International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2024, Vol. 20, Issue 3, pp. 60-78

Artificial Intelligence for educational sustainability in the South African school system: A bibliometric analysis and literature review

Alton Dewa
University of the Witwatersrand, South Africa

ABSTRACT

Artificial intelligence (AI) focuses on developing computers capable of human-like cognitive activities, profoundly impacting education and global sustainability trends. This has significant impacts on both education and global sustainability. In education, AI offers the potential to improve access, equity, and quality, while also preparing students for the future workforce. To explore this connection, a clear research plan was developed. This plan investigates how integrating AI into education contributes to achieving Sustainable Development Goal 4 (SDG 4). The methodology relied on a comprehensive literature review using peer-reviewed journal articles and conference proceedings from the Scopus database, focusing on publications between 2010 and 2023. Boolean algebra was used as a search query with keywords such as "Artificial Intelligence," "educational sustainability," "South Africa," and "school system." The result from Scopus displayed 22 documents found. VOSviewer was used to analyse and map the intellectual landscapes of various fields by examining relationships between publications, authors, keywords, and institutions. Analysed data was presented using descriptive statistics. The results revealed that the research is limited to higher learning of institutions, leaving out teachers at the school level. Despite AI's potential to advance the United Nations' Sustainable Development Goals, especially Goal 4, which emphasises inclusive and quality education, disparities persist. The study concludes by emphasising the imperative of involving teachers in AI tool implementation to truly enhance educational sustainability, addressing existing gaps in the educational landscape.

Keywords: *Artificial intelligence (AI); education; sustainable development goals; curriculum; digital integration; school system*

INTRODUCTION

As the world becomes increasingly interconnected and technologically advanced, leveraging Artificial intelligence (AI) in education is not merely a choice but a necessity. The South African school system faces unique challenges, including resource constraints and disparate access to quality education. By deploying AI-powered tools for personalised learning, automated administrative tasks, and data-driven decision-making, we can unlock a future where every child receives the tailored education they deserve, irrespective of location or socioeconomic background (Spiteri, 2023). The implementation of AI technologies can also streamline administrative tasks, allowing educators to focus more on innovative teaching methods and fostering critical thinking skills. Furthermore, AI can assist in creating inclusive learning environments by accommodating diverse learning styles and abilities. With an emphasis on the development of 21st-century skills, such as problem-solving and collaboration, AI can empower South African students to thrive in an increasingly digital and globalised world. Embracing AI in education is not just about keeping pace with technological advancements; it is a strategic investment in the future of South Africa, ensuring that the nation's youth are equipped with the skills needed to contribute meaningfully to a sustainable and prosperous society (Sekwatlakwatla & Malele, 2023).

The invention of computers and its numerous ancillary technologies during the Second World War brought a significant change in human history. These technologies facilitated the complete reorganisation of new industries, such as automobiles, locomotives and processing of information to name a few. Skinner (2021) claims that the military gave birth to the advancement of technology and is the driver of technological innovation including computers. The Turing machine in 1950, digital computers, Internet in 1969, cybernetics and Artificial Intelligence (AI) are the progeny or offspring of computers. Put it differently, AI is embodied in computers, and has the capability of learning from large data to produce amazing results. The AI attempts to replicate human intelligence using computer systems. This paper examines the origins of AI, mechanisation of computation embodied in AI and what contemporary human beings believe about computing technologies. Furthermore, we will examine the context of why human beings believe that there is such a thing called 'Artificial Intelligence' and that it should be taught in schools. Finally, we conclude by recommending that teachers should do all possible to comprehend the new technologies. Fundamentally, the prospect of technology evolving may have significant societal repercussions that will not be visible now but with time the results will be of benefit to the society (Martinez, 2019). This paper attempts to answer the research question: ***How does AI-integrated education specifically contribute to different aspects of SDG 4, such as access, equity, quality, lifelong learning, and impact student motivation, engagement, and self-directed learning?***

Artificial Intelligence, what is it?

Recently we have witnessed how AI has become applicable in evaluating large data sets in real-time, on-line purchasing, and fraud-detection, along with autonomous driving cars. The phrase 'Artificial Intelligence' is ubiquitous nowadays and is linked to forms of advanced technology. AI has become ingrained in various facets of the societies and communities in which we live, particularly the industrialised nations. The invisible way personal electronic devices work bears a testimony that the computing technologies have transitioned from just doing mechanical work to an unprecedented scale where human beings can converse with machines. Artificial Intelligence is a term which people may associate with images of Hollywood movies of a killer robots, or perhaps more subtle and sinister, or computer games. However, artificial intelligence (AI) is not solely the domain of science fiction. Numerous books have been published exploring its potential impact, with titles like Our Final Invention: Artificial Intelligence at the End of the Human Era, Superintelligence: Paths, Dangers, Strategies, The Artificial Intelligence Revolution, and Artificial Intelligence: Will It Save Us or Replace Us? This surge in interest begs the question: Why is there such a fascination with AI? (Grohmann, & Araujo, 2021). More importantly, what optimistic views do we hold about AI's potential to benefit humanity, rather than pose an existential threat? Then, what is AI?

Artificial intelligence (AI), defined as a "system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019, p.17), will very certainly have a profound influence on humans and society as a whole. Martinez (2019) cited Stuart Russell and Peter Norvig who gave various abstract definitions of "artificial intelligence", such as "acting humanely", "thinking humanely", "thinking rationally", and "acting rationally". Kok, Boers, Kosters, Van der Putten & Poel (2009) view AI as a field of Computer Science, mainly concerning the "concept that machines can be improved to assume some capabilities normally thought to be like human intelligence such as learning, adapting, self-correction". Bach (2020) quoted John McCarthy who coined the phrase 'artificial intelligence' "as making a machine behave in ways that would be called intelligent if a human were so behaving" (p. 15). The definitions afore-mentioned picture a scenario where, an artificial intelligence system should "match the human-mode of thinking in order to be considered intelligent" Bach (2020). From the afore-mentioned definitions, we can conclude that AI is concerned with strategies for achieving goals in situations where the information provided is complex. Whether the issue solver is a human, or a computer program, the approaches that must be applied are tied to the problem given by the circumstance (McCarthy, 1988).

AI is the science of creating intelligent machines, particularly intelligent computer programs. It is analogous to the task of utilising computers to study human intellect, but AI does not have to be limited to physiologically or biological observable ways. Furthermore, it is perceived as computer systems that, in some ways, resemble the human mind, yet a computer and a human mind cannot be identical in every way (Wang, 2019). As a result, the major issue here is where the two are similar, if not identical. AI is an abstraction of the human mind that explains the mind from a particular point of view, or at a particular level of abstraction, with the idea that this is what intelligence is all about. This abstraction directs the development of a computer system that resembles a human mind in that sense, while dismissing other features of the human mind as irrelevant or secondary (Wang, 2019). AI proponents just want to construct computer programs that accomplish tasks as well as or better than people, without having to worry about whether or not these programs are thinking in the same way humans do (Jackson, 2019). Williams, Park, Oh & Breazeal (2019) say AI education extends beyond computational thinking to investigate how computers detect, think, act, learn, make decisions, create, observe, and make sense of things. Students in higher education take courses in which they program and test algorithms and systems that span the whole range of AI principles. Younger generation (learners at both primary and secondary schools) are concrete thinkers and active learners and can gain the most from hands-on STEM education. Exposing learners to social robots at an early stage of their education will have a significant influence on their future. Artificial intelligence has potential to raise several challenges, and humans will have to learn to coexist with machines and robots. Pushed by the global crisis such as health, education, climate change, and so on, it is clear that AI will deeply impact societies around the world (Kaplan 2021). When robots and people coexist, it is critical that each do what they are good at.

