

DATA-DRIVEN DECISION-MAKING: UTILISING AI-POWERED LEARNING ANALYTICS TO MAKE INFORMED PRIMARY EDUCATORS' DECISIONS

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ABSTRACT

This paper provides a comprehensive overview of the research on the application of artificial intelligence (AI) in primary education to explore its potential to enhance teaching and learning processes. Through a systematic review of the relevant literature, this study identifies key areas in which AI can significantly impact primary education and offers recommendations for its effective utilisation to sustain or acquire quality education. These recommendations encompass various facets of AI integration in primary education, including tailored learning experiences, intelligent tutoring systems, data-driven decision making, virtual reality and augmented reality technologies, intelligent content creation, adaptive assessment and feedback mechanisms, intelligent course design, and support for students with exceptional needs. Additionally, this paper emphasises the importance of addressing ethical considerations and ensuring responsible AI use, along with advocating continuous professional development opportunities for educators to enhance their AI literacy and pedagogical skills. Drawing on insights from the existing literature, this study underscores the potential of AI to revolutionise primary education by providing personalised learning experiences, facilitating intelligent tutoring and feedback, and enabling immersive and engaging learning environments. However, it also highlights the need for careful consideration of the ethical implications and ongoing professional development initiatives to harness the benefits of AI in education.

Keywords: *artificial intelligence, educators, primary education, data-driven decision-making, virtual reality, augmented reality*

INTRODUCTION

In the past century, rapid advances in education and information technologies have catalysed significant social and economic transformations worldwide (Fischer et al., 2020; Kaputa et al., 2022; McDiarmid & Zhao, 2023). The evolution of the education sector has attracted considerable attention from various stakeholders, including policymakers, educational institutions, academics,

parents, and industry. Deep learning, a new academic discipline, has emerged with the development of artificial intelligence rooted in machine learning, enabling machines to independently learn, think, and perform complex tasks (Pramod et al., 2021; Raschka et al., 2020; Samtani et al., 2023). This transformation has profoundly affected the education sector, which has been reinvented through knowledge verification. Major companies,

including Google, Microsoft, Baidu, and Midea, have invested heavily in pioneering “intelligent education” and “intelligent teaching” in the education sector, resulting in a decade of vigorous growth. Artificial intelligence technology in education has also rewarded a plethora of start-ups and established achievements in both education and intelligence globalization (Alqahtani et al., 2023; Chen et al., 2020; Perrotta & Selwyn, 2020). Hence, artificial intelligence has emerged as a prominent area of focus in contemporary education. (Aldosari, 2020; Ajani, Akintolu & Afolabi, 2024).

Primary education institutions are actively exploring the potential of AI to enhance teaching and learning processes, especially through data-driven decision-making. Data-driven decision-making (DDDM) has become increasingly prevalent in various fields, including education (Olatoye et al., 2024; Sywelem & Mahklouf, 2024; Syifa, 2024). This approach involves the use of data to inform decision-making processes with the aim of improving the outcomes. By utilising the data to inform their decisions, educators can make more informed choices tailored to the needs of individual students that lead to improved learning outcomes. The ever-emergent nature of AI informs the potential of AI-powered learning analytics to revolutionise the way primary educators make decisions. Existing studies in this field have primarily focused on the use of learning analytics in higher education (Abgaryan et al., 2023; Aldosari, 2020; Gray et al., 2022; Kharbat et al., 2020; Wang & Lund et al., 2023). However, a growing body of research explores the potential of AI-powered learning analytics in primary education (Bridge & Bridge, 2019; Ju, 2023; Khatri & Karki, 2023; Sywelem & Mahklouf, 2024). Despite the growing interest in AI-powered learning analytics in primary education, there remains a significant knowledge gap regarding the effectiveness of this approach. Further research is required to explore the potential benefits and challenges of using AI-powered learning analytics in primary education. Hence, the importance of this study.

METHODOLOGY

This study adopted a systematic literature review (SLR) approach to critically analyse the use of AI-powered learning analytics in primary education. It is worth noting that this study is not

restricted to a particular region or location because it covers a wide range of relevant literature. The SLR was adopted for this study to synthesise the existing research, which enables a broader understanding of the concept under study by systematically identifying, evaluating, and interpreting all the related literature (Boudjelida et al., 2016). The thrust of this study clearly establishes the research objective as follows: This study aims to explore the application of artificial intelligence (AI) in primary education and its potential to enhance teaching and learning processes, and to identify the importance of addressing ethical considerations and ensuring responsible AI use. This objective influenced the selection of literature to be used and ensured the inclusion of directly related studies.

To identify the relevant literature, we engaged in a thorough search across several academic databases, including Scopus, JSTOR, and Google Scholar, using keywords such as “Artificial Intelligence,” “Educators,” “Primary Education,” “Data-Driven Decision-Making,” “Virtual Reality,” and “Augmented Reality.” The search only considered peer-reviewed publications, including book chapters, books, journal articles, conference proceedings, and reports, published between 2015 and 2024 to capture the recentness of AI development (Taş & Tanrıöver, 2020). The literature selected for the study was chosen based on its relevance and quality, and the extent to which it addressed the research objective. Some studies were excluded because they did not focus on our keywords or were not directly relevant to the study objective.

Data mining involved a systematic review of the selected studies to identify key themes, patterns, and gaps in the literature. A thematic analysis was adopted to synthesise the findings, focusing on the key areas where AI can significantly impact primary education. The analysis also considered the importance of ethical considerations and responsible AI usage. This methodological approach allowed for an in-depth understanding of the current state of research on this topic that provided a solid background for drawing conclusions and making useful recommendations for future research and practice.

EDUCATION AND ARTIFICIAL INTELLIGENCE

As educational intelligence has experienced a nationwide upsurge, big-data-based learning

analytics (LA) has gradually emerged as a new research area. Falling within the broad datafication trend, this multidisciplinary field analyses data produced or recorded in educational contexts. Institutions are turning to learning analytics as a potential solution to these challenges (Kuleto et al., 2021). LA has been instrumental in enhancing educational outcomes, improving the quality of education, and transforming institutional decision making (Alzahrani et al., 2021; Díez et al., 2020). However, the advent of big data has led to new challenges in LA. Barriers to the effective and extensive implementation of data-informed decision-making (DIDM) practices exist, notably the lack of affordable data analysis technologies. In addition, the two theoretical limits further complicate the discussion. Traditional theories of decision-making processes mainly stem from cognitive psychology research, while the ecological rationality paradigm roots the decision-making process perspective in cognitive limitations (Kozyreva & Hertwig, 2021; Lieder & Griffiths, 2020; Suomala, 2020). Neither approach adequately addresses AI in education systems, because in the education setting data-driven machine learning algorithms and teaching adaptations are processed in real time, continuously, or cyclically.

By providing an overview of research on AI applications in primary education through a systematic review (Ju, 2023), this study aims to explore potential innovative solutions to the challenges that LA faces because of the complexities of decision-making processes and the deficiencies of educational AI technologies in current LA. The use of systematic reviews should aid in revealing the potential of AI-powered learning analytics to inform primary educators' decisions and identify the benefits and challenges of this approach.

In the era of rapid advancements in educational technology, artificial intelligence has emerged as a powerful tool for enhancing learning experiences. AI-Powered Learning Analytics (AI-LA) refers to the use of AI algorithms to analyse data on student learning behaviour, academic performance, and engagement to gain insights into their learning preferences and needs (Reethika & Priya, 2024; Rekha et al., 2024; Yildirim-Erbasli et al., 2024), which can provide educators with learning analytics dashboards that are visual representations of real-time data on student behaviour and performance.

Focusing on the role of AI-Powered Learning Analytics in data-driven decision-making for primary educators, this study addresses the knowledge gap regarding the use of AI-powered learning analytics in primary education. It presents a systematic literature review that examines how AI-LA can support DDDM processes (i.e., data collection, data analysis, and decision-making) in the context of K–12 education. By exploring the potential benefits and challenges of this approach, this study aimed to contribute to the development of more effective data-driven decision-making processes in primary education.

The findings revealed that AI-LA can support educators in DDDM by investigating trends, identifying problems, and recommending actions. Furthermore, the paper discusses opportunities and challenges for implementing AI-LA in practice and suggests future research directions. This study also argues that the use of AI-powered learning analytics can lead to more informed decision-making processes in primary education that results in improved learning outcomes for students. In addition, it should be noted that the findings of this study can have practical applications for primary educators, policymakers, and technology developers, as they can inform the development and implementation of AI-powered learning analytics in primary education.

OVERVIEW OF AI-POWERED LEARNING ANALYTICS

AI-powered learning analytics can significantly aid primary educators in making informed decisions by providing insights into individual student performance and learning needs. These analytics can facilitate personalised education by identifying student strengths and areas for improvement, thus enabling educators to tailor their teaching strategies accordingly (Vashishth et al., 2024). Additionally, intelligent assessment techniques can continuously diagnose and monitor students' cognitive levels, offering a dynamic and precise understanding of their progress (Caspari-Sadeghi, 2023). However, there are some challenges that need to be addressed. The effectiveness of AI in education depends on the transparency and comprehensibility of AI models because educators must trust the recommendations provided by these systems (Feldman-Maggor et al., 2024). Moreover, the integration of AI into educational practices requires careful alignment

with instructional needs and goals as well as educators' acceptance and understanding of technology (Rachmadtullah et al., 2024).

In summary, AI-powered learning analytics has the potential to transform primary education by enabling customised learning experiences and supporting educators in their decision-making processes. To realize this potential, it is essential to address ethical considerations, ensure the explainability of AI systems, and provide adequate training for educators to effectively integrate AI into their teaching practices (Feldman-Maggor et al., 2024; Rachmadtullah et al., 2024; Vashishth et al., 2024).

The importance of addressing ethical considerations in AI use for primary educators' decision-making is underscored by the potential impact of AI-driven tools on educational outcomes and student welfare (Sywelem & Mahklouf, 2024). Ethical issues such as data privacy, algorithmic bias, and transparency of AI decision-making processes are central to ensuring that AI applications in education are aligned with societal values and the best interests of students (Schweitzke, 2024; Sywelem & Mahklouf, 2024). While the ethical frameworks and guidelines discussed in various studies provide a foundation for responsible AI use, they also reveal the complexity of translating ethical principles into practical applications. For instance, ensuring fairness and avoiding bias in AI systems requires not only technical solutions but also a deep understanding of the sociocultural context of the educational environment (Aggarwal, 2023; Morchhale, 2024). Moreover, the need for transparency and accountability in AI decision-making is not only a technical challenge, but also a pedagogical one, as educators must be able to explain and justify AI-driven decisions to students and parents (Olatoye et al., 2024; Syifa, 2024).

In summary, primary educators must navigate a landscape in which AI tools can offer significant benefits but also pose ethical risks. To ensure responsible AI use, educators should be equipped with knowledge of ethical principles and practical guidelines that address privacy, bias, transparency, and accountability in AI systems (Schweitzke, 2024; Syifa, 2024; Sywelem & Mahklouf, 2024). Educators must proactively engage with these ethical considerations, fostering an environment where AI is used to enhance educational practices while safeguarding the rights and interests of all

students. Getting this done effectively will require the application of AI to the personalised learning experiences of educators.

AI-POWERED LEARNING ANALYTICS IN PRIMARY EDUCATION: A CRITICAL APPRAISAL

The potential of AI to revolutionise primary education through personalised learning experiences has been well-documented in the literature. AI's capacity to tailor educational content and methodologies to individual learners' needs is a recurring theme (Aggarwal, 2023; Bhattacharya & Pal et al., 2024; Hasibuan & Azizah, 2023; Khensous et al., 2024; Pandy, 2023). These personalised approaches enhance student engagement, accommodate diverse learning styles, and improve educational outcomes. However, the literature also acknowledges the challenges and ethical considerations. The need for a balanced integration of AI, where technology complements rather than replaces human educators, is emphasised (Hasibuan & Azizah, 2023). Concerns regarding privacy, bias, and ensuring equitable access to AI-enhanced education are also prevalent (Pandy, 2023; Fuchs, 2023). These issues highlight the complexity of implementing AI in primary education, suggesting that, while the potential benefits are significant, they must be pursued with caution and responsibility. In summary, AI holds transformative potential in primary education by enabling personalised learning experiences that can adapt to the particular needs of each student. Some scholars suggest that AI can make education more engaging and effective, thus fostering a conducive environment for individual growth (Aggarwal, 2023; Bhattacharya & Pal et al., 2024; Hasibuan & Azizah, 2023; Khensous et al., 2024; Pandy, 2023). However, the successful realisation of this potential requires careful consideration of ethical implications and a commitment to maintaining an irreplaceable human element in education (Hasibuan & Azizah, 2023; Pandy, 2023; Wang & Lund et al., 2023).

It is clear that artificial intelligence has the potential to significantly impact primary education through various key areas. One such area is the enhancement of personalised learning experiences, where AI can tailor educational content to meet individual student needs, thereby improving learning efficiency (Wang & Wang et al., 2023). Additionally, AI applications can support adaptive testing and predictive analytics, which can help

identify students' learning patterns and potential difficulties early on (Wang & Wang et al., 2023). However, the integration of AI into primary education raises philosophical and ethical concerns. Philosophical perspectives emphasise the importance of human creativity, oversight, and ethical concerns, suggesting that AI should not replace uniquely human attributes, but rather augment them (Bridge & Bridge, 2019). Ethical considerations include ensuring the protection of student data privacy, addressing algorithmic bias, and maintaining academic integrity (Khatri & Karki, 2023; Sywelem & Mahklouf, 2024). These concerns highlight the need for a framework that ensures appropriate human input and ethical AI use in education (Bridge & Bridge, 2019; Sywelem & Mahklouf, 2024). AI can significantly impact primary education by providing personalised learning and predictive insights, but it is crucial to approach its integration with a philosophical orientation that respects human attributes and ethical principles. Thus, while AI offers transformative potential, it is imperative to address ethical considerations and maintain human oversight to ensure that AI's integration into primary education is responsible and beneficial (Bridge & Bridge, 2019; Khatri & Karki, 2023; Sywelem & Mahklouf, 2024).

AI-powered learning analytics can significantly enhance primary educators' decision-making by

1. Providing personalised learning insights:
 - Analyse individual student performance data to identify strengths and weaknesses
 - Enable tailoring of teaching strategies to each student's needs
 - Facilitate early intervention for struggling students
2. Offering continuous assessment:
 - Use intelligent assessment techniques to diagnose and monitor students' cognitive levels in real-time
 - Provide a dynamic understanding of student progress throughout the school year
3. Improving resource allocation:
 - Identify areas where additional support or resources are needed

- Help optimize the allocation of teaching time and materials
4. Enhancing curriculum development:
 - Analyse learning patterns across students to identify effective teaching methods
 - Inform curriculum updates based on data-driven insights
 5. Supporting evidence-based decision making:
 - Provide objective data to inform pedagogical choices
 - Enable more accurate student placement and grouping decisions
 6. Identifying trends and patterns:
 - Detect broader educational trends across classrooms or schools
 - Help in developing targeted interventions or policy changes
 7. Facilitating communication:
 - Generate easy-to-understand reports for parents and administrators
 - Improve collaboration between educators by sharing data-driven insights

RECOMMENDATION

By leveraging AI-powered learning analytics responsibly, South African primary educators can make more informed decisions that improve educational outcomes and provide more effective resource use. The following recommendations are based on the discussion above regarding the effective use of AI to sustain or acquire quality-driven data decision-making processes in primary education:

Tailored Learning: AI can provide tailored learning experiences for students by assessing their particular learning needs, preferences, and progress (Feng et al., 2021). AI systems can customise instructional content, tempo, and feedback to optimise learning outcomes for each learner (Wang & Wang et al., 2023). Implementing AI-powered adaptive learning platforms can provide students with individualised educational experiences.

Intelligent Tutoring Systems: AI-powered intelligent tutoring systems can provide tailored advice and support to students by delivering

immediate feedback and adaptive learning pathways (Rane et al., 2024). These systems can identify students' strengths and shortcomings, provide tailored solutions, and measure their development over time (Feng et al., 2021). Intelligent teaching systems can boost student learning and mastery of difficult subjects.

Data-Driven Decision-Making: AI can assess enormous datasets created by students' interactions with learning platforms and deliver significant academic insights (Ouyang et al., 2022). By employing AI-powered learning analytics, academics can uncover patterns, trends, and correlations in student data, thereby enabling them to make data-informed decisions and interventions (Ouyang et al., 2022). This data-driven strategy can strengthen instructional tactics and improve student results.

Virtual Reality and Augmented Reality: AI technologies paired with virtual reality (VR) and augmented reality (AR) can enable immersive and engaging learning experiences (Zhao et al., 2023). VR and AR can imitate real-world settings, allowing students to engage in hands-on learning and problem-solving activities (Papanastasiou et al., 2019). Integrating AI with VR and AR technologies can boost students' ability to grasp and recall complicated ideas.

Intelligent Content Creation: AI can assist academics in developing high-quality instructional content (Rios-Campos et al., 2023). Natural language processing algorithms can create automatic feedback, summaries, and explanations for students (Rios-Campos et al., 2023). AI-powered content production systems can save academics time and effort in producing educational materials, thereby allowing them to focus on pedagogical tactics and student engagement.

Adaptive Assessment and Feedback: AI can automate the assessment process by evaluating student replies and providing rapid feedback (Wang, 2022). Adaptive assessment systems can dynamically modify the difficulty and type of questions based on students' performance, thereby offering a tailored and challenging learning experience (Wang, 2022). AI-powered evaluation tools can deliver timely and tailored feedback to students, thereby boosting their self-reflection and progress.

Intelligent Course Design: AI can assist in planning and optimising course structures and curricula (Gray et al., 2022). By assessing student data

and learning outcomes, AI systems can discover areas for improvement and suggest improvements to course content and delivery techniques (Gray et al., 2022). AI can also help discover gaps in students' knowledge and propose extra materials or activities to enhance their learning experience.

Support for Students with Exceptional Requirements: AI technology can provide support for students with exceptional requirements, such as those with visual or hearing impairments (Abgaryan et al., 2023; Koc-Januchta et al., 2022; Liang et al., 2021). AI-powered solutions can enable real-time captioning, speech recognition, and text-to-speech capabilities, ensuring equal access to educational resources and opportunities (Abgaryan et al., 2023). Implementing AI-based accessibility solutions can establish an inclusive learning environment for all students (Li et al., 2021).

Ethical Considerations and Responsible AI Use: It is vital to address ethical considerations and ensure responsible AI use in education (Lainjo & Tsmouche, 2023). Academics and organisations should set standards and procedures for the ethical use of AI, including data protection, algorithmic transparency, and fairness (Lainjo & Tsmouche, 2023). It is vital to promote ethical awareness and digital citizenship among students.

Continuous Professional Development: Academics should receive continual training and seek out professional development opportunities to strengthen their AI literacy and pedagogical skills (Gray et al., 2022; Kim & Bennekin, 2016). Institutions should provide tools and assistance for academics to learn about AI technologies, comprehend their potential uses, and effectively integrate them into their teaching practices (Gray et al., 2022; Kharbat et al., 2020).

CONCLUSION

This study examines the role of artificial intelligence (AI) in primary education, highlighting its potential to improve teaching and learning processes. Through a systematic literature review, key areas in which AI can significantly impact primary education were identified, along with recommendations for effective implementation to maintain or enhance educational quality. Ethical considerations and responsible AI use were stressed along with the need for continuous professional development to boost educators' AI literacy and pedagogical

skills. Insights from the existing literature reveal AI's potential to revolutionise primary education by offering personalised learning experiences, intelligent tutoring, and engaging learning environments. This study used a systematic literature review (SLR) to analyse the use of AI-powered learning analytics in primary education and identify key themes, patterns, and gaps. Thematic analysis was employed to synthesise the findings, focusing on the impact of AI on data-driven decision-making, while also considering ethical and responsible AI usage. The rise of big data in education has led to big data-based learning analytics (LA) that enhance educational outcomes, improve educational quality, and transform DDDM in institutions.

In contemporary education, AI-powered analytics has become transformative, offering benefits that could revolutionise student learning, teaching methods, and DDDM processes. One significant advantage is the potential for a personalised learning experience. By analysing extensive data on student performance, learning styles, and preferences, AI systems can tailor content and approaches to individual needs, leading to more effective learning outcomes, increased engagement, and improved academic performance. Additionally, AI analytics in primary education, particularly in DDDM, facilitates early intervention by identifying students at risk of failing sooner than traditional methods. Detecting patterns in student data allows AI to alert educators to potential issues early, which enables timely support and interventions to prevent academic setbacks and enhance success rates. Moreover, AI analytics can improve the resource allocation in educational institutions. By examining student performance, attendance, and engagement data, schools can make informed decisions about resource focus and optimise the use of teaching staff, materials, and support services, thereby enhancing the overall quality of education.

Despite these advantages, the use of AI analytics in primary education has several concerns and challenges. The primary issue is the privacy of the data. Collecting and analysing extensive student data prompts questions about storage, protection, and use. Concerns regarding the potential misuse of sensitive student data and the implications of creating detailed digital profiles for young learners

are valid. Another challenge is the risk of overreliance on technology. Although AI offers valuable insights and support, excessive dependence on these systems could undermine the essential elements of teaching and learning. AI cannot replicate the nuanced understanding and empathy that skilled teachers provide, which necessitates a balance between technological support and human instruction.

Additionally, the potential for bias in algorithmic decision-making is significant. The objectivity of AI systems depends on the data received and the algorithms used. These systems risk perpetuating or exacerbating biases related to race, gender, socioeconomic status, or other factors, which may lead to unfair treatment or misclassification of students and reinforce societal inequalities in education. Moreover, implementing AI-powered analytics in primary education may widen the digital divide, especially between urban and rural areas. Schools with more financial resources are likely to access advanced technologies, potentially creating a two-tiered education system in which some students benefit from AI-enhanced learning while others do not, further entrenching existing educational inequalities based on socioeconomic factors. However, future research on the use of AI-powered analytics in DDDM education, particularly in primary education, should consider these areas of concern and challenges.

The integration of artificial intelligence in primary education offers transformative potential for improving teaching and learning through data-driven decision-making. Continuous professional development of educators is crucial to equip them with the skills to effectively use AI technologies in their practices. By addressing these challenges and leveraging AI opportunities, primary educators can create inclusive, engaging learning environments tailored to diverse student needs. This study highlights the significance of responsible AI use and calls for ongoing research on AI's benefits and challenges in primary education. Primary educators must navigate a landscape where AI tools provide substantial benefits, but also present ethical risks. They should be informed of ethical principles and practical guidelines concerning privacy, bias, transparency, and accountability in AI systems.

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