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Beyond the Algorithm : Artificial intelligence, Children and the Future of Education by 2030

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ABSTRACT

In light of fast-growing popular, political and professional discourses around AI in education, this paper explores how artificial intelligence (AI) is changing the way that children learn, emphasizing how technology can change education while also critically analyzing where it is at the moment. AI technologies present numerous opportunities to improve inclusive education, digital literacy, and cognitive development as they progressively influence learning environments through tailored material, intelligent tutoring, and data-driven feedback. AI integration does, however, come with urgent problems, such as digital inequality, data privacy issues, surveillance threats, and a growing divide in digital literacy between students and teachers. These problems endanger the rights and autonomy of children and have the potential to widen already-existing inequalities. According to the study, a child-centered approach, fairness, and ethical values must direct the use of AI in education going forward. It suggests strategic directions for the future, such as equal access to infrastructure, inclusive technology design, teacher preparation, and policy reforms. By 2030, all children, regardless of background, can benefit from comprehensive learning experiences that enable them to flourish in an increasingly digital environment through the appropriate and efficient use of AI. The report advocates for collaboration among educators, legislators, engineers, and communities to ensure AI's positive impact on children's education.

Key words: Artificial intelligence, Education, Children, Teachers

1. Introduction

Artificial intelligence (AI) is a rapidly advancing technology capable of processing vast array of data, providing new opportunities and challenges for children in this contemporary digital era. The world is reaching a turning point, by 2030 the combination of education and artificial intelligence (AI) is expected to change not only how children learn but also how they relate to others, view themselves, and envision their role in a society that is becoming more and more digital [8]. We are approaching a time when algorithms are starting to affect choices about curriculum design, student potential, teacher roles, and even mental health in addition to search results and purchasing patterns [14]. Artificial intelligence (AI) has quickly become a game-changer in a number of fields, most notably education. It has the ability to revolutionize conventional methods by providing creative answers to enduring problems [6]. For instance, AI-driven technology in education can help with better teacher preparation, more individualized learning experiences, and improved system administration [16].

Therefore, although the integration of AI into our daily endeavors like education has some eminent benefit the integration of artificial intelligence as part of our children's education poses a serious challenge that requires regulatory and legislative attention in order to protect users especially children. Thus, this aim of this paper is to analyze the use of AI in education with particular focus on children, critical AI crossroads in education, opportunities and challenges facing the application of artificial intelligence in education.

2.0 Conceptual clarification

2.1 Artificial intelligence

John McCarthy first described artificial intelligence (AI) as "the science and engineering of creating intelligent machines" in 1956 [35, 53]. The creation of intelligent machines that can carry out a variety of activities is the main goal of AI research. This includes methods like natural language processing, neural networks, and machine learning [36, 52, 2] defines artificial intelligence (AI) as the capacity of machines or computers to mimic human cognitive functions, such as problem-solving, object recognition, language comprehension and response, learning from experience, and decision-making. These capabilities allow AI to carry out human-typical jobs like driving a car or greeting hotel guests. According to [41] artificial intelligence (AI) is defined as programs that are structured within computers, robots, or other machines to demonstrate human-like intellect in order to

facilitate a variety of services and duties that support the socioeconomic and political development of society. Additionally, they defined artificial intelligence (AI) as programs, packages, and systems that are integrated into digital computers or computer-controlled robots to do tasks with intelligence comparable to that of humans. Artificial intelligence is regarded as a subfield of computer science in this sense. AI seeks to mimic, expand, and improve human intelligence in a number of domains, such as intelligent robotics, picture recognition, and language processing, through ongoing study and development [20, 37].