AI History

The history of AI is quite fascinating, and it goes back a long way. Alan Turing, a Cambridge mathematician, laid the foundation in the 1930s for modern computer science. He conceptualised the digital computer and asked questions such as “Could such machine emulate the capabilities of the human mind, or could a machine think?” Alan Turing's article Computing Machinery and Intelligence, published in 1950, looked at the conditions for considering a machine intelligent. He believed that a computer should be regarded intelligent if it could successfully simulate a human in the eyes of a trained observer (McCarthy, 2007). The development of digital computers with modern silicon chips containing billions of components have necessitated the birth of AI. These machines slavishly follow instructions written by the programmer. People quickly understood that the computer's capabilities were not limited to numerical calculations after its invention in the 1940s, and that it could be utilised to perform a wide range of intellectual tasks that would normally need human intelligence (Wang, 2019). For the initial decades of AI's development, history favoured John McCarthy, Marvin Lee Minsky, Allen Newell, and Herbert Alexander Simon (Skinner, 2021). These four, along with a wider generation, benefited from the Cold War's increasingly open intellectual climate, as professional groups, universities, research institutes, and even popular media all fostered discussion of computing, intelligence, and emulation. They viewed AI as a subject devoted to the creation of intelligent machines. John McCarthy (Dartmouth College), Claude Shannon (Bell Laboratories), and Marvin Minsky (MIT), for example, conducted the Dartmouth Summer Research Project on Artificial Intelligence and were as interested in explaining natural intelligence and, in certain cases, answering philosophical puzzles as they were in creating intelligent new machines (Monett, Lewis and Thórisson, 2020; Dick, 2019). Herbert Simon and Allen Newell, were influential in proposing that human minds and modern digital computers were “species of the same genus, namely symbolic information processing systems; both take symbolic information as input, manipulate it according to a set of formal rules, and can solve problems, formulate judgments, and make decisions” in this way (Dick, 2019, p. 1).

In the 1950s, computer scientists working with machines found that it is possible to program a computer to exhibit intelligence or mimic intelligence. Programmers could write a computer program or set of instructions such that when a computer follows these instructions it will exhibit intelligence.

With the passage of time, in the 1970s, the field of computer science became positively unfashionable; thus, AI came to a winter period. Nevertheless, the field of computer science advanced with great rapidity such that a computer program that plays chess was developed (Dainton, 2021; Rehak, 2021). Chess was considered to be the one of the pinnacles of human intellectual achievement. In 1997 a computer program, called the deep blue build by the IBM beat the world chess champion Gary Kasparov (Skinner, 2021). The machine was dedicated to playing chess. It was doing one thing only, to play chess and it did it very well. It was following a series of instructions to analyse the moves and responses to moves and to evaluate board positions. In addition, it made use of the high speed of digital computers and analysed millions of possible moves and counter moves in order to choose a good move for the machine. With this example and others, we began to see computers doing things which previously could only be done by humans and being able to do better than human beings, even things that appear to be very intellectual in nature. Every time work has been completed by a machine to a level greater than humans it has been considered intelligent.

The Computer Science and Artificial Intelligence Laboratory at the Massachusetts Institute of Technology (MIT) has developed a cleaning, four-foot walking robot (Lu, Li, Chen, Kim and Serikawa, 2018). But what is the role of AI in our schools? It can play a role as an active platform in learning, and provide a novel way of learning, where a social network is created and students come together to collaborate. AI has the potential to pinpoint the subjects and skills that students struggle with the most, as well as the best way to help them perform better and tailor their learning experiences in a virtual space, much faster and easier than they could in a physical library or classroom.

Why do humans believe in AI?

Over the last five years AI has invaded our everyday lives. The smart phones that we use are packed full of AI powered apps including software such as Google Translate that lets you point the phone at a magazine in foreign language and read it in a language that the reader understands. It is neural networks that makes it possible. Code-driven systems have touched more than half of the world's population in terms of ambient information and connectivity, bringing previously unimagined promise as well as tremendous risks (Anderson, Rainie & Luchsinger, 2018). Several of the optimistic views have focused on health care and the numerous potential uses of AI in identifying and treating ailments, as well as supporting the elderly in living fuller and better lives. Anderson et al. (2018) has been particularly enthusiastic about AI's role in large-scale public-health initiatives based on massive amounts of data ranging from personal genomes to diet that will be collected in the coming years.

Several of these experts also predicted that AI would aid in the long-awaited development of both formal and informal education systems (Anderson et al., 2018). AI has made significant progress in areas such as self-driving cars, speech recognition, language translation, natural language understanding, and computer-generated music production and art. AI has the power of self-learning from the data it manipulates, allowing it to outperform human intelligence (Jackson, 2019). Businesses and governments throughout the world are injecting billions of dollars into wide range AI applications for various sectors of their economy and social engineering. Its impact has made the education sector think otherwise; and introduced it to its mainstream curriculum. AI has gained huge success in the health sector especially in medicine; thus, it would be unwise to believe that AI will have no impact on education; and the possibilities are vast, albeit overhyped for the time being (Cope, Kalantzis & Searsmith, 2020). Artificial intelligence's inevitable rise and development is not a surprise.

The bigger the impact of AI on humans, the more urgent it is for humans to comprehend it. Thus, education is the rightful sector to understand this phenomenon. AI research is increasingly focusing on perception and human audio-visual literacy, or the capacity to see, hear, read, and write. As a result, education should focus on improving children's cognitive thinking in addition to their computational thinking. Google Maps can recognise when a car is approaching traffic congestion and suggest an alternate route. Furthermore, when we draw massive data inferences, we already know what we don't know (known or unknown) and can use reasoning to get insight; disclosing what we do not know (unknown or unknown) is more difficult, and AI can help find various hidden values and unknown results (Krittanawong, Zhang, Wang, Aydar & Kitai, 2017). Education seeks to employ AI's machine learning and learning analytics to improve teaching quality and learning effectiveness by identifying at-risk learners and making timely interventions possible. Teachers may be able to intervene in real time to improve students' learning results if AI and other related technologies are used to assess learning problems. In terms of the move from technology to humankind, AI has the potential to boost human productivity (Krittanawong et al, 2017).

We hear the acronym "AI" all the time, in the news, on social media, and at conferences, but few people understand what it truly means. It is frequently used to refer to other complicated algorithms that do not fall under the purview of AI. AI is sometimes used interchangeably with other terms such as "Machine Learning" (ML) and "Deep Learning," (DL) although they are not synonymous. In reality, ML is regarded as a subset of AI, whereas DL is regarded as a subfield of Machine Learning. One of the most prevalent kinds of Artificial Intelligence is Machine Learning. Machine learning is generally used to speedily process enormous volumes of data (Rakhimov, Yuldashev & Solidjonov, 2021).

Capabilities of AI in Education

Many businesses have put money into artificial intelligence (AI) to help change education systems and rethink their teaching models and strategies. One of the areas where AI will have a significant impact is education. What's crucial to note is that AI is not a threat to teachers and will not replace them; rather, it exists to provide learners with a better education and radically change the role of teachers to fit into a 21st century curriculum related to computational skills that are relevant to the economy. AI is assisting us in rethinking our entire educational system and how it is delivered. The current educational system requires a hybrid paradigm in which both the students and teacher will benefit from AI-enabled tools (Alexander, Ashford-Rowe, Barajas-Murph, Dobbin, Knott, McCormack & Weber, 2019). When students spend time at school with their teachers, they should focus on developing their creativity through discovering, discussing, and solving problems, as well as improving their communication skills. Simultaneously, AI can be used to provide a more distinct and personalised learning experience. As previously said, technology companies are developing content learning systems that will allow learners to receive AI-driven learning, testing, and feedback. Consider an app that helps students learn math; it tracks the student's progress by indicating areas where the student excels and regions where the learner requires assistance. This type of app allows learners to learn more. Every learner's speed can be customised and adjusted individually.

Even the most experienced teachers have challenges since learners learn at varying speeds based on their diverse skills, learning preferences, and academic learning histories. Students of all ages, on the other hand, may grasp and retain challenging topics at their own pace and on their own time thanks to the utilisation of cutting-edge technology. Cognii Company, for example, created its own educational platform, the Virtual Learning Assistant (VLA), to help students feel more successful and educators be more productive (Marwan, 2020). The VLA provides interactive one-to-one tutoring, open response evaluation, and immediate feedback using powerful AI natural language processing and cognitive computing technology, all of which are proven tactics for fostering active learning and deeper engagement. Similarly, this computer-generated training is increasingly customised based on learner responses.

A teacher in a large class of 30 to 40 learners has a difficult situation in customising individual leaners needs. Learners can study at their own pace with AI-driven systems, and they can see where they need additional help. If these two learning approaches are merged, such as instructors' knowledge transfer and outsourcing some to AI, it can make the position of a teacher more fascinating, allowing them to focus on the truly human interactive and creative portion of learning with their pupils (Alexander et al., 2019). Teachers can use AI in education to provide universal access to learning Teachers can use AI in education to provide universal access to learning, alongside apps like Quizlet, Khan Academy, Photomath, and Wolfram Alpha which offer learners the option to select their preferred language.

AI chatbots, led by powerhouses like Chat Generative Pre-Trained Transformer (ChatGPT), are rapidly infiltrating our digital landscape, colonising websites, apps, and even smartphones (Memarian & Doleck, 2023). Their tentacles reach across industries, from private companies to government and finance, boosting innovation and productivity with each embrace (Chapinal-Heras & Díaz-Sanchez, 2023). But while AI chatbots like ChatGPT promise a smooth revolution in education, concerns linger about unintended consequences, ethical dilemmas, and potential job displacement (Sekwatlakwatla & Malele, 2023). As automation creeps closer to crucial academic roles, it is important to consider how can chatbots de destined as partners. AI chatbots hold the key to personalised learning, skill development, and adaptive assessments, whispering promises of a transformed educational landscape (Sekwatlakwatla & Malele, 2023). They can free educators from mundane tasks and enhance online learning, paving the way for a more engaging and effective experience (Menon & Shilpa, 2023). But for South African students to reap these benefits, proactive action and collaboration are crucial. There is a need for South African researchers to leverage shared resources and integrate AI with purpose to bridge the gap to equitable education.

AI can assist teachers by performing administrative activities, such as grading multiple choice examination questions and short essays in a short amount of time, as well as writing book summaries and checking for plagiarised student work. To put it another way, AI helps teachers to spend more time on other things by delegating more mundane administrative work to AI. The VLA, for example, is a valuable tool since it provides several benefits, such as decreasing the need for time-consuming and difficult-to-scale face-to-face remedial interventions. In addition, teachers can use the administration dashboard to track each student's progress while also detecting common problems that may require curriculum changes or enhancements (Marwan, 2020). AI is extremely relevant to schools and other learning institutions in this period, as education is increasingly becoming a lifelong learning process. It allows teachers to engage with students throughout their lives, and it has the potential to transform teaching and improve it for both students and teachers. But is South Africa as a developing nation ready for such transformation?

Digital revolution for sustainable development goals (SDG)

The Sustainable Development Goals were introduced and developed in September 2015 by all 193 UN member nations. It was a three-year process that saw over 8 million individuals discuss and frame the issues that mattered most in their communities and on their planet. They ended up with 17 goals, although they raised over 300 problems throughout the community consultation process. So, wrapped inside each of these 17 goals is a tremendous lot of thinking and consultation. Countries know that eradicating poverty and other deprivations must be combined with initiatives to promote health and education, decrease inequality, and stimulate economic growth – all while addressing climate change and striving to protect our seas and forests. Things that, if accomplished during the next few years, would radically change the earth. The SDGs clearly highlight the new goals of economic, social, and environmental development, such as poverty eradication, economic growth, and environmental protection, among others. The SDGs encourage everyone on the planet to contribute to the objectives, including governments, businesses, civic groups, and the general people (Cai & Choi, 2020).

The SDGs are really a global agenda since they are both domestic and international in character. The SDGs are a far more complete data collection, providing us with a unique and deeper chance to analyse our influence as an organisation, as communities, and as a country. The objective of the SDGs is 'to not leave anyone behind'. SDGs demand that data gathered does not pay to an aggregate how these 17 goals look at every single sub population, including those who have been historically and traditionally disadvantaged. Failure to reach the targets for any of those populations suggests that less attention is being paid to such communities in order to tackle some of their complicated challenges. SDGs enable governments to collaborate across geographical locations and begin to exchange knowledge and information in a trustworthy manner that is data-driven.

Quality education has been described as the vehicle that provides inclusive and equitable quality education, promoting opportunities for lifelong learning for all (Elfert, 2019), expressed as one of the 17 development goals (UNESCO, 2016; Webb, Holford, Hodge, Milana & Waller, 2017). For example, the UNESCO (2016, p. 8) guidelines on how to unpack education within the 2030 agenda identify three underlying principles as follows: firstly, 'Education is a fundamental human right and an enabling right', secondly, 'Education is a public good' and thirdly, 'Gender equality is inextricably linked to the right to education for all'. Hopes for better global education agendas and strategies have been rekindled by the inclusion of lifelong learning. Quality education appears to be a distant reality despite all the beautiful promises. For instance, in South Africa, high-quality education is sectorial. The majority of urban schools in wealthy regions offers top-notch instruction. A disparity exists in access to digital learning resources between urban schools in affluent regions and those in rural and township settings. This is reflected in national matriculation results, which often show a pattern of consistent performance in urban, well-resourced schools, while schools in rural and disadvantaged areas tend to lag behind. The government is struggling to provide schools with 21st-century classrooms that will enable learning incorporating artificial intelligence. While "quality education" is a goal in itself, it is vital to recognise that member states do not give quality education the attention it needs. For example, studies on the benefits of educational attainment demonstrate that persons with greater skill levels have better employment, better health, are more involved in their communities, and practice more active citizenship (Boeren, 2019).

In the fourth industrial revolution, artificial intelligence is beginning to deliver on its promises of producing actual value, which is necessary by the availability of relevant data, processing capabilities, and algorithms. The impact of artificial intelligence on the achievement of Sustainable Development Goal 9 (poverty reduction, industry, innovation, and infrastructure development) in emerging economies is apparent. Industry 4.0, often known as the fourth industrial revolution (4IR), is gaining popularity because of its potential influence on humanity. AI technologies have the potential to play a critical role in achieving the Sustainable Development Goals (SDGs). Investment in infrastructure and innovation is a vital component of economic growth and development. Because the majority of the world's population live in cities, infrastructure development and innovation via the emergence of new sectors, information and communication technologies (ICT), and artificial intelligence (AI) are vital.

Industry 4.0 (industry automation) and ICT (Information and Communication Technologies) in general can be critical elements in SDG implementation. To ensure sustainable development, research and innovation must also be prioritised. These are all aspects that can alter production and consumption systems and give vital aid in attaining sustainability goals (Geibler, Piwowar & Greven, 2019). Technological advancement and innovation can lead to advances in areas such as resource and energy efficiency. SDG 9 focuses on resilient infrastructure, sustainable industrialisation, and research and innovation. More precisely, it encourages the creation of resilient and sustainable infrastructure that will contribute to economic development and human well-being, as well as inclusive and sustainable industrialisation. Furthermore, it encourages the modernization of infrastructure and industry in order to make them more resource-efficient, greener, and ecologically friendly. The 9th SDG also emphasises research and development and fosters innovation (Geibler et al., 2019). However, the development and innovation of digital driven technologies is on uneven terrain in South Africa. Rural areas together with their schools are still lagging in terms of development.

Inequalities were previously explored by taking into account aspects such as people's wealth, education, and health. Recently, disparities have been considered from a broader perspective, with variables such as discrimination, a lack of fiscal, wage, and social protection laws, and a lack of representation being analysed (Healy, 2024; Nakhle, Sadler, Archer & Todorovski, 2024). SDG 10 seeks to address inequality both within and between countries. More specifically, the aim is to generate population income growth that is faster than the national average. Furthermore, the objective is to attain social, economic, and political inclusion for all through assuring equal opportunity, minimising outcome inequalities, and implementing policies that promote equality. The world is a long way from eliminating intra-country inequality, with little or no progress to show for it. Most Sub-Saharan Africa countries are far from nearing the target of reducing the inequality.

Position of AI in South African Schools

The world as we know it is fast changing as a result of technology, and future employment opportunities (across disciplines) are becoming increasingly reliant on computer-based competencies, with data scientist skills and abilities in particular in great demand. In response to these advances, the South African Basic Education sector released the Digital Skills Curriculum for Grades R–9. According to the Minister of Basic Education, Minister Angie Motshekga, the teaching of this new subject “aims to equip learners to contribute in a meaningful and successful way in a rapidly changing and transforming society” (ASSAF, 2021.). Because school is part of a much larger ecosystem in which we all coexist, it has the obligation to prepare and adequately equip learners for both post-graduate education and the world of work, addressing the need for more entrepreneurs and innovators. Our rapidly evolving society is technology-centric, with information technology driving practically everything.

AI and machine learning are increasingly prevalent in many aspects of life, including online shopping, online registration, 3-D printing, and drone technology, credit check to name a few. We now have robots in our houses as well as clever agents in our smartphones. Children in their early childhood may now engage with tablets and gadgets that have orders of magnitude and more computational power than personal computers even a decade ago. Personal history, individual experiences, societal and cultural variables (such as how parents discuss technology) all influence how children perceive AI-enabled gadgets as mental, psychological, and emotional creatures (Williams, Park, Oh & Breazeal, 2019)

The majority of AI education now takes place in universities, which are the only ones with curricula. Their objective is to create qualified academic and professional AI experts. In the same line, primary and secondary schools should promote AI literacy. The skills that are particular to students in each grade level should be considered in the school's AI curriculum. Giving students the chance to develop the core abilities they need to effectively engage in society is the main objective of basic education. The goal of education should be to help students understand a world with integrated AI. In recent years, block-based coding has proliferated among school students as a preferred method for learning about AI, which enable them to create apps with AI components without having to grasp the intricate syntax of coding languages (Kim, Jang, Kim, Choi, Jung, Kim & Kim, 2021). Further, the authors noted that platforms also enable teachers to facilitate programming activities at technical levels that young learners can handle, which opens up a wide range of educational opportunities. The curriculum should be customised to support the growth of AI literacy among students and aims to develop school learners who would be proficient in the AI competencies such as skills that enables a person to successfully interact in a society that has integrated AI, use AI as a tool, interact and work with AI, and evaluate AI critically (Kim et al., 2021).

In keeping with the global trend of incorporating AI into school curricula, South Africa through its Curriculum Assessment Policy Statements (CAPS) document has advocated for the introduction of AI, starting off with coding and robotics. Woo, Wang & Susanto (2022) claim that AI is a new subject for primary and secondary schools worldwide, and AI technologies are new to education. Progress has been made in several areas despite the lack of historical knowledge regarding how to envision AI integration in educational programs. There are three primary strategies Wang and Cheng (2021) propose for integrating AI into schools' curricula: and these are learning from AI, learning about AI, and learning with AI. Similar to this, Kim et al. (2021) suggested that the three stages of curriculum development might include learning about AI, learning from AI, and learning together. It is not clear what exactly students will be learning about AI. More direction is needed for schools to create AI curricula and its learning outputs, not just to must find space for it in an already-clogged curriculum (Wang & Cheng, 2021). It is not a good idea to copy and paste just because other nations are doing it. It is necessary to conduct a feasibility study to verify that adding a new subject is, in fact, doable. Due to the subject's introduction in Grades R through 9, the curriculum appears to be one-size-fits-all. This raises doubts about how to teach learners AI and the appropriate age to introduce certain concepts. Instead of just adding a new subject to the curriculum in response to political pressure, the South African government should ensure that resources are available, such as qualified AI teachers, adequate support, responsive policies and computing infrastructures. Learning AI should be done gradually, starting with simple programming and working up to more complicated ideas. Ma, Adesope, Nesbit & Liu (2014) conducted a study and reported that students were interested in AI technology, but they had challenges in understanding how crucial it was to comprehend AI on a deeper level. It was also discovered that a student's foundational knowledge of mathematics could impede their growth. A disconnection between mathematics and AI entails that not all learners can do AI but only those that are good in mathematical foundations have the potential of having a deeper understanding of AI and its elements. Non-programming activities can also be created to increase learners who are not good in programming to understand AI and practice skills essential to AI. It is crucial to take the proper course of action that addresses the elements that have been identified as potential barriers to the introduction of AI in schools rather than simply implementing it and failing to get the desired results.

METHODOLOGY

To investigate the role of AI integration in advancing Sustainable Development Goal 4 (SDG 4) within South Africa's educational context, a systematic literature review was used. This review aimed to elucidate how AI contributes to key dimensions of SDG 4, including accessibility, equity, quality, and lifelong learning, while also assessing its impact on student motivation, engagement, and self-directed learning. The central aim of this inquiry is to examine the application of artificial intelligence in fostering educational sustainability within school environments. A thorough literature review was conducted to identify relevant studies focusing on AI within educational settings. These studies underwent rigorous scrutiny, analysis, and curation (Lim & Kumar, 2024) to construct a cohesive dataset capturing the multifaceted impacts of AI on educational sustainability. By delving into the intersection of artificial intelligence and sustainable education, this study engaged in a meticulous examination of pertinent literature. This process began with the precise definition of search terms tailored for querying the Scopus database, chosen for its comprehensive coverage of peer-reviewed research across reputable journals and its established recognition within the academic community (Lim & Kumar, 2024).

To ensure a focused yet comprehensive overview of the field, the need for a rigorous and transparent data foundation, the research methodology employed a targeted search in Scopus with clearly defined inclusion criteria. Only peer-reviewed journal articles published within the relevant timeframe and relevant and focus on AI's contemporary teaching and learning role were retained. Additionally, articles from diverse disciplines spanning humanities, science, philosophy, mathematics, and computer science were included to capture the full scope of AI's educational engagement. The initial choice of keywords stemmed from an initial examination of existing literature. A search was performed on Google Scholar using the keyword "Artificial Intelligence and sustainable education," and the first 22 studies were briefly assessed. This review aimed to uncover additional terms recurrently or interchangeably used in the current literature. Following this exploration, it was determined that the terms "Artificial intelligence," "sustainable education," and "school system" were also deemed suitable and thus included as viable keywords. Employing Boolean algebra, the search query encompassed key terms such as "Artificial Intelligence," "educational sustainability," "South Africa," and "school system." The final dataset encompassed 95 documents found within the timeframe spanning 2010 to 2023 across various journals. This distribution underscores the relatively recent emergence of the application of AI in education and related fields. Furthermore, specific criteria were applied to determine the inclusion of articles in the database, ensuring their suitability for subsequent bibliometric and content analyses. All retrieved articles were meticulously stored in both RIS and CSV formats for seamless data transfer and accessibility, ensuring transparency and facilitating further analysis.

Descriptive Statistical Data

Data reveals that South Africa, the USA, and Kenya rank among the top 10 countries extensively integrating AI applications into their education systems as shown in Table 1 below. Remarkably, the prevalence of AI usage appears more pronounced in higher education institutions (Sekwatlakwatla & Malele, 2023) compared to primary and secondary schools. This trend implies that, while numerous studies mention AI across diverse domains, the focus of their publication leans toward discussing theoretical aspects of AI's potential to enhance teaching and learning, rather than emphasising practical implementation. Utilising descriptive statistics on bibliographic details extracted from Scopus can also contribute to elucidating the extent of this research domain, particularly in terms of author contributions and geographical delineations.

Table 1: *Citation by countries*

Country	Documents	Citations
South Africa	65	692
United States	12	149
Kenya	2	32
Sweden	2	23
Hong Kong	2	16
Australia	2	11
United Kingdom	2	8
Canada	2	7
Germany	2	6
Poland	2	1

ANALYSIS

To delve into the connections between publications, VOSviewer was utilised. It is a software renowned for its efficient analysis of large datasets and diverse visualisation options (Cao, Wang, Yang, Wang & Liu, 2023; Ogutu, Archi & Dénes Dávid, 2023) In addition, Vosviewer is used as a data visualisation tool for literature knowledge analysis (Wang, Tang, Jiang, He & He,2023). A three-pronged approach was employed: citation analysis, co-citation analysis, and clustering. VOSviewer automatically categorises publications into clusters based on their interconnectedness, ensuring clear and easily recognisable groupings. To optimize the accuracy and interpretability of these clusters, the resolution settings for each network analysis individually were adjusted.

Analysis of co-occurrence of keywords

Utilising the gathered bibliographic data, a co-occurrence map was generated to investigate the interrelation of keywords targeted for extraction. In the realm of AI research, these keywords mirror the focal points and trajectories of the concept, helping in the categorisation of pivotal themes within sustainable educational discussions. These identified categories or clusters of keywords serve as a foundation for exploring diverse hot topics and dimensions of AI within the specified timeframe. In adherence to the study's methodology, the extraction of keywords was capped at 5 (the default number). Consequently, to qualify for extraction, a keyword needed a minimum of 5 co-occurrences in both author and source-indexed keywords. The analysis unveiled a total of 209 keywords across the 95 extracted articles. Among these, 23 surpassed the stipulated threshold of 5 co-occurrences and were further consolidated into 4 distinct clusters. Figure 1 shows the size of the nodes denoting the frequency of keyword occurrences, with larger nodes indicating more frequent appearances. The lines, conversely, symbolize co-occurrence relationships, with thicker lines signifying stronger connections.

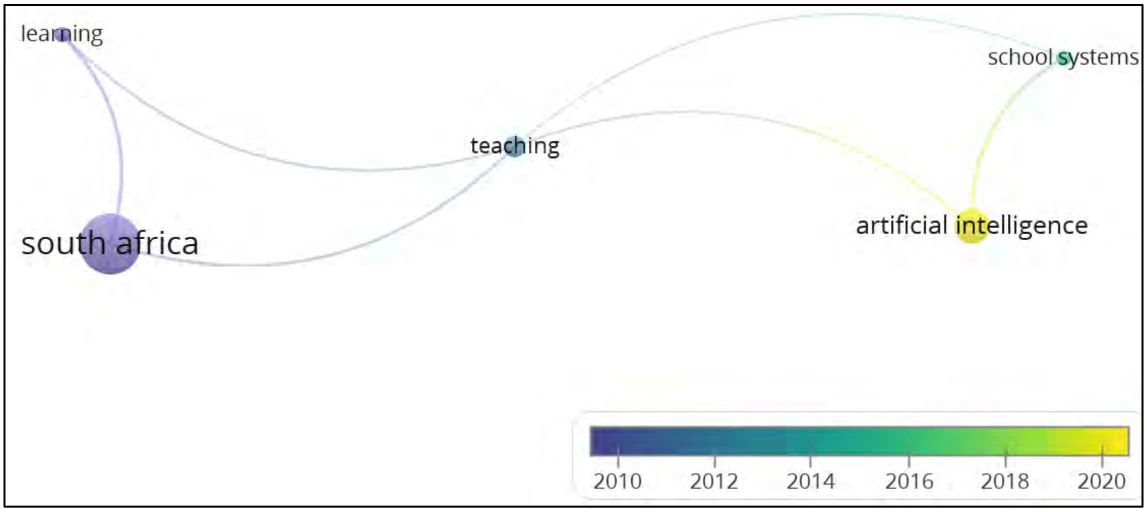

Figure 1: Network visualisation map for co-occurring keywords

Cluster 1: Artificial Intelligence- It is dominating the yellow region on the timeframe map scale, (refer to Figure 1). It is championing the fusion of Artificial Intelligence (AI) with Sustainable Learning approaches. The cluster's five core keywords – machine learning, big data, computational thinking, e-learning, and critical thinking – reveal a clear focus on utilising AI in education to cultivate future-ready learners. The emphasis on non-academic skills like problem-solving, and creativity approaches highlights the cluster's interest in fostering not just academic excellence, but well-rounded individuals equipped to thrive in an AI-driven world.

Cluster 2: Teaching - dominated by the blue-coloured region on the timeframe map scale, cultivates the seeds of pedagogical transformation. Its five core keywords – learner-centred, collaboration, personalised learning, continuous learning and feedback, and engaging content – paint a vibrant picture of classrooms where teachers become gardeners, nurturing individual growth and fostering dynamic collaboration. This cluster champions pedagogies that put the learner at the heart of the learning journey, ensuring tailored pathways, ongoing feedback, and captivating content that ignites curiosity and fuels progress.

Cluster 3: learning - dominated by the purple-coloured region on the timeframe map scale. The role of students in the classroom is characterised by the concept of learning, which centres around six keywords with a specific focus on sustainability. The keywords are sustainable development, artificial intelligence in education, 21st-century skills, digital literacy, collaborative learning, and digital citizenship. This cluster of keywords is intricately tied to the overarching theme of sustainability, an area of increasing significance in UNESCO research and initiatives.

Cluster 4: School System - dominated by the green-coloured region on the timeframe map scale. In the context of Sustainable Development Goal 4 (SDG 4) of UNESCO, the term "School System" refers to the organised structure and components that constitute the educational framework within a country or region. SDG 4 is focused on ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. In addition, the term "School System" in this context encompasses formal education institutions, including primary and secondary schools, and the policies, resources, and infrastructure supporting them. It emphasises the importance of creating an educational environment that is accessible, inclusive, and provides quality learning experiences to all individuals, regardless of gender, socio-economic background, or other potential barriers. Its five core keywords quality education, inclusive education, equitable education, lifelong learning, access to education, education for sustainable development (ESD), gender equality in education, and education for all.

Document Citation

Document citation in a bibliometric review refers to the systematic recording and acknowledgment of the sources or documents cited within scholarly literature. It plays a pivotal role in assessing the scholarly impact and influence of a particular document, enabling researchers to trace the lineage of ideas, methodologies, and findings. The process involves citing relevant articles, books, reports, and other scholarly works that contribute to the understanding and development of a particular research field (Sekwatlakwatla & Malele, 2023). Document citation serves as a means of giving credit to the original authors, substantiating claims, and situating a piece of work within the broader academic discourse. In the context of bibliometric analysis, understanding the patterns of document citation allows researchers to quantify the impact of specific publications, identify influential works, and map the intellectual structure of a research domain. In Figure 2, a comprehensive overview of document citations by South African universities in the field of AI for educational sustainability is presented. Notably, the schools of education within universities emerge as frontrunners, with 28 citations, showcasing their leading role in advancing research in AI educational sustainability. Following closely are prominent institutions such as the University of South Africa (27 citations), the University of the Witwatersrand (25 citations), the University of Pretoria (17 citations), the University of KwaZulu Natal (5 citations), and the University of Western Cape (4 citations). These compelling descriptive statistics not only underscore the prominence of AI research in higher education but also bring attention to a notable gap—there is a lack of evidence suggesting the integration of AI in basic education, specifically at the primary and secondary levels. This insight prompts further exploration into how AI initiatives can be extended to enhance educational sustainability across all levels of South Africa's academic landscape.

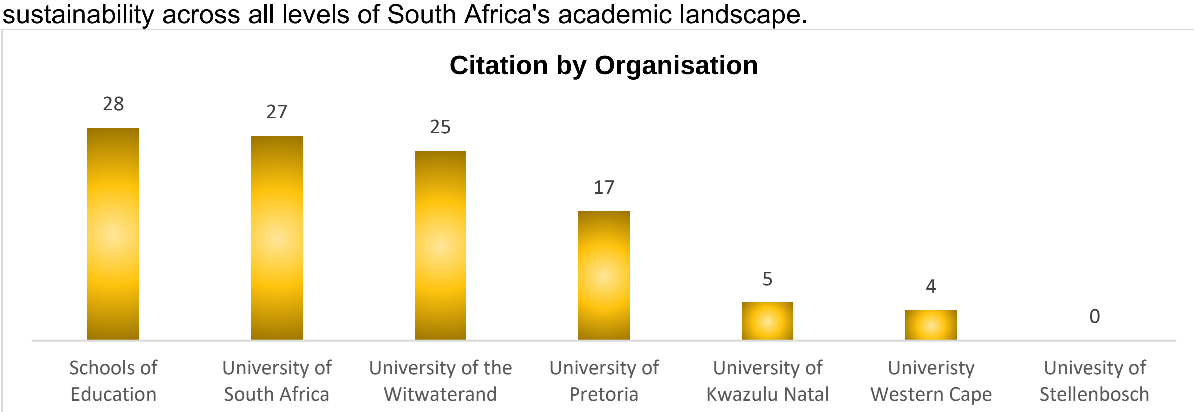

Figure 2: Citation by Organisation

Publications per county

Upon examining the publication count per country, it is crucial to acknowledge that certain articles are affiliated with multiple countries, contributing to the observed overlap. As depicted in Figure 3, South Africa emerges as the leader with 692 articles, followed by the USA with 148 articles. Notably, Australia, the United Kingdom, and Canada also make substantial contributions with 11, 8, and 7 articles, respectively. A noteworthy observation is that South Africa and Kenya stand out as the only developing countries with publications related to "AI in education" and "educational sustainability." However, it is imperative to highlight that this research primarily focuses on higher institutions of learning, revealing a critical gap in understanding how AI can be effectively integrated into primary and secondary schools. Addressing this gap holds significant potential for advancing educational sustainability on a broader scale.

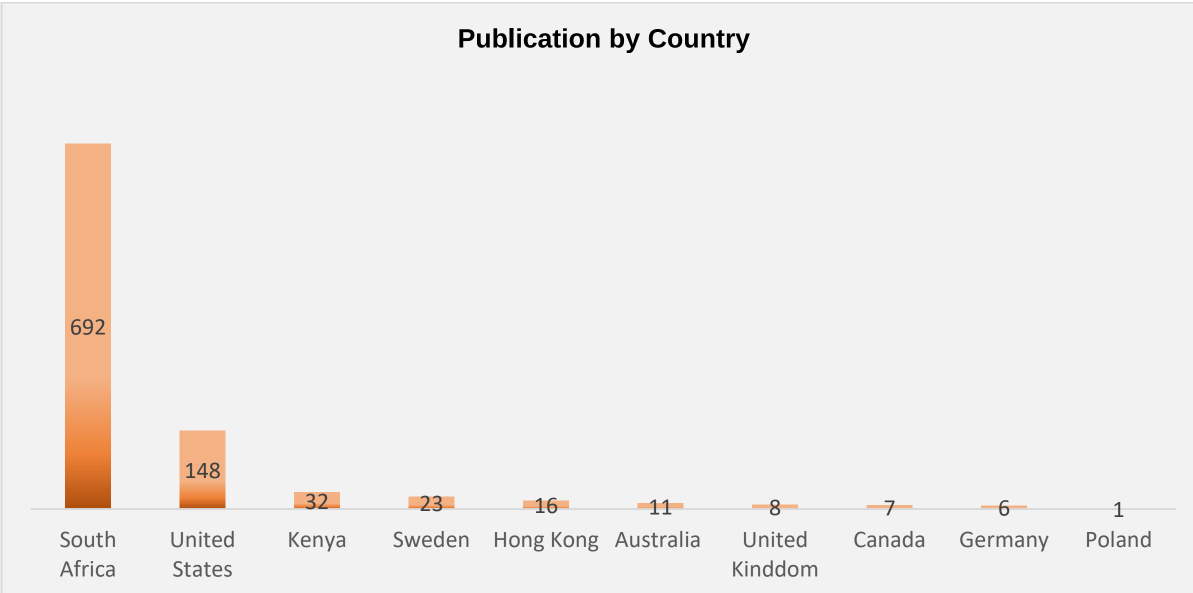

Figure 3: Number of publications per country

DISCUSSION

AI technologies revolutionise learning by tailoring instruction to individual learners' unique needs and demands (Chen, Xie, Zou & Hwang, 2020). Traditional educational approaches, constrained by the diversity of learning styles and preferences, may struggle to accommodate every student effectively. In contrast, AI empowers educators to customize their teaching methods for each student, fostering increased motivation, engagement, and self-directed learning (Ventura, 2017; Della Ventura, 2018; Wang, 2017). Notably, AI also offers a pathway to engage learners facing difficulties in the learning process. As AI technologies gain prominence in teaching, teachers can streamline repetitive tasks, provide timely feedback, and enhance adaptive and personalised teaching methodologies. The evolution of hardware, especially high-speed graphics processing units and extensive software libraries, further accelerates the integration of AI in education. The trajectory of education's future is intricately intertwined with AI's development, marking a transformative shift in pedagogical approaches. The ongoing breakthroughs in innovative technologies and the computing capabilities of intelligent machines will undoubtedly propel the growth and enrichment of future education.

The incorporation of digital computing technologies in education has undergone significant transformations over time (Chen, Xie, Zou & Hwang, 2020). Originally, computer-based education systems were standalone applications with limited utilisation of artificial intelligence, lacking in features such as student modelling, adaptability, and personalisation. However, with the advent of the Internet, a new wave of educational web-based systems, including e-learning platforms, emerged. The increasing integration of AI techniques has led to the development of sophisticated adaptive and intelligent systems for educational purposes. This shift foresees a future where AI handles fundamental aspects of learning, potentially replacing traditional teaching roles with behavioural monitors and facilitators. The prospect of virtual classrooms gradually supplanting traditional classrooms gains momentum as the Internet of Things (IoT) and 5G connections become more seamlessly integrated into educational landscapes.

CONCLUSION

In summary, artificial intelligence is having a significant influence on the modern educational environment. To accommodate the usage of learning machines and the blend of learners envisioned, teaching techniques must be modified. Artificial intelligence will help to improve the quality of distance and online education. AI is used in advanced technical systems such as virtual reality (VR), augmented reality (AR), and other next-generation technologies. AI will allow all learners, even those with disabilities, to receive an education. There is a need to redesign the educational paradigm to foster continuous backed using IA technologies.

REFERENCES

Alexander, B., Ashford-Rowe, K., Barajas-Murph, N., Dobbin, G., Knott, J., McCormack, M., & Weber, N., 2019. *Horizon report 2019 higher education edition ,* s.l.: EDU19.

Anderson, J., Rainie, L., & Luchsinger, A., 2018. *Artificial intelligence and the future of humans,* s.l.: Pew Research Center, vol. 10, no. 12.

ASSAF (2021). *The Status of Coding and Robotics in South African Schools*, Academy of Science of South Africa. Aveliable at: https://www.assaf.org.za/2021/06/23/the-status-of-coding-and-robotics-in-south-african-schools-2/

Bach, J., 2020. When artificial intelligence becomes general enough to understand itself. Commentary on Pei Wang's paper "on defining artificial intelligence". *J. Artif. Gen. Intell,* vol. 11, pp. 15-18.

Boeren, E., 2019. Understanding Sustainable Development Goal (SDG) 4 on "quality education" from micro, meso and macro perspectives. *International review of education,* vol. 65, pp. 277-294.

Cai, Y. J., & Choi, T. M., 2020. A United Nations' Sustainable Development Goals perspective for sustainable textile and apparel supply chain management. *Transportation Research Part E: Logistics and Transportation Review,* vol. 141, p. 102010.

Cao, Y., Wang, X., Yang, Z., Wang, J., Wang, H., & Liu, Z, 2023. Research in marine accidents: A bibliometric analysis, systematic review and future directions. *Ocean Engineering,* vol. 284, p. 115048.

Chapinal-Heras, D., & Díaz-Sánchez, C, 2023. A Review of AI applications in Human Sciences research. *Digital Applications in Archaeology and Cultural Heritage,* pp. 1-5.

Chen, X., Xie, H., Zou, D., & Hwang, G. J., 2020. Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence,* vol. 1.

Cope, B., Kalantzis, M., & Searsmith, D. , 2020. Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. *Educational Philosophy and Theory,* pp. 1-17.

Dainton, B., 2021. Artificial General Intelligence An artificial intelligence that isn't designed to perform just one sort of task well (eg playing chess or Go or driving a car), but instead has the same broad range of abilities as a typical human.. In: *Minding the Future: Artificial Intelligence, Philosophical Visions and Science Fiction.* Liverpool: SpringerLINK, p. 251.

Della Ventura, M., 2018. *Twitter as a music education tool to enhance the learning process: conversation analysis.* Singapore, Springer, pp. 81-88.

Dick, S., 2019. *Artificial intelligence.* s.l.:s.n.

Elfert, M., 2019. Lifelong learning in Sustainable Development Goal 4: What does it mean for UNESCO's rights-based approach to adult learning and education?. *International Review of Education,* vol. 65, no. 4, pp. 537-556.

Geibler, J. V., Piwowar, J., & Greven, A., 2019. The SDG-check: Guiding open innovation towards sustainable develop. *Technology Innovation Management Review,*vol. 9, no. 3, pp. 20-37.

Grohmann, R., & Araujo, W. F, 2021. Beyond Mechanical Turk: the work of Brazilians on global AI platforms.. In: P. Verdegem, ed. *AI for everyone.* London: University of Westminster Press, pp. 247-266.

Healy, L. M., 2024. Sustainable Development Goal 10: The Challenge of Reducing Inequality. In: *In The Routledge International Handbook of Social Development, Social Work, and the Sustainable Development Goals.* s.l.:Routledge, pp. 138-152.

Jackson, P. C., 2019. *Introduction to artificial intelligence.* s.l.:Courier Dover Publications.

Kaplan, A. , 2021. *Higher education at the crossroads of disruption: The university of the 21st century.* s.l.:Emerald Group Publishing.

Kaplan, A., & Haenlein, M., 2019. Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business horizons,* vol. 62, no. 1, pp. 15-25.

Kim, S., Jang, Y., Kim, W., Choi, S., Jung, H., Kim, S., & Kim, H., 2021. *Why and what to teach: AI curriculum for elementary schoo.* s.l., PKP Publishing Services Network, pp. 15569-15576).

Kok, J. N., Boers, E. J., Kosters, W. A., Van der Putten, P., & Poel, M., 2009. Artificial intelligence: definition, trends, techniques, and cases. *Artificial intelligence,* vol. 1, pp. 270-299.

Krittanawong, C., Zhang, H., Wang, Z., Aydar, M., & Kitai, T., 2017. Artificial intelligence in precision cardiovascular medicine. *Journal of the American College of Cardiology,* vol. 69, no. 21, pp. 2657-2664.

Lim, W. M., & Kumar, S, 2024. Guidelines for interpreting the results of bibliometric analysis: A sensemaking approach. *Global Business and Organizational Excellence,* vol. 43, no. 2, pp. 17-26.

Lu, H., Li, Y., Chen, M., Kim, H., & Serikawa, S. , 2018. Brain intelligence: go beyond artificial intelligence. *Mobile Networks and Applications,* vol. 23, no. 2, pp. 368-375.

Ma, W., Adesope, O. O., Nesbit, J. C., & Liu, Q., 2014. Intelligent tutoring systems and learning outcomes: A meta-analysis. *Journal of Educational Psychology,* vol. 106, no. 4, pp. 901–918.

Martinez, R., 2019. Artificial intelligence: Distinguishing between types & definitions. *Nevada Law Journal,* vol 19, no. 3, p. 9.

Marwan, A., 2020. Impact of artificial intelligence on education for employment. *(learning and employability Framework).*

McCarthy, J., 1988. Mathematical logic in artificial intelligence. *Daedalus,* pp. 297-311.

McCarthy, J., 2007. *What is artificial intelligence* [Interview] 2007.

Memarian, B., & Doleck, T, 2023. ChatGPT in education: Methods, potentials and limitations. Computers in Human Behavior. *Artificial Humans,* p. 100022.

Menon, D., & Shilpa, K, 2023. “Chatting with ChatGPT”: Analyzing the factors influencing users' intention to Use the Open AI's ChatGPT using the UTAUT model. *Heliyon,* vol. 9, no. 11, pp. 1-19.

Monett, D., Lewis, C. W., & Thórisson, K. R., 2020. Introduction to the JAGI special issue “on defining artificial intelligence”—commentaries and author’s response. *Journal of Artificial General Intelligence,* vol. 11, no. 2, pp. 1-100.

Mosk, C., 2021. Safety First in a Hostile Environment:: The Historical Origins of Artificial Intelligence. Available at SSRN 3819348..

Nakhle, N., Sadler, J., Archer, J., & Todorovski, A, 2024. *Reduced Inequalities-A United Nations Sustainable Development Goal,* s.l.: UWILL DISCOVER 2023.

Ogutu, H., El Archi, Y., & Dénes Dávid, L, 2023. Current trends in sustainable organization management: A bibliometric analysis. *Oeconomia Copernicana,* vol. 14, no. 1, pp. 11-45.

Rakhimov, M., Yuldashev, A., & Solidjonov, D, 2021. The role of artificial intelligence in the management of e-learning platforms and monitoring knowledge of students. *Oriental renaissance: Innovative, educational, natural and social sciences,* vol. 1, no. 9, p. 308.

Rehak, R., 2021. The language labyrinth: Constructive critique on the terminology used in the AI discourse. In: P. Verdegem, ed. *AI for Everyone.* London: University of Westminster Press, pp. 87-102.

Sekwatlakwatla, S. P. & Malele , V, 2023. A Bibliometric Analysis of Generative Artificial intelligence Chatbots in Higher Education: A case study of African countries collaborating with developing nations. *nternational Journal of Education and Development using Information and Communication Technology (IJEDICT), 2023,* vol. 19, no. 3, pp. 39-49.

Skinner, R., 2021. *Building the Second Mind: 1956 and the Origins of Artificial Intelligence Computing.* s.l.:s.n.

Spiteri, J., 2023. Education and Sustainability: Debates, Tensions, and Possibilities in Practice, Policy and Research. In Educating for Sustainability in a Small Island Nation: Voices from Early Childhood Education. *Cham: Springer International,* pp. 37-60.

UNESCO, 2016. *Unpacking sustainable development goal 4 education 2030 guide,* s.l.: UNESCO.

Ventura, M. D., 2017. *Creating inspiring learning environments by means of digital technologies: A case study of the effectiveness of WhatsApp in music education. In E-Learning, E-Education, and Online Training: Third International Conference.* s.l., eLEOT 2016.

Wang, N., Tang, G., Jiang, B., He, Z., & He, Q, 2023. The development of green enterprises: A literature review based on VOSviewer and Pajek. *Australian Journal of Management,* vol 48, no. 2, pp. 204-234.

Wang, T., & Cheng, E. C. K. , 2021. An investigation of barriers to Hong Kong K-12 schools incorporating Artificial Intelligence in education. *Computers and Education: Artificial Intelligence,* vol.2, p. 100031.

Wang, F. H., 2017. An exploration of online behaviour engagement and achievement in flipped classroom supported by learning management system. *Computers & Education,* vol. 114, pp. 79-91.

Wang, P., 2019. On defining artificial intelligence. *Journal of Artificial General Intelligence,* vol. 10, no. 2, pp. 1-37.

Webb, S., Holford, J., Hodge, S., Milana, M., & Waller, R., 2017. Lifelong learning for quality education: exploring the neglected aspect of sustainable development goal 4. *International Journal of Lifelong Education,* vol. 36, no. 5, pp. 509-511.

Williams, R., Park, H. W., Oh, L., & Breazeal, C., 2019. *Popbots: Designing an artificial intelligence curriculum for early childhood education.* s.l., s.n., pp. 9729-9736.

Woo, D. J., Wang, Y., & Susanto, H., 2022. *Student-AI Creative Writing: Pedagogical Strategies for Applying Natural Language Generation in Schools.* s.l., s.n., pp. 1-30.
