheless, several challenges remain, such as the reliance on high-quality data and the potential reduction in human oversight. Despite these challenges, AI continues to make significant contributions to SDGs, particularly #3 (Good Health), #6 (Clean Water and Sanitation), and #14 (Life Below Water) [12].

3.2 Case study 2: PlantVillage

The PlantVillage project, launched by Marcel Salathé and David Hughes [3], seeks to enhance agricultural disease management through the application of information technology. Central to the initiative is a smartphone application paired with an expanding database of over 15,000 images (with a goal of reaching 3 million) that enables the identification and diagnosis of plant diseases via mobile devices, using AI as the primary tool for disease detection and prediction [13].

The project addresses significant challenges faced by approximately 550 million small-scale farmers, many of whom lack the knowledge and resources to enhance agricultural productivity [14], [15]. Initially focused on 10 major plant diseases affecting 30 crops, the system demonstrated over 99% accuracy in disease detection using high-quality images. However, the accuracy dropped to 32% when using lower-quality field photos. The database, which is comprised of publicly available images, is open-access, allowing others to contribute to the development of improved algorithms [5].

Additionally, a mini spectrometer, integrated into smartphones with the contributions of Zhiwen Liu, enables the detection of plant diseases in leaves before visible symptoms manifest, thus facilitating early intervention. This innovative technology is instrumental in supporting global food security and advancing the achievement of Sustainable Development Goals (SDGs), particularly SDG #2 (Zero Hunger) and SDG #13 (Climate Action) [16].

The PlantVillage project not only fosters agricultural productivity but also helps bridge the digital divide and address food security challenges in developing regions, aligning with multiple SDGs, including SDG #2, SDG #9 (Industry, Innovation, Infrastructure), and SDG #10 (Reduced Inequality).

3.3 Case study 3: Clean Water AI

Access to clean water is fundamental to both human health and sustainable development. Clean Water AI, developed by Peter Ma, utilizes AI to monitor water quality, identify contaminated sources, and detect pathogens such as *Escherichia coli* and cholera-causing bacteria. By employing convolutional neural networks, the project analyzes contaminants and aims to expand its capabilities to distinguish between harmful and beneficial microorganisms, as well as viruses [11], [17].

This technology, with a low-cost assembly priced under \$500 USD, is accessible for deployment in both urban and rural areas, particularly benefiting resource-limited

regions. Clean Water AI significantly improves the detection and management of waterborne pathogens, ensuring safer water access and contributing to enhanced public health and environmental sustainability. Its affordability makes it a powerful tool for democratizing technology, in alignment with key Sustainable Development Goals (SDGs) such as SDG #3 (Good Health), SDG #6 (Clean Water and Sanitation), and SDG #11 (Sustainable Cities and Communities) [11].

The project's success hinges on effective collaboration among governments, local authorities, and water utilities. Clean Water AI exemplifies how innovative technologies can address global challenges, improve public health outcomes, and contribute to the achievement of sustainable development goals on a global scale.

4. CONCLUSION

Although the presented case studies do not directly focus on education, they clearly illustrate the potential of AI in enhancing knowledge, skills, and information dissemination—key elements of sustainable education. The application of AI in smart water management and water quality monitoring (e.g., Clean Water AI) provides practical examples that can be integrated into STEM education to raise youth awareness of global environmental issues and encourage their engagement in research and development in this field. The PlantVillage project, with its intelligent plant disease diagnostics, stands as a model of AI application in sustainable agriculture, emphasizing the importance of data and global collaboration. AI undoubtedly plays a pivotal role in advancing sustainable development globally, driving significant progress across sectors from industry to the environment. To fully leverage its potential in education and sustainability, we propose the following solutions and recommendations:

Invest in AI infrastructure and training programs for education: Governments and educational institutions must prioritize investment in technological infrastructure and develop comprehensive AI training programs for both teachers and students. This includes designing AI-focused curricula, providing AI-enabled learning platforms and tools, and training educators to effectively integrate AI into their pedagogical practices.

Develop context-specific educational AI applications: It is essential to support research and development of AI tools tailored to the specific educational challenges and needs of individual countries and regions, especially in developing nations.

Establish legal and ethical frameworks for AI in education: To ensure AI is used in an equitable, transparent, and privacy-respecting manner, clear legal and ethical guidelines must be established for its application in education.

Promote multi-stakeholder collaboration: Strengthened collaboration among educational institutions, tech companies, research organizations, and governments is critical to sharing knowledge, experience, and resources in

developing and implementing AI-driven solutions for sustainable education.

Focus on skills and mindsets for the AI era: Education should not only teach about AI but also cultivate soft skills such as critical thinking, problem-solving, creativity, and adaptability—competencies essential for thriving in an increasingly automated world.

Conduct in-depth research on AI's educational impacts: Further studies are needed to better understand the effects of AI on learning outcomes, student engagement, socio-emotional skill development, and issues of equity and inclusion in education.

Strategically and responsibly integrating AI into education is essential for achieving the Sustainable Development Goals (SDGs) and building a more resilient future. The academic community plays a crucial role in advising policymakers, business leaders, and educators on how to harness AI to foster a more equitable, sustainable, and prosperous world.

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