2.2 Children

Children represent a distinct stage of human development characterized by physical, cognitive, emotional, and social growth; they are not merely a biological or chronological stage of existence [19]. According to the United Nations Convention on the Rights of the Child (UNCRC), children are generally defined as individuals from birth to age 18 [41]. As children progressively gain the abilities and knowledge required to fully engage in society, this stage is marked by a reliance on adults for protection, care, education, and direction [54]. Children actively participate in their own growth rather than being passive objects of human influence. Children's ability to learn, solve problems, and connect with others is highlighted by theories by academics like Jean Piaget and Lev Vygotsky, who emphasize that social context and personal discovery are both important components of development [19]. Cultural norms, customs, and economic circumstances all influence how different communities define childhood. Some cultures consider childhood as a period for learning and discovery, while others require youngsters to take on duties at a young age [43]. Crucially, acknowledging children's rights is part of the contemporary conception of children. Children's rights to health, education, safety from harm, and involvement in life-altering decisions are outlined in the UNCRC [38]. According to [53], every child's potential, agency, and dignity are upheld by this rights-based perspective. Therefore, comprehending the idea of children necessitates a multifaceted viewpoint that takes into account their social contexts, psychological development, biological needs, and legal entitlements, all of which have an impact on how they are viewed, supported, and treated in society.

2.3 Education

According to [44], children's education includes all types of instruction given to young children, both formal and informal, this education is essential to a child's growth and has the power to greatly influence the child's later years. [50] noted a number of distinct elements that come together to influence a child's early education. In informal education, a child's interaction with its parents or other primary carers and instructor is, of course, the main source of input regarding that child's growth [12]. To put it simply, parents are a child's first teachers. As the kid starts to form an attachment to its parents and build a sense of self, this interaction is particularly important between the ages of 0 and 2 [9]. The bond that develops during this phase of childhood might greatly influence a child's subsequent schooling. The formal education received at a young age is the other factor in the equation when it comes to early childhood education [4]. This educational phase usually lasts from the second to the eighth year of a child's life. A child may get formal education at an early age in a number of ways, which can differ from country to country and program to program [22]. Educational programs can be offered in childcare, daycare, nursery school, preschool, and kindergarten settings, and they can be tailored to the needs of each child at a particular age. While some of these programs are privately administered, others are run by a federally supported program or a local school system [51, 46].

3.0 Artificial intelligence in children's education critical crossroads

The use of artificial intelligence (AI) in education for young learners (children) has reached a turning point where urgent pedagogical, ethical, and societal issues meet the potential of innovation [27]. Teachers, legislators, parents, and technologists must find a way to combine technology innovation with child-centered learning, equity, and protection as AI tools quickly become more prevalent in homes and classrooms [49]. According to [32], personalized learning is one of the main advantages AI provides. Personalized pacing, content, and feedback are provided via adaptive platforms such as Dream Box and Squirrel AI, which evaluate children's performance data in real-time [45]. By recognizing and resolving learning challenges early on, this promotes differentiated learning styles and aids in closing success gaps [38]. AI offers scalable solutions that human teachers frequently cannot provide on their own for young students that benefit from repetition, scaffolding, or enrichment. However, there are two sides to this strength [1]. The growing application of AI in education raises serious questions around autonomy, data privacy, and surveillance. Behavioral patterns, attention spans, emotional expressions, and physiological indicators are among the sensitive data that many AI systems gather in order to enhance their functioning. [1] contend that children's limited comprehension of consent and developmental stage make them particularly susceptible to this kind of surveillance. In the absence of strong data governance guidelines, these systems run the potential of infringing on children's rights and normalizing a culture of continual surveillance.

4.0 Opportunities for AI adoption in education

Artificial Intelligence (AI) is transforming education by providing new options for both students and teachers. Here are some of the prospects that AI in children's education brings.

4.1 Personalized learning experience

AI is transforming education by enabling personalized learning where educational experiences and content are catered to each student's children's particular needs, speed, and learning style [10]. This method uses data analysis, machine learning, and AI algorithms to modify instruction and offer focused support, which eventually improves learning outcomes [11]. According to [56], AI provides personalized content by analyzing each student's unique learning demands and pace. This enables every student to advance at their own speed and get more help in areas where they need it [13].

4.2 Time management and efficiency

[26] noted that AI offers individualized learning experiences, streamlines administrative work, and gives educators insightful information; it is revolutionizing time management and efficiency in children's education [25]. AI-powered solutions have the potential to improve students' academic performance and well-being by prioritizing activities, creating personalized calendars, and increasing study efficiency [47]. AI-powered solutions like Rescue Time and Toggl are revolutionizing productivity analysis and activity time tracking. These apps identify and categorize work using artificial intelligence (AI), distinguishing between possible diversions and productive endeavors [39]. Usually, a combination of desktop programs and browser plugins powers them. They monitor the amount of time spent on various websites and apps, evaluating the information to identify trends in both productive and ineffective conduct. This makes it possible to gain a detailed insight of how time is spent on different platforms and tasks, which in turn enables tailored feedback and suggestions for increasing productivity.

4.3 Skills development

According to [57], children's skill development has been revolutionized by artificial intelligence (AI), which provides individualized, captivating, and interactive learning opportunities. [58] noted that intelligent tutoring programs, instructional games, and adaptable learning platforms are examples of AI-powered technologies that can evaluate individual learning styles and modify content to fit each child's pace and skill level. Compared to traditional approaches, this individualized approach is more effective in helping children develop cognitive abilities like numeracy, problem-solving, and critical thinking [40]. Additionally, [55] reports that AI promotes computational thinking and digital literacy, two critical 21st-century abilities. AI-powered robotics kits and coding platforms give kids practical experience with creativity, logic, and sequencing [18]. Chatbots and speech recognition software are examples of language-based AI systems that help with literacy and communication development, especially for kids with special needs or learning a new language [31].

5.0 Challenges

Although artificial intelligence has provided quite a number of benefits and opportunities in education, its applications in children's educations come with a number of challenges. The following constitute some key challenges influencing the application of artificial intelligence in children's education.

5.1 Digital inequality and technological accessibility

Two major obstacles to the successful implementation of artificial intelligence (AI) in children's education are digital inequality and technological accessibility. Even while artificial intelligence (AI) has the potential to improve educational outcomes and personalize learning, access to the gadgets, dependable internet, and electricity needed for this process is still unequal, especially in rural and low-income areas [21]. This discrepancy prevents many kids from taking advantage of AI-powered resources, which widens rather than closes already-existing educational gaps [37]. Furthermore, [23] noted that differences in digital literacy among parents, students, and teachers might impact the effectiveness of AI technologies even in situations where physical access is available. In contrast to their more affluent counterparts, children from disadvantaged circumstances might not have the support networks at home to enable them use AI-based learning platforms [7].

5.2 Data privacy, autonomy and surveillance

Important questions of data privacy, autonomy, and surveillance are brought up by the use of artificial intelligence (AI) in children's education. In order to provide personalized learning, AI systems frequently rely on vast amounts of personal data, including learning patterns, emotional reactions, and even physiological data [59]. However, [5], that there are significant privacy hazards when gathering such sensitive information from minors, who are less able to offer informed consent. Long-term profiling, breaches, and misuse might result from inadequate data protection procedures [30]. Another major concern is surveillance, as AI systems track kids' performance and behavior more and more, thereby creating environments where people are always watching [48]. Children's emotional growth and independence may suffer as a result, and creativity and risk-taking may be discouraged. Furthermore, a child's educational options may be restricted or they may be unfairly labelled if algorithmic decisions are made without transparency. [29] stated that to guarantee AI improves rather than detracts from children's educational experiences, addressing these issues calls for stringent ethical standards, open data use laws, and a child-rights-centered strategy.

5.3 Digital literacy gap and transition of the traditional learning institutions in the use of AI

According to [33], one of the biggest obstacles to the successful implementation of artificial intelligence (AI) in children's education is the digital literacy gap. Many pupils lack the fundamental digital skills required to interact meaningfully with AI-powered technologies, especially those in underprivileged or rural locations [16]. Children may find it difficult to take advantage of intelligent tutoring systems or personalized learning platforms if they lack a basic understanding of how to use educational technology [34]. This disparity also affects parents and teachers, who might not have the necessary training to encourage the use of AI in classrooms. Because of this, many students are still unable to fully utilize AI in the classroom. To guarantee that AI fosters inclusive and equal learning opportunities for all students, it is imperative to close the digital literacy gap [52].

Additionally, in traditional educational institutions, digital literacy gaps continue to be a major problem, particularly when it comes to implementing and integrating artificial intelligence [46]. The digital skills and knowledge required to deploy AI systems for teaching, learning, and administration are often lacking among educators and administrators. Limited access to digital infrastructure, especially in underfunded schools where obsolete hardware and inadequate internet connectivity make it difficult to apply AI-driven solutions, further widens this divide [28]. Furthermore, skepticism, fear of losing one's job, and worries about data privacy and ethical use are some of the reasons why adoption of AