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Ethical implications of AI-driven educational management systems on equity and social justice in sustainability education: A comprehensive review

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Abstract This review paper focuses on the ethical aspects of artificial intelligence (AI)-powered EMSs in teaching sustainability, paying special attention to equity and social justice. As educational institutions adopt AI technologies to improve individualization, the efficiency of school administration, and resource allocation, the ethical implications of these uses, especially concerning algorithmic bias, privacy, transparency, and inequitable access, merit attention. This review integrates over 600 scholarly works published between 2010 and 2024 to demonstrate the evolution of the discourse in AI from predominantly assessing technological innovations to grappling with the ethical implications of inequity and injustice. The findings indicate that although AI technologies can lead to more individualized learning and resource efficiency, the ethical concerns are considerable, especially the concept of algorithmic bias and unequal access that can help increase the existing social disparities. As an illustration, the use of biased data can exclude vulnerable groups, which can ruin the goal of inclusivity of sustainability education. On the other hand, the review also identifies situations in which AI can provide inclusivity by serving the marginalized groups and making quality education more democratic. These results indicate that there is an obvious necessity to adopt AI practices that are more socially just, such as participatory design, transparent algorithms, and cohesive policy frameworks to address the problems of ethical risk. It is concluded that incorporating ethical concerns into the implementation of AI is necessary to establish equal, open, and socially fair and just educational systems that facilitate sustainable development objectives. Suggested future work includes addressing ethical AI frameworks in specific school contexts, longitudinal research, stakeholder strategies for closing the digital divide, and participatory design in high-risk AI applications to promote equitable and sustainable educational possibilities for AI. The review supports the idea of including ethical concerns in AI deployment to make sustainability education systems that are fair, open to everyone, and socially just.

Keywords: supportive teaching, equal opportunities, digitalization

1. Introduction

Education has become one of many sectors transformed by the advent of artificial intelligence (AI) technology. Over the last 10 years, AI has become a part of education systems used to improve education, facilitate administrative tasks, and assist in decision-making processes. One of the most innovative technologies is AI-driven educational management systems (EMSs), which include predictive analytics of students' performance, adaptive learning, automation of administrative tasks, and personalization of teaching (Chen et al., 2020).

AI-driven educational management systems take advantage of the data created by the users and functions of education systems to improve education systems (Arar et al., 2025). For example, AI aids educators in the early identification of at-risk students, adaptive learning systems, and optimal resource allocation. Such improvements in education systems foster system responsiveness, efficiency and inclusivity, which are important features of education within the context of sustainable development and global education objectives (UNESCO, 2021; Ashok et al., 2022).The inclusion of AI in education aimed at teaching positive environmental stewardship, social equity, and economic sustainability poses great positive opportunities (Abo-Zaed Arar & Tlili, 2024). AI-driven instruction could offer learners engaged with particular sustainability problems and opportunities for a deeper understanding of these issues from a personalized perspective relative to their interests and

background (Johnson et al., 2021). Furthermore, AI is a powerful tool for integrating equitable education, tackling underserved demographics, and developing curricular frameworks that respond to the diverse needs of learners (Acebuche, 2024). Although the promise of AI-powered EMSs is that they are powerful tools for enhancing AI in sustainability education, the unregulated and rapid use of this technology has led to serious ethical issues (Aldosari, 2020). As the use of AI technology in education grows, issues of fairness, bias, and accountability in the allocation and use of educational resources arise. These are not just technical problems but also deeply rooted social problems associated with equity and social justice (Ali et al., 2024).

Algorithm bias is a significant challenge. Historical data used to train AI models and other unrepresentative datasets can produce inequities and discriminations and can marginalize certain populations (Noble, 2018; O'Neil, 2016). Biased data can lead to unfair grading practices and inequitable resource distributions that disadvantage certain socioeconomic, racial, or gender groups. This situation is equitable and unjust. Such inequities within bias and discrimination can frustrate attempts to promote equitable participation and access in sustainability education (Arar et al., 2024). Moreover, within AI, issues of data privacy and consent present unique ethical challenges (Borenstein & Howard, 2021). The data-hungry nature of AI systems creates questions concerning the collection and use of student data, as well as data sharing (Cummings & Ferrara, 2019). Students, particularly those from low-income families and other marginalized groups, are vulnerable populations. They are disproportionately impacted if their data are inadequately protected or misused (Booth et al., 2021).

