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# A Systematic review of Integrating AI in Education to Achieve Sustainable Development Goal 4 (SDG 4)

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## ABSTRACT

This comprehensive review examines the ever-evolving field of educational technology, focusing on the application of artificial intelligence (AI) in the classroom. Based on data froma carefully selected collection of fifty-five research papers published between 2019 and 2023,it explores how artificial intelligence is changing the field of education and provides an in- depth analysis of its impact on the digital age. The evaluation carefully examines the ways in which education systems are adapting to technological advances to equip students with the tools they need for the workforce of the future. It brings together the perspectives of various stakeholders, including educators, students, policy makers and ethicists, to provide a comprehensive understanding of the opportunities, challenges, and moral issues of AI in education.

The numerous literature studies in the collection help to comprehensively understand the various aspects of educational technology. These include in-depth research on AI chatbots, AIethics, adaptive learning systems and AI-infused curricula. In addition, we highlighted potentialbenefits while pointing out important gaps and difficulties to explore faculty perspectives and specific AI applications. Despite the hope, the reviews emphasize how critical it is to respondto the criticisms and disadvantages presented by researchers. They support a multifaceted strategy that fosters further learning in key areas to ensure the ethical application of AI in education.

***Keywords:*** *Educational Technology, Artificial Intelligence, Future of Work, Ethical Considerations, AI Chatbots, Adaptive Learning, AI in Curricula.*

# Chapter 1: INTRODUCTION

Modern society faces many important challenges, such as fighting global warming, promotinghealth care, stopping plastic pollution, preserving species, and ensuring equality. These urgentissues require immediate action (Earth.org 2020, Nishant et al. 2020 and Vision-2030 2019). In response, the United Nations (UN) launched "2030. year Agenda" In 2015, the goal is to respond to sociological, ecological, and economic challenges. Central to this agenda are the Sustainable Development Goals (SDGs), a globally applicable framework for achieving the well-being and security of people and the planet (UN, 2015). Although the 2030 Agenda offerslimited guidance on how to use technology to achieve its goals, digital advances show rapid progress towards sustainable development (2019; Herweijer and Waughray; 2020; Leong et al).

Among these technologies AI stands out, offering significant potential to promote sustainability by revolutionizing various aspects of human existence and economic activity (Bertenet et al., 2021; Wanner et al., 2020). AI, broadly defined as technology that facilitates or imitates human tasks and uses computational resources to solve complex problems (Dwivediet al., 2021; Janiesch et al., 2021), can effectively address interconnected sustainabilitychallenges (Nishant et al. . . , 2020 , p. 2).The intersection of AI and SDG4 , which aims to ensure inclusive and equal quality education for all, is becoming an important area amid major technological advances (Gregor, 2019). Education, essential for sustainable developmentbecause it empowers individuals and promotes social development, is key to achieving the ambitious goals set by the 2030 Agenda (Gregor and Hevner, 2020). Incorporating artificial intelligence into educational systems is becoming increasingly important to achieve these goals. SDG4 not only emphasizes why it's crucial that everyone have access to high-quality education, but also the need for flexibility to respond to changing social demands. Thus, the impact of artificial intelligence on education is explored, considering its capability to revolutionize learning, the challenges it presents and the implications for achieving SDG4. Theincorporation of artificial intelligence in education pledges to enhance educationalopportunities, respond to various learning needs and promote innovation in educationalpractice (UNESCO, 2020). However, it also raises concerns about equality, privacy and the future work (Gewerc et al., 2021). Balancing these opportunities and challenges is essential toharness the full potential of AI to advance SDG4 and promote inclusive, quality education forall.

# RESEARCH QUESTIONS

**(Question 1) -** Which specific sustainability-oriented goals are the subject to investigation, andhow do these align with broader initiatives for sustainable development?

**(Question 2) -** What specific AI techniques and approaches are utilized to advanceunderstanding and solutions?

**(Question 3) –** How AI can be explored in application to foster university societycollaboration?

**(Question 4) -** Discuss AI's implications for education sustainability and student outcomes.

*Artificial Intelligence (AI)*

AI as a concept is not new. AI was first developed in the 1950s with the goal of creating machines that could mimic human senses, reasoning, and thought processes ( Bertente et al., 2021; Wang et al., 2019). Even though AI has been around for more than 50 years, new developments in complex algorithms, the availability of larger datasets, and the growing uptakeof digital technologies have caused a dramatic evolution in the field (Duan et al., 2019; Frenchet al., 2021). These days, several goods and services—like voice-activated virtual assistants and driverless cars—use artificial intelligence (AI) (Berente et al., 2021; Brynjolfsson & McAfee, 2017; Taddeo & Floridi, 2018).

The four main categories of AI-based systems are: autonomous systems, which use AI to automate repetitive and labour-intensive tasks (like medical diagnosis); automated systems, which perform repetitive and labour-intensive tasks (like forest management); assisted systems,which help humans perform tasks (like ambient smart living); and augmented systems, whichsupport people in understanding and predicting complex (future) events (like agricultural decisions) (Holzinger et al., 2021). AI supports solving complex tasks among these four maincategories of AI-based systems.

*SDG 4*

SDG 4 is an abbreviation of Sustainable Development Goal 4, which is part of the United Nations' 2030; The 2030 Agenda for Sustainable Development. It focuses on ensuring inclusiveand equal quality education for all. This goal recognizes the transformative power of educationin eradicating poverty, promoting gender equality, promoting economic growth, and building apeaceful and sustainable society. SDG 4 is not only about access to education, but it also aimsto improve the quality of education, improve learning outcomes and promote lifelong learningopportunities.

| **SDG 4: Targets** | **Meaning of Target** |
|---|---|
| "Quality primary & secondary education by 2030, ensure that all girls and boys complete free equitable and quality primary and secondary education leading to relevant and effective learning outcomes". | "The provision of 12 years of free, publicly-funded inclusive, equitable, quality primary and secondary education – of which at least nine years are compulsory leading to relevant learning outcomes – should be ensuredfor all, without discrimination". |

| | |
|---|---|
| "Early childhood & pre- primary education by 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education". | "The provision of at least one year of free and compulsory quality pre-primary education is encouraged, to be delivered by well-trained educators, as well as that of early childhood development and care". |
| "Equal access to TVET & higher education by 2030, ensure equal access for all women and men to affordable and quality technical, vocational, and tertiary education including university" | "It is imperative to reduce barriers to skills development and technical and vocational education and training (TVET) starting from the secondary level, as well as to tertiary education, including university, and to provide lifelong learning opportunities for youth and adults. The provision of tertiary education should be made progressively free, in line with existing international agreements". |
| "Gender equality & equal access for all by 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities indigenous peoplesand children in vulnerable situations". | "Regardless of an individual's gender, age, race, color ethnicity, language, religion, political perspective, national or social and economic origin, property, or placeof birth inclusion and equity are essential to guaranteeing that everyone has access to high-quality education and opportunities for lifelong learning. This covers children and young people in risky circumstances, immigrants indigenous peoples, and those with impairments. Gender equality guarantees that all boys and girls obtain the best education possible, achieve at the same levels, and receive equal advantages. Because of early pregnancy, child marriage, poverty, remote rural settings, adolescent girls and young women require special attention. Gender-based violence is another issue. In disadvantaged circumstances boys should also receive extra consideration. Policies promoting gender equality function best when they are incorporated within a more comprehensive package that addresses child labour, justice, health, and good governance". |

Source: UNESCO's Unpacking SDG4

# Chapter 2: REVIEW OF LITERATURE

The literature review highlights the rapid growth of technology, particularly in SDG4, emphasizing the integration of AI and ML technologies.

In recent years, the integration of ICT into education has become increasingly prevalent worldwide. This trend has prompted extensive discussions on how ICT can enhance learning experiences and ensure accessibility for all students, regardless of their backgrounds or circumstances (Meschede, 2020).Various stakeholders, including educators, students, policymakers, and ethicists, have contributed their perspectives to the discourse on the benefits,challenges, and ethical considerations surrounding AI in education (van der Vorst & Jelicic, 2019).While many researchers have highlighted the positive aspects of AI in education, it is essential to acknowledge and address critiques and potential downsides raised by others (Donget al., 2020)Furthermore, existing course planning frameworks and instructional design methodologies may have limitations in catering to the specific needs of AI education for non-computer science students (Laupichler et al., 2023).The literature review on AI in educationalcontexts has explored its potential impact, ethical considerations, and implications for teaching and learning (Affde, 2021).Additionally, there has been significant research on AI literacy initiatives, expert-level education, interdisciplinary approaches, and the landscape of AI in education research publications (Zhang & Aslan, 2021).Some studies have focused on specificAI technologies, such as ChatGPT, and their transformative effects on education, including instructional content creation and student support (Singh et al., 2023).Moreover, systematic reviews have examined the impact of AI chatbots on student motivation, language skill development, and educator workload, highlighting both advantages and drawbacks (Gokcearslan et al., 2024).Ethical considerations are paramount in the deployment of AI technologies in education, emphasizing the need for responsible implementation and regulatory frameworks (Luckin, 2016).Additionally, AI has been explored for its potential contribution toachieving SDGs in education, health, and communication, although concerns about over- reliance and the digital divide persist (Jungwirth & Haluza, 2023).Various studies haveinvestigated the correlation between students' intrinsic motivation for learning AI concepts, their comprehension of computational thinking, and their academic performance (Martín- Núñez et al., 2022).Furthermore, the effectiveness of AI-driven voice applications in daily tasksand the potential of holistic education models in rural contexts have been examined (Al Said et al., 2022; Nedungadi et al., 2023).Overall, while AI holds promise for transforming education and contributing to sustainable development, it is essential to address ethical,

accessibility, and efficacy concerns to ensure its responsible integration into educational practices (Kabudi, 2022).

Certainly! Let's delve deeper into the literature review on the integration of AI in education.ThePRISMA extension for scoping reviews has been utilized to systematically identify and analyzeexisting knowledge on AI

integration in education (Abulibdeh et al., 2023).There is a growing recognition of the need to balance practicality and ethicality in the implementation of educational technology, particularly in the context of large language models (LLMs) (Yan et al., 2023).Strategies to improve information literacy in education have been explored, includingthe use of adaptive learning platforms and frameworks like the BIG6 model (Xiang et al., 2023).Concerns and challenges surrounding the use of AI tools like ChatGPT as English writing assistants have been addressed, emphasizing the importance of comprehensive approaches that combine technological tools with traditional teaching methods (Bibi & Atta, 2023).The evolution of AI and its transformative influence on various sectors, including education, has been extensively studied, highlighting both advancements and ethical considerations (Nath et al., 2022).Furthermore, AI technologies have been employed to assesscommunity outreach efforts of Higher Education Institutions in alignment with SDGs, promoting knowledge exchange and collaboration (Silva Borsatto et al., 2019).Predictive modeling using AI algorithms has been applied to forecast student performance and behaviors,contributing to education sustainability during the COVID-19 pandemic (Jokhan et al., 2022).Moreover, the potential of AI in enhancing m-learning experiences in Zimbabwean higher education has been explored, despite challenges related to planning, ethical considerations, and inclusivity (Maketo et al., 2023).

Studies have examined the predictability of universal healthcare outcomes using AI and machine learning models, highlighting the importance of tailored public policies and inclusivehealthcare financing strategies (Kumar et al., 2022).Efforts to improve the quality of basic education in Nigeria through government initiatives and partnerships have been documented, emphasizing the importance of school-based management committees and evidence-based policy advocacy (Ndamobissi et al., 2022).Research on public perceptions of AI technology inTaiwan has revealed a balanced perspective among educated individuals, underscoring the synergy between AI and sustainable development goals (Yeh et al., 2021).The tension betweenglobal and local priorities in inclusive education has been highlighted, calling for nuanced approaches to measuring academic progress and outcomes (Ydesen & Elfert,2023).Furthermore, studies have investigated Eastern European students' views on AI

technology replacing university teachers, suggesting recommendations for enhancing higher education sustainability amidst AI integration (Okulich-Kazarin et al., 2023).The Digitalization-Sustainability Matrix (DSM) has been proposed as a research tool to connect digitalization and AI with sustainable development goals, encouraging transdisciplinary dialogues and inclusive planning (Gupta et al., 2020).The Fourth Industrial Revolution (4IR) is transforming education globally, with Zimbabwe aligning its education system with the UN's Sustainable Development Goals to promote inclusive, quality education (Yingi et al., 2022).Additionally, efforts to address educational inequality in Iran through improved governance and education spending have been discussed, highlighting the need for systemic transformation and investment in teacher qualifications (Jariani, 2021).Finally, the role of education in promoting social development and sustainable consumption has been explored, emphasizing the need for effective policies and investments in

educational aid (Atabekova et al., 2022).

Under the guidance of Ms. Rodriguez, the school's visionary principal, initiatives werelaunched to enhance information literacy skills through AI-driven adaptive learning platforms.Students, once overwhelmed by the vast sea of information, now navigated it with confidence,empowered by personalized learning approaches tailored to their individual needs and preferences (Luckin, 2016; Xiang et al., 2023). However, amidst the excitement of technological innovation, concerns lingered in the air. In the faculty lounge, discussions revolved around the ethical implications of AI technologies in education. From data privacy toalgorithmic bias, educators grappled with the responsibility of ensuring that the benefits of AIwere not outweighed by unintended consequences (Laupichler et al., 2023).Meanwhile, in Mr. Chang's language arts class, AI-driven voice applications were put to the test. While these applications showed promise in enhancing language learning and communication skills,challenges regarding data privacy and accuracy reminded educators of the importance of striking a delicate balance between innovation and responsibility (Al Said et al., 2022).Yet, amidst the challenges, there were glimmers of hope. In the school's bustling student support center, chatbots provided timely assistance and guidance to students outside of traditional classroom settings. These digital companions, leveraging the power of AI, offered personalizedsupport tailored to each student's unique needs, ensuring that no student was left behind (Singhet al., 2023).As the school year progressed, the impact of AI integration on the role of educatorsbecame increasingly evident. Through workshops and professional development sessions, teachers explored how AI technologies could augment teaching practices, facilitate assessment,and support their ongoing growth and development (Abulibdeh et al., 2023). And beyond the

walls of Brookstone High, a broader movement was underway. Researchers and policymakersalike were exploring the alignment between AI education initiatives and Sustainable Development Goals (SDGs), recognizing the potential of AI technologies to address global challenges and promote inclusive, quality education for all (Jungwirth & Haluza, 2023).

# Chapter 3: RESEARCH METHODOLOGY

The study methodology employed a comprehensive review technique to methodically examine and summarize the body of literature on the incorporation of AI in education, with a particular emphasis onhow well it aligns with SDG 4. With this method, pertinent research articles published between 2018 and 2023 were found and chosen, essential findings were extracted, and data was analyzed to provide insights into all aspects of AI in education. The review study used this technique in an effort to providereaders with an accurate understanding of the present status of the subject, point out gaps and difficulties, and make suggestions for future routes for research in the area of artificial intelligence in education.

# Chapter 4: CHALLENGES AND DISCUSSIONS

*CHALLENGES*

Addressing the challenges in AI integration within education necessitates a comprehensive examination of both positive and negative aspects, a task often overlooked in reviews primarilyemphasizing the benefits. Striking a balance between advantages and potential drawbacks, ethical concerns, and negative implications poses a significant challenge. Furthermore, incorporating diverse stakeholder perspectives, including educators, students, policymakers, and ethicists, is essential for a holistic understanding.

Overcoming this challenge involves effectively gathering and integrating insights from variousviewpoints to capture the multifaceted implications of AI in education. Additionally, actively seeking opposing viewpoints is crucial, as highlighted in a review that identifies a limited exploration of critiques. For AI education tailored to non-computer science students, a challenge is posed by existing limitations in course planning frameworks. Proposing ordeveloping frameworks addressing the specific needs of these students is vital. The explorationof potential biases in AI applications, especially within educational contexts, demands attentionto ensure fair and equitable learning experiences for diverse student populations. Ethical considerations are integral, and further exploration is needed to identify specific challenges, propose solutions, and develop guidelines for responsible AI implementation.

Evaluating the long-term effects of emerging technologies like ChatGPT is challenging but crucial, involving an in-depth understanding of user experiences, sustained impact, and potential adaptations over time. Additionally, delving deeper into the socio-economic implications of AI evolution is essential, especially concerning its influence on job markets, industries, and societal structures. Ensuring equitable access to ICT in education, addressing barriers for students with diverse backgrounds, is another critical challenge for fostering inclusivity. Finally, refining AI literacy initiatives requires further exploration and optimization, with a focus on identifying effective strategies for teaching AI literacy, particularly to those without a strong technical background. These challenges collectively underscore the need for a nuanced and inclusive approach to the integration of AI in education.

Addressing challenges in the integration of AI in education requires a multifaceted approach. Achieving scalability and transferability necessitates adapting AI-based assessment approaches to diverse HEI's and contexts, considering variations in resources and cultural factors. Educator

support and policy alignment are crucial for effective AI integration, addressing risks and ensuring alignment with educational policies. Robust regulatory frameworks are needed to govern AI deployment, mitigating concerns about automation, the digital divide, and socioeconomic inequalities. Identifying practical AI applications for Sustainable DevelopmentGoals (SDGs) while addressing ethical considerations is paramount.

Ensuring diversity and inclusivity in AI-enabled learning systems involves tackling biases and commercialization pressures. Evaluating AI-driven health interventions and promoting equity in access are challenges in healthcare integration. Motivating and engaging students in AI education, ensuring reliability and privacy, and assessing the scalability and sustainability of digital learning models are key concerns. Financing gaps in achieving SDGs, generalizability of predictive models, overcoming implementation barriers, and promoting equity in education access require collaborative efforts. Balancing perspectives on AI and fostering AI literacy arecrucial, while effective training and measurement are essential for preparing a digital workforcealigned with sustainable development goals.

*DISCUSSION*

The field surrounding the use of AI in education is vast, according to a thorough analysis of theliterature, with special attention paid to how this integration may affect the achievement of SDG4. The research under review highlight how AI technologies have the capacity to completely alter educational paradigms on a worldwide scale. The literature anticipates a futurein which technology will be essential to improving learning outcomes and fostering diversity,from the changing role of educators to the use of AI chatbots in educational settings.

As with SDG 4, which aspires to provide inclusive, egalitarian, and high-quality education forall, the studies continuously emphasize the significance of ethical considerations while implementing AI in education. The way that Yan et al. (2023) and Luckin (2016) have examined ethics in the context of educational technology highlights the necessity of striking abalance between practicality and morality in order to guarantee that AI-driven educational projects respect moral principles and protect students' welfare.

The body of research also highlights how important it is to handle the difficulties and hazardsthat come with using AI in education. According to Gokcearslan et al. (2024), there are benefitsand drawbacks to using AI chatbots, such as limited contact and the possibility of receiving false information in the responses.

According to Allen et al. (2018), the application of AI to global environmental issues links thetechnology to more general sustainability objectives. In line with SDG4's goal of creating informed and responsible global citizens, Nasir et al. (2023) call for the incorporation of SDGsinto curricula, which highlights the importance of preparing students for the challenges faced by environmental crises.

Furthermore, as the study by Kabudi (2022) shows, the literature emphasizes the significance of looking into AI's effect on educational outcomes. The focus on racial and data biases, addressing the commercialization of AI-enabled learning systems, and promoting inclusivity for students with intellectual disabilities aligns with the SDG4 goal of ensuring that educationis equal, relevant, and accessible to everyone.

To sum up, a review paper on AI in education that focuses on SDG4 may explore the revolutionary power of AI technologies, the moral issues raised, the difficulties encountered, and the possible contributions to the goal of universal access to high-quality education. Such astudy might provide recommendations for future paths in

harnessing AI for educationalsustainability, highlight research gaps, and provide a comprehensive knowledge of the existinglandscape by combining ideas from varied studies.

# Final Chapter: FUTURE SCOPE AND CONCLUSION

*FUTURE RESEARCH*

Subsequent investigations into artificial intelligence in education may concentrate on many auspicious paths to augment our comprehension and application of these technologies. The impact of AI-driven chatbots and educational platforms on student learning outcomes and engagement is one area that might be further investigated. To maximize these instruments' efficacy, it will be necessary to look at both the positive and negative long-term consequencesand refine them to fix any flaws that are found. Further research may include the creation andevaluation of AI-driven voice applications in the classroom, examining how these tools might be improved to give students accurate and trustworthy information.

The changing role that educators play in the context of integrating AI could likewise be the subject of future research. There can be a smoother transition of these technologies into the educational landscape if we have a better understanding of how teachers use and adapt to AI tools, as well as what training and support systems are required. Making sure the advantages are available in a variety of academic fields entails looking at the opportunities and problems related to the application of AI in various educational contexts and topic areas.

The use of AI in education must take ethics very seriously, and further study can explore the ethical implications of these tools in greater detail. It will be essential to examine the ethicalityof AI applications in educational technology and learn how to properly balance moral issues with functionality, as mentioned in the literature. The creation of moral frameworks and rulesfor the appropriate application of AI in educational contexts can benefit from this research.

Further research may examine the relationship between AI, the Sustainable Development Goals(SDGs), and AI ethics, as indicated by the literature reviews. Ethical considerations surrounding the applications of AI in the context of sustainable development and its potential to help achieve SDGs, including high-quality education (SDG 4), must be considered for responsible and significant adoption of AI.

Finally, given the growing reliance on AI in education and its possible impact on the nature ofwork in the future, study may focus on the changing competencies and abilities needed by students in the digital age. Investigating the efficacy of current AI literacy programs, multidisciplinary approaches, and expert-level education in equipping students for the demandsof the quickly evolving labour market is part of this.

**CONCLUSION**

As per the search findings, the integration of AI in education can make a substantial contribution towards the attainment of Sustainable Development Goal 4, which is to guaranteeequitable and high-quality education for everyone. AI integration into educational systems hasa lot of promise to enhance student learning, address a range of learning requirements, and encourage creativity in teaching methods. But it also brings up issues with privacy, equality, and the nature of labor in the future. Thus, in order to fully utilize AI's potential to achieve SDG4 and develop inclusive, high-quality education for everyone, it is imperative to strike a balancebetween these benefits and difficulties. In order to guarantee that artificial intelligence is responsibly incorporated into educational practices, further study is required to address the accessibility issues and ethical considerations related to this activity.

# REFERENCE


• Yoshida, K., Hirosato, Y., & Tanaka, S. (2018). SUMMA (2018), Technical Appendices on Effective Education Practices, available at http://www. summaedu. org/effective-education-practices-platform/? lang= en. BRIDGES TO THE FUTURE OF EDUCATION: POLICY RECOMMENDATIONS FOR THE DIGITAL AGE. C Meschede (2020). The Sustainable Development Goals in Scientific Literature 12(11), 4461; https://doi.org/10.3390/su12114461

• Pratama, M. P., Sampelolo, R., & Lura, H. (2023). Revolutionizing education: harnessing the power of artificial intelligence for personalized learning. Klasikal: Journal of Education, Language Teaching and Science, 5(2), 350-357.

• van der Vorst, T., & Jelicic, N. (2019). Artificial Intelligence in Education: Can AI bringthe full potential of personalized learning to education?.https://www.econstor.eu/bitstream/10419/205222/1/van-der-Vorst-Jelicic.pdf

• Limna, P., Jakwatanatham, S., Siripipattanakul, S., Kaewpuang, P., & Sriboonruang, P.(2022). A review of artificial intelligence (AI) in education during the digital era. Advance Knowledge for Executives, 1(1),https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4160798

• Schleiss, J., Laupichler, M. C., Raupach, T., & Stober, S. (2023). AI course design planning framework: Developing domain-specific AI education courses. Education Sciences, 13(9), 954. 13(9),

• Flores-Vivar, J. M., & García-Peñalvo, F. J. (2023). Reflections on the ethics, potential,and challenges of artificial intelligence in the framework of quality education (SDG4). Comunicar, 31(74), 37-47.

• Nasir, O., Javed, R. T., Gupta, S., Vinuesa, R., & Qadir, J. (2023). Artificial intelligenceand sustainable development goals nexus via four vantage points. Technology in Society, 72, 102171.

• Nurunnabi, M., Mitchell, C., Koubaa, A., & Hoke, T(2023). Sustainable Development Goals and AI integration into Curricula in the MENA Region.

• Zhang, K., & Aslan, A. B. (2021). AI technologies for education: Recent research & future directions. Computers and Education: Artificial Intelligence, 2, 100025. https://doi.org/10.1016/j.caeai.2021.100025

• Berente, N., Gu, B., Recker, J., & Santhanam, R. (2021). Managing artificial intelligence. MIS quarterly, 45(3).

- Collins, C., Dennehy, D., Conboy, K., & Mikalef, P. (2021). Artificial intelligence in information systems research: A systematic literature review and research agenda. InternationalJournal of Information Management, 60, 102383.
- Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. AI and Ethics, 2(3), 431-440.,
- Flores-Vivar, J. M., & García-Peñalvo, F. J. (2023). Reflections on the ethics, potential,and challenges of artificial intelligence in the framework of quality education (SDG4). Comunicar, 31(74), 37-47.
- Nasir, O., Javed, R. T., Gupta, S., Vinuesa, R., & Qadir, J. (2023). Artificial intelligenceand sustainable development goals nexus via four vantage points. Technology in Society, 72, 102171.
- Gokcearslan, S., Tosun, C., & Erdemir, Z.G. (2024). Benefits, challenges, and methods of Artificial Intelligence (AI) chatbots in education: A systematic literature review. International Journal of Technology in Education (IJTE), 7(1), 19-39. https://doi.org/10.46328/ijte.600
- Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. European Journal of Education, 57(4), 542-570.
- Abulibdeh, A., Zaidan, E., & Abulibdeh, R. (2024). Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions. Journal of Cleaner Production, 140527..
- Zhao, L., Yan, L., Gasevic, D., Dix, S., Jaggard, H., Wotherspoon, R., ... & Martinez- Maldonado, R. (2022, March). Modelling co-located team communication from voice detection and positioning data in healthcare simulation. In LAK22: 12th International LearningAnalytics and Knowledge Conference (pp. 370-380).
- Bibi, Z., & Atta, A. (2024). The Role of ChatGPT as AI English Writing Assistant: A Study of Student's Perceptions, Experiences, and Satisfaction. Annals of Human and Social Sciences, 5(1), 433-443.
- Pinzolits, R. (2024). AI in academia: An overview of selected tools and their areas of application. MAP Education and Humanities, 4, 37-50.
- Cardona, M. A., Rodríguez, R. J., & Ishmael, K. (2023). Artificial Intelligence and theFuture of Teaching and Learning: Insights and Recommendations.
- Jungwirth, D., & Haluza, D. (2023). Artificial Intelligence and the Sustainable Development Goals: An Exploratory Study in the Context of the Society Domain. Journal of Software Engineering and Applications, 16(4), 91-112.
- Singh, A., Kanaujia, A., Singh, V. K., & Vinuesa, R. (2023). Artificial intelligence for Sustainable Development Goals: Bibliometric patterns and concept evolution trajectories. Sustainable Development..
- Kabudi, T. M. (2022, May). Artificial Intelligence for Quality Education: Successes andChallenges for AI in Meeting SDG4. In International Conference on Social Implications of Computers in Developing Countries (pp. 347-362). Cham: Springer International Publishing.
- Smith, T. B., Vacca, R., Mantegazza, L., & Capua, I. (2023). Discovering new pathwaystoward integration between health and sustainable development goals with natural language processing and network science. Globalization and Health, 19(1), 44..
- Al Said, N., Gura, D., & Karlov, D. (2022, December). Efficiency of Smart AI-Based Voice Apps and Virtual Services Operating With Chatbots. In MENDEL (Vol. 28, No. 2, pp. 9-16).
- Nedungadi, P., Menon, R., Gutjahr, G., & Raman, R. (2024). Evaluating Holistic Education and Digital Learning model for advancing SDG4: a longitudinal mixed-effects modeling approach. Cogent Social Sciences, 10(1), 2299134.
- Kakupa, P., & Shayo, H. J. (2021). Implementing Sustainable Development Goal on Education (SDG4)

amid Donor Fatigue: Challenges for the Global South. Advances in SocialSciences Research Journal, 8(11), 20-28.

• Jokhan, A., Chand, A. A., Singh, V., & Mamun, K. A. (2022). Increased digital resourceconsumption in higher educational institutions and the artificial intelligence role in informing decisions related to student performance. Sustainability, 14(4), 2377..

• Maketo, L., Issa, T., Issa, T., & Nau, S. Z. (2023). M-Learning adoption in higher education towards SDG4. Future Generation Computer Systems, 147, 304-315.

• MV, M. K., Sastry, N. K. B., Moonesar, I. A., & Rao, A. (2022). Predicting universal healthcare through health financial management for sustainable development in BRICS, GCC,and AUKUS economic blocks. Frontiers in Artificial Intelligence, 5, 887225.

• Hanachor, M. E., & Wordu, E. N. (2021). Achieving Sustainable Development Goal 4in Nigeria: Problems and Prospects. International Journal of Education, Learning and Development, 9(2), 10-25.

• Yeh, S. C., Wu, A. W., Yu, H. C., Wu, H. C., Kuo, Y. P., & Chen, P. X. (2021). Publicperception of artificial intelligence and its connections to the sustainable development goals. Sustainability, 13(16), 9165.

• Ydesen, C., & Elfert, M. (2023). SDG4 as a global governance tool and the quest for recognizing diversity–Implications emerging from the intersections between inclusive education and assessment. International Journal of Educational Development, 103, 102932.

• Okulich-Kazarin, V., Artyukhov, A., Skowron, Ł., Artyukhova, N., Dluhopolskyi, O.,& Cwynar, W. (2023). Sustainability of Higher Education: Study of Student Opinions about the Possibility of Replacing Teachers with AI Technologies. Sustainability, 16(1), 55.

• Gupta, S., Motlagh, M., & Rhyner, J. (2020). The digitalization sustainability matrix: A participatory research tool for investigating digitainability. Sustainability, 12(21), 9283.

• Yingi, E., Hlungwani, P. M., & Nyagadza, B. (2022). The Fourth Industrial Revolution(4IR) in the Heart of the SDG Agenda: The Role of Education in Zimbabwe. Africa Review, 14(2), 213-229.

• Kuroda, K., & Nakasato, L. (2022). The Historical Development of SDG4: Evolution of the Global Governance of Education. In Sustainable Development Disciplines for Humanity:Breaking Down the 5Ps—People, Planet, Prosperity, Peace, and Partnerships (pp. 37-53). Singapore: Springer Nature Singapore.

• Jariani, F. (2021). The Impact of Governance on Inclusive and Equitable Quality Education (SDG4) in Iran.

• Atabekova, N. K., Dzedik, V. A., Troyanskaya, M. A., & Matytsin, D. E. (2022). The role of education and social policy in the development of responsible production and consumption in the AI economy. Frontiers in Environmental Science, 1219..

• Jain, K., & Raghuram, J. N. V. (2024). Unlocking potential: The impact of AI on education technology. Multidisciplinary Reviews, 7(3), 2024049-2024049.

Jan, N. U., Naqvi, S., & Ali, Q. (2023). Using Fuzzy Logic for Monitoring Students Academic Performance in Higher E