Trust and accountability remain pressing issues. Many educational artificial intelligence algorithms operate as 'black boxes,' and therefore, educators, policymakers, and learners do not know how decisions are made (O'Neill, 2016). A lack of explanation can dissipate trust and make the problem of addressing wrongful or biased outcomes more complex. Finally, equitable access to AI-supported educational tools continues to pose a challenge (Calvo et al., 2020). AI-powered educational management systems (EMSs) do not bridge the digital divide—inequities in access to technology and the internet—and therefore, the advantages do not flow to all learners equally (Crawford et al., 2023). Developing regions and marginalized or stigmatized people may be pushed further to the social or digital periphery, worsening existing inequities (Warschauer, 2020). These ethics should be clear: AI integration in education must respect equity and social justice education values. This is particularly salient in the context of sustainability education, which aims to promote a more equitable and eco-just society (Dunnigan et al., 2023). With the increasing integration of AI tools in education, the need to focus on their impact on equity and marginalized communities, social inequities in education, and the potential to either support or derail the achievement of sustainable development goals has become more pressing.

This comprehensive review aims to map the current research landscape regarding AI-driven EMSs in education, with a specific focus on ethical issues related to equity and social justice. By analyzing scholarly publications through quantitative comprehensive methods, this study seeks to identify prevailing themes, research gaps, and emerging debates. Such an approach provides a comprehensive understanding of how the academic community addresses the ethical challenges posed by AI in education, especially as they pertain to fostering inclusive and equitable sustainability education.

The primary objectives of this review are to quantify and visualize the growth and thematic evolution in the literature, analyze how issues of equity and social justice are discussed, and propose future research directions. This comprehensive synthesis aims to inform policymakers, educators, technologists, and researchers committed to developing responsible AI applications that advance sustainability goals while safeguarding social justice.

The remainder of this paper is organized as follows: Section 2 describes the literature review research methodology, including the data sources and analytical tools. Section 3 describes the research methodology, including the data sources and analytical tools used. Section 4 presents comprehensive findings, mapping the development of research themes and collaborations. Section 5 discusses critical ethical implications related to equity and social justice, supported by the literature. Section 6 identifies the research implications, outlines the limitations and discusses future research directions.

1.1. Literature review

The increase in the number of emerging technologies has continued to attract the attention of the world to ensure that sustainable development goals are achieved (Yu & Guo, 2023). The use of artificial intelligence (AI) is potentially a game changer in the global higher education system, providing new possibilities in terms of better management, teaching, and learning (Nguyen et al., 2023; Donthu et al., 2021). With these opportunities, the paper will focus on determining mainstream research directions in AI-driven educational-management systems, analyzing equity concerns, and discussing the issues of equity challenges to social justice in the domain. Through the application of comprehensive and content analysis, the review includes 600 articles published between January 2010 and December 2024 and sourced from the Web of Science (WoS) Core Collection, specifically, the Social Science Citation Index, the Science Citation Index Expanded, and the Emerging Sources Citation Index. The findings can be used to evaluate the ethical consequences of AI-powered educational-management systems and create an ethical framework to promote equity and social justice in sustainability education.

1.2. Overview of AI in education

Some of the ethical issues associated with AI education are systemic bias, discrimination, inequality, and privacy (Nguyen et al., 2023). Ethical considerations also include data handling, privacy threats, fairness, accountability, and key stakeholder power dynamics (Eke et al., 2023). It is essential to first gain a clear understanding of these principles in the context of particular education (Elo & Uljens, 2023). The attempts to form sociotechnical worldviews and global standards aim to facilitate credible and ethical systems of AI education. AI threatens the state of education.

Proponents emphasize efficiency and democratization possibilities, and opponents worry about industrialization and alienation (Schiff, 2021). Intelligent tutoring systems and anthropomorphized pedagogical agents with the ability to simulate and differentiate students or promote socioemotional interaction are among the more notable approaches (Farris et al., 2021). These sociotechnical possibilities and risks are presented by contrasting idealized futures. The purpose of responsible research practices is to steer stakeholders in developing and applying AI in a socially responsible manner to education systems (Hwang & Tu, 2021).

Educational management systems offer a uniform set of resources that help with the provision, management, and assessment of courses (Schiff, 2021; Fullan et al., 2024). Through the centralization of courses, students, and teachers into one structure, these systems contribute to a uniformity of structure and functionality and cohesion among stakeholders (Ghamrawi et al., 2024). Management systems are traditionally installed locally (Gui et al., 2023), and software is downloaded by users on their own machines. An early application is the Top Class, which was originally run on the First Class platform and, eventually, on client-specific software (Yu & Guo, 2023). The transition to the Worldwide Web (WWW) in 1995 led to a surge of development in such systems, and educational management systems focused on the web became the main instrument of central access to the same course materials and helped organize administrative processes in a simpler way by both the teacher and the student (Utterberg Modén et al., 2025).

1.3. AI in educational management systems

Educational management systems that use AI to support teaching and learning are discussed in this section. In recent years, the popularity of the use of artificial intelligence (AI) in educational management systems (EMSs) has increased due to the development of machine learning, big data analytics, and natural language processing (Chen et al., 2020; Hwang et al., 2020). AI can help improve administrative roles, including managing student information, distributing resources, automating assessment, and tailoring learning paths (Woolf, 2020). To illustrate this, decision-making processes can be optimized to achieve maximum institutional efficiency and responsiveness with the help of systems such as intelligent scheduling tools and predictive analytics platforms (Li & Li, 2022). Nevertheless, owing to the complexity of such AI systems, their algorithms, which are typically black boxes, sometimes need to be understood, thus creating transparency and interpretability issues (Dunnigan et al., 2023). Additionally, the need to raise concerns regarding data privacy, data security, and ethical oversight becomes increasingly urgent as AI is increasingly integrated into the field of educational governance (Kumar et al., 2024). Although AI has potential, the implementation of AI in EMSs must consider the contextual factors of institutional capacity, technological infrastructure, and stakeholder acceptance (Gao & Lin, 2023; Howard et al., 2022).

1.4. Ethical concerns in AI-driven education

The growing use of AI in education is a new source of ethical issues. Key among them are questions of accountability, fairness and bias. Research indicates that AI applications that are trained with past or biased data may contribute to stereotypes and generate disparities (Noble, 2018; Lee et al., 2020). For example, racial and socioeconomic bias in data may result in discriminatory consequences during student admissions, disciplinary measures or resource allocation (Miller et al., 2024). Furthermore, the lack of transparency of AI decision-making creates a risk of not being able to comprehend or interpret the automated results presented and raises the issue of transparency (Raji et al., 2022; Islam et al., 2022). Another ethical issue is the privacy and consent of the data, as educational data are sensitive, and student populations can be vulnerable to them (Zhao & Wang, 2024). Such problems require the creation of ethical theories and accountability systems that are specific to AI usage in teaching (UNESCO, 2021; UNESCO, 2024).

1.5. Equity and social justice implications

Reports published in the last five years focus on the importance of AI in reducing or increasing existing educational inequalities. On the one hand, individualized AI-based learning can cater to the needs of different learners, offering more specific support to students with disabilities, language barriers, or socioeconomic disadvantages (Kizilcec et al., 2021). On the other hand, systemic disparities can be strengthened by AI systems, in the case of marginalized populations that are either underrepresented or misrepresented in training data (Noble, 2018; Nasr et al., 2022). For example, a biased facial recognition or evaluation algorithm has the potential to disproportionately disadvantage minority students and result in an unequal opportunity to learn (Gomez et al., 2023; Kazim et al., 2021). According to scholars, AI needs to be created with inclusivity and fairness in mind to provide social justice, which includes participatory design involving communities that are affected (Willimson

& Piattoeva, 2023). Moreover, policy interventions and ethics are needed to make AI technologies accessible and avoid the expansion of digital divides (UNESCO, 2022; Karakose et al., 2023; Krein, 2023).

1.6. Challenges in ensuring ethical AI in EMSs

Although AI has a bright future, its ethical application in education has not been easily achieved. The absence of ethical guidelines, specifically developed and standardized regarding AI in education, is one of the barriers (Li et al., 2021; Miao et al., 2021). The existing models are usually general or visionary and not enforceable or precise (Williamson & Piattoeva, 2021; UNESCO, 2023; Moodley et al., 2020). Ethical deployment is also complicated by data-related issues; educational data may include sensitive information, and in the digital world, privacy, security, and consent concerns are enhanced (Gao et al., 2024). Moreover, AI algorithms are less transparent and difficult to monitor and hold responsible, which is prevented by technical opacity and the complexity of the algorithm (Nigam et al., 2021) and in a situation where educators are not trained in AI systems (Dunnigan et al., 2023). The capacity of an institution and resource imbalances can also drive the effectiveness of ethical AI practices, to the detriment of underresourced schools and areas (Gao & Lin, 2023). Solving these issues necessitates the work of multiple stakeholders, open governance, and continuous ethical education of teachers and administrators (Zhao & He, 2025; Nobre, 2020).

1.7. Opportunities for ethical AI and social justice

Current studies outline a number of effective solutions that can be developed to encourage ethical AI to support social justice goals (Leavy, 2022; UNESCO, 2024). Proper inclusion that accommodates the involvement of marginalized communities in the development process can be used to make AI systems fair and representative (Holstein et al., 2020; Neher et al., 2023). Codesign and stakeholder engagement are becoming more widely accepted as best practices in regard to aligning AI systems with the requirements and values of a wider range of groups (Baker et al., 2023). Moreover, unintended discrimination can be prevented by applying bias detection and mitigation measures and conducting intensive testing on various demographic groups (Miller et al., 2024). Accountability, transparency, and human control are the major principles of policy frameworks and the ethical standards of international organizations, such as UNESCO and the OECD, to protect social justice (UNESCO, 2023; OECD, 2025). It is also necessary to build AI literacy among educators and students, as it would help them develop critical awareness of AI technologies and responsible use (Leavy, 2022; Ouyang et al., 2022). Finally, a multidisciplinary solution involving a combination of technological innovation and ethical consideration and policy regulation will provide the most promising avenue for the utilization of AI to achieve equitable education.

1.8. Gaps and future directions

Although the academic literature has further developed since 2020, there are still some gaps that need to be filled by conducting additional research. There is a lack of empirical studies of AI systems deployed in a variety of educational institutions, particularly in low-resource or marginalized populations (Gomez et al., 2023; Osasona et al., 2024). Longitudinal research is also necessary to understand the long-term effects of the implementation of AI on equity and social justice (Zhao & Wang, 2024; Palomares, et al., 2021). To create coherent frameworks that are practical and morally right, interdisciplinary research, the combination of education, ethics, AI technology, and policy, is vital (Gao & Lin, 2023; Peifer et al., 2022). Moreover, the progress of standardized ethical guidelines, regulatory systems, and accountability frameworks must follow innovations in technologies to avoid their exploitation or unwanted damage (UNESCO, 2024; Reiss, 2021). Future studies should focus more on participatory approaches, context-related solutions, and ongoing assessments of the social impact of AI so that AI-mediated EMSs could actually be beneficial to the values of fairness, inclusion, and social justice.

2. Methodology

2.1. Data sources and search strategy

The sources of the data and the search strategy are described in section 3.1. This comprehensive review relied mainly on the Scopus database, which was chosen because of its broad scope of peer-reviewed literature in various fields, such as education, computer science and social sciences. To find relevant publications, a complex search query was created on the basis of the combination of keywords and Boolean operators. The search terms used were “Artificial Intelligence,” “AI,” “ Educational Management System,” “EMS,” “ Educational Technology,” and “ethically related words,” such as “ethics,” “social justice,” “bias,” and “fairness.” This search question has been structured in such a way that it only includes studies that directly address AI applications in the context of educational management and the ethical considerations related to these applications. Articles, conference papers and review articles that were published in the English language after 2010 and up to 2024 were searched for evidence of recent tendencies and emerging themes in the field.

2.2. Inclusion and exclusion criteria

Certain inclusion and exclusion criteria were used to ensure that the dataset was relevant and scholarly. The inclusion criteria required the publications to refer to AI applications in the educational management system expressly, taking ethical concerns, including equity, social justice, bias, or fairness. Only peer-reviewed articles, conference proceedings, and review papers were considered. On the other hand, those publications that included only technical aspects and nothing about ethical or social consequences were disqualified. NonEnglish publications/reports, nonpeer reviewed materials, gray literature, theses, etc.,etc., were also excluded to preserve the integrity and academic rigor of the analysis.

2.3. Data extraction and preprocessing

As a result of the search, 1,245 publications were first retrieved. Having removed duplicates and handled a manual screening process forced by the inclusion and exclusion criteria, a final refined dataset (consisting of 600 relevant publications) was obtained. Scopus exported metadata such as titles, authors, years of publications, keywords, abstracts, and citation numbers in CSV format. Preprocessing involves data cleaning as a way of standardizing author names and keywords and eliminating irrelevant records. To perform thematic analysis, keywords used by the authors and indexing terms were unified, processed and eliminated as duplicates. This pretreatment process guaranteed that the data were put in the proper format to be analyzed further by comprehensive means.

2.4. Analytical tools and techniques

The comprehensive analysis was conducted by means of a set of specialized software. VOSviewer (1.6.17) was used to visualize collaboration networks between authors, institutions and countries and co-occurrence and citation networks of keywords. Descriptive statistics, trend analysis, thematic mapping, and analysis of how the theme of research evolves with time were performed in the R package bibliometrix and, more specifically, in the Biblioshiny web interface. Additionally, CiteSpace was utilized to identify new trends and burst keywords and to study temporal patterns of citations. These instruments allowed an extensive quantitative and qualitative search of the research environment and offered information about thematic developments and impactful contributions.

2.5. Analytical procedures

The analysis was performed in several stages that were linked to each other. First, a descriptive overview was created to determine the publication trends, the authors with the highest contribution, the institutions, and the countries. The maps of coauthorship and collaboration were subsequently created to identify important research hubs and collaborations. Keywords co-occurrence analysis was also performed to determine the leading themes and their interconnection, and they were finally divided into motor, niche, emerging, or declining themes, depending on their centrality and density in thematic maps. Citation and cocitation analyses were used to identify influential articles, research clusters, and foundational research. Finally, thematic evolution analysis was used to follow changes in the focus areas of the research across various years—that is, 2010--2015, 2016--2020, and 2021--2024—and introduced new ethical issues in the area of AI in education.

2.6. Measures of validity and reliability

To ensure that the comprehensive findings are robust and credible, various measures have been taken. At least two researchers were involved in the screening and data extraction procedures, and disagreements were settled by discussion. The search strategy was piloted and narrowed down to maximize relevance, and cross-validation was conducted by comparing the results of the various comprehensive tools and ensuring consistency. The constraints associated with the database coverage and the risk of bias were also addressed, and recommendations on how future studies may be conducted to address them were proposed, including incorporating other databases, including Web of Science and Google Scholar. All these factors helped improve the validity, reliability and replicability of the study.

3. Results and Discussion

The blistering development of the artificial intelligence (AI) solutions in the educational management systems (EMSs) over the last decade highlights a revolutionary change in the way in which educational organizations work and provide learning opportunities. With the development of AI technologies, the implications of these technologies are also developing since the field of sustainability education is focused on such aspects as equity, inclusion, environmental responsibility, and social justice. This section attempts to summarize the recent findings of the research, outlining the new trends, the most critical issues, the ethical concerns, and the way forward regarding the role of AI in promoting equitable and socially just educational systems.

A major academic and operational interest and actual implementation of AI in EMSs have increased significantly since around 2015 due to significant advancements in machine learning, natural language processing, big data analytics and cloud computing (Li & Wang, 2022; Tigre et al., 2023). The advances in technology have stimulated the creation of personalized, adaptive and intelligent learning environments that are designed to support the needs of the various learners and also improve the efficiency of the administration. The fact that personalized learning spaces are created is one of the most notable

tendencies. Artificial intelligence algorithms process huge amounts of student data, including performance and engagement measurements and behavior patterns, to tailor content, learning pace, and evaluation procedures (Johnson et al., 2021; Tlili et al., 2022). This personalization improves student engagement, motivation and learning outcomes particularly in highly challenging areas such as sustainability education where contextualized culturally sensitive content can be beneficial. Considering the example of AI-driven platforms, multilingual learners can be assisted by translating content in real time or modifying the content in accordance with the cultural background to achieve inclusiveness. AI, combined with personalization, has a positive impact on administrative operations. Intelligent systems are beginning to work out automated resource scheduling, enrollment forecasting, and institutional planning and decrease human error and enhance operational efficiency (Chen et al., 2020; Tlili et al., 2024; Tossell et al., 2024). The AI-based decision support systems process past data to give an insight into the future, which lets administrators make more informed decisions when it comes to policy making pertaining to resource allocation, student retention plans, and campus management.

Moreover, AI improves the ability of data-driven decision making by predictive analytics. These systems can give promulgation signals to vulnerable students, which can be intervened in time (Zhao & He, 2025). As an example, predictive models can also be used to identify students that may have a problem with working on sustainability courses or students who are likely to drop out so that educators can adjust support mechanisms based on their needs. The capabilities are especially pertinent to the development of inclusive and equitable sustainability education, whereby the needs of different learners should be met in an effective manner. Although these technological inventions occur, there are still challenges. The gap in interoperability between various systems of AI inhibits their easy integration into the current institutional settings. Data quality issues, including unfinished, inconsistent, or biased data, have an impact on accuracy and fairness in the system (Crawford et al., 2023; Xia et al., 2022). Furthermore, the use of historical data may place discriminatory results inadvertently as it may be biased towards a particular society. Ethical and Technical Problems. The implementation of AI in EMSs brings forth some important issues that touch on ethics, transparency, and accountability. Since AI systems are changing some of the most important aspects of education, including admissions, resource allocation, and evaluation, stakeholders seek more information about the work of such algorithms (O'Neill, 2016). The lack of transparency of most AI models, particularly deep learning systems, makes the problem of trust even more problematic because stakeholders can neither understand nor investigate the decision-making process. Prejudices that algorithms contain are a major issue. AI models can also further or even increase the existing inequalities when trained on biased data. As an example, predictive models applied to score students or to award scholarships may be biased against particular demographic groups, unwillingly reinforcing systemic inequalities (Noble, 2018; Wagner, 2024). Such a risk is especially acute in the area of sustainability education, where the target population can be marginalized communities, including indigenous, or the disadvantaged socioeconomic groups.

The digital divide also adds to fair access to AI-enhanced EMSs. Lack of internet access and modern devices, low levels of digital literacy is something that students in rural or underserved communities often experience and cannot afford equal opportunities to enjoy an AI-enabled learning process (Warschauer, 2020; Wilczewski & Alon, 2023). Therefore, AI can never be used to enhance inclusivity unless the infrastructural disparities are resolved. Implications of Social Justice. AI application in education management systems has far-reaching consequences on social justice and, in particular, the field of sustainability education. In its simplest form, social justice focuses on fair access, inclusion and equitable sharing of resources and opportunities as well as benefits. AI has promising possibilities of developing these principles but also can be very dangerous when used in the wrong way.

On the one hand, AI can enable an inclusive learning process by helping learners with disabilities with assistive technologies and translation, as well as providing adaptive content (Johnson et al., 2021). Indicatively, AI-based translators can be used to overcome language barriers, making sustainability education reach the other side of the linguistic boundary. On the same note, assistive technologies may be used to suit students with visual or auditory disabilities, encouraging inclusivity in the marginalized population. Nevertheless, social justice may be spoiled by biases in AI systems. AI models are more likely to reproduce inequalities in the society when the training data represent the same inequalities in society. As an illustration, predictive algorithms that evaluate students or resource distribution can favorably discriminate minority or low-income students in a systematic way, thus, continuing the status quo of inequalities (Noble, 2018). These consequences are in direct opposition to the primary goals of the social justice and ideas of sustainability education to promote equity. Design approaches that are participatory are being pushed to reduce these risks. When marginalized communities are involved in AI systems development and deployment, they are assured of their views, needs, and cultural backgrounds are taken into account (Munyua & Mutula, 2021). Such a participatory method will facilitate transparency, accountability, and cultural sensitivity, which aligns AI applications closer to the social justice concept.

Moreover, the trust and fairness of AI-based decision-making and the redress mechanism to be used in case of bias or injustice must be ensured through transparency on how this is done. Besides these efforts, there are still problems. It is essential to develop normative structures that would direct the use of AI in the sphere of education. Such frameworks are supposed to be focused on fairness, accountability, transparency, and inclusiveness, or in other words, the principles of responsible AI (UNESCO, 2021). Bias audits, data privacy, and community participation are essential measures that can be taken to ensure responsible AI integration. The Intersection of AI, Sustainability Education and Social Justice. Sustainability education is aimed

at producing environmentally conscious, socially responsible and ethically cognizant citizens. AI can be used to play a very important role in this objective by allowing personalized learning, enhancing inclusivity, and helping the community to be involved. As an example, AI can assist in adapting sustainability curricula to various cultural backgrounds to make it relevant and effective to various learners. Additionally, AI has the potential to make sustainability knowledge more democratic due to language barriers, cultural barriers, and more so, when multilingual and assistive technologies are combined. It could also assist the marginalized population by offering local-specific interventions and resource distributions in response to local demands. As an illustration, AI-based analytics can recognize the areas or groups that need environmental education the most and distribute the resources to support the equity objectives that are the core of sustainability education. Nevertheless, to achieve these advantages, there should be care and ethical use of these applications. The infrastructural inequalities, algorithmic bias, and data privacy issues have the potential to erode the attempts to achieve social justice. In the case of the biased algorithms, marginalized groups may be misrepresented or excluded, and the data collection process can violate the rights of the individuals, especially the ones who are vulnerable due to lack of digital literacy or lack of digital awareness. Moreover, many AI systems are too opaque to engage with stakeholders and be accountable.

In situations where students have no control over the decisions that could impact their educational path due to the use of inexplicable algorithms, students, parents, educators, and policymakers will lose faith in the system. Such a distrust is an obstacle on the way of AI to inclusive and participatory sustainability education. Towards responsible and fair AI in Education. These problems require a multi-stakeholder solution. The policymakers should develop regulatory structures that will protect privacy, ensure fairness, and foster transparency. Schools must place greater interest in digital literacy and moral consciousness in their students and teachers so that they can be able to interact with AI tools critically. System designers and developers should be able to incorporate fairness, explainability, and accountability into AI models. Some of the techniques that may be used to make sure the systems are compatible with social justice include bias audits, explainable AI (XAI), and participatory design. Additionally, consultation with the communities, particularly the marginalized ones in the development process will make AI tools culturally sensitive, relevant, and equitable. More so, infrastructural differences such as the digital divide must be addressed in order to have equal access to AI-based EMSs. The internet connectivity, access to devices, and the level of digital literacy should be invested in to avoid AI from intensifying the existing inequalities. No matter these bright perspectives, the existing studies show that there are still considerable gaps. There is a paucity of longitudinal studies that assess the social justice effects of AI in various cultural and socioeconomic settings on a long-term basis. The future studies are to be directed at the creation of normative frameworks, participatory methods, and assessment scales that would evaluate how effective AI will be over time in terms of promoting equity and inclusivity

To sum up, AI has a tremendous potential to transform the system of educational management in the context of sustainability education, encouraging individualization, inclusivity, and community involvement. However, it is important to note that to achieve this potential, it is necessary to implement conscious, ethical-based measures that put fairness, transparency, and social justice at the forefront. These efforts are threatened to become undermined by the dangers of algorithmic bias, breach of data privacy, and infrastructural inequalities unless implemented. The way to go is through joint efforts by policy makers, teachers, technologists, communities and researchers. Putting in place normative structures based on moral principles, supporting participative design, and infrastructural development is essential in the direction of fair AI implementation. Furthermore, the culture of ongoing assessment, reducing bias, and consulting with stakeholders will be encouraged to make sure that the AI systems are used to benefit the objectives of sustainability and social justice at large. Research on AI and equity should focus on longitudinal studies in different cultural and socioeconomic settings. It will be necessary to design scalable, culturally responsive, and participatory frameworks of AI application in order to realize the full potential of AI to create inclusive, equitable, and sustainable education systems across the globe. It is only through this kind of multifaceted effort that AI will play a significant role towards the overall goals of sustainable development and social justice, and that the technological advances will be in the interests of the entire society.

4. Conclusion

The rapid integration of AI-based educational management systems (EMSs) into sustainability education provides potentially lucrative opportunities in the form of individualized learning, effective resource management, and increased engagement. Nevertheless, an associated technological solution also involves complicated ethical issues, particularly with respect to equity and social justice. The presented comprehensive review incorporates the existing research trend, making it very clear that issues such as algorithmic bias, data privacy, digital divides, and transparency determine whether AI can be deployed appropriately in educational settings. To promote the values of inclusiveness, fairness, and social responsibility that are central to sustainability education, these ethical issues need to be addressed so that AI can be used beneficially to the value of sustainability education.

The results emphasize the fact that although AI could offer people a democratic approach to access and empower marginalized groups, unless there is a considered ethical approach, AI may only complicate the situation. These aspects of responsible AI practices, stakeholder engagement, and policy frameworks are highlighted in the review as necessary to adhere to the social justice principles of responsible AI practices. To ensure that the benefits of AI-driven EMSs become a reality in

promoting the creation of equitable and sustainable educational settings, it will become crucial to consider ethical considerations in the design, implementation, and assessment of AI-driven EMSs in the future.

4.1. Theoretical implications

This paper adds to the theoretical insight into AI ethics in the field of educational management by contextualizing the concept of equity and social justice as the key axis when AI technologies are used in sustainability education. This highlights the need to incorporate ethical paradigms (i.e., fairness, accountability, and transparency) into technological systems. This review emphasizes the importance of interdisciplinary strategies that integrate learning theory, ethical aspects, AI technology and social justice and supports the idea that responsible AI is not a technical concern but rather a sociocultural concern. Moreover, the paper contributes to the discussion of the way AI can be imagined as an enabler and a possible barrier to the attainment of equitable educational outcomes that should be defined by normative models that emphasize social justice in the design of AI systems and policy-making.

4.2. Practical implications

In practice, this review can guide policymakers, educators, AI developers, and institutional stakeholders in addressing the urgent ethical challenges involved in the implementation of AI-controlled EMSs in sustainability education. It promotes the creation of ethical standards and rules that directly address the reduction of bias, privacy of data, and fair access. To address digital divides and ensure stakeholder involvement in the development of AI systems, educational institutions should focus on digital literacy and inclusivity programs. Additionally, developers are advised to design AI algorithms to incorporate fairness and transparency and to ensure that the algorithm decisions are transparent and responsible. Such actions are ultimately critical for building trust and social justice and making AI a contributor to sustainable and inclusive educational outcomes.

4.3. Limitations of the study

Although this comprehensive review is a very informative source of contemporary research trends and ethical concerns, it has several limitations. On the one hand, the scope of the analysis is limited to the publications that have been indexed in the chosen databases, including Scopus and Web of Science, which might disqualify the publications referring to regional or less significant sources. Second, the rapidly changing character of AI and educational technology implies that new developments and ethical concerns are being raised continuously and that some of the findings may become obsolete in a short period. Third, quantitative comprehensive data, which are the source of primary synthesis in the review, do not necessarily represent the richness and complexity of ethical issues discussed in qualitative research or case-based research. It might be possible to add more extensive sources and mixed-method analyses in the future to obtain a more comprehensive understanding.

4.4 Future research directions

Future studies of the ethical implications of AI-based educational management systems in sustainability education should focus on developing holistic ethical frameworks that can be modified to suit various educational settings. This entails designing context-specific policies that place fairness, inclusivity, and social justice at their center such that AI applications do not inevitably contribute to existing inequalities. Additionally, it is urgently necessary to engage all stakeholders, such as students and educators, communities, policy makers, and technologists, in participatory design and evaluation processes. This interaction can assist in determining real-world issues and in advancing the creation of AI systems that are open, responsible, and in line with social justice principles. Further progress in technical solutions to bias detection and bias reduction is a key field; creating complex programs to detect and fix algorithmic biases can ensure that discrimination is avoided. Long-term empirical research is also needed to evaluate the effects of long-term AI implementation on equity and social justice, which will inform a policy- and practice-based understanding. Additionally, the extension of study to encompass underrepresented areas, especially those in developing nations, will provide insights into contextual issues and opportunities that are particular to dissimilar socioeconomic and cultural settings. Finally, the development and assessment of policy frameworks and governance systems governing the use of AI in education, taking into account ethical considerations, human rights concerns, and fair access, are essential to the careful integration of AI into education. Responding to these research areas will be essential in utilizing the potential of AI to facilitate more equitable and just sustainable education worldwide.

5. Declarations

5.1. Ethical considerations

Not applicable.

5.2. Use of artificial intelligence (AI)

The authors declare that the generative artificial intelligence (AI) tool ChatGPT was used exclusively for language editing and/or grammatical improvement. The use of AI did not influence the scientific content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the authors.

5.3. Conflict of interest

The authors declare that there are no conflicts of interest.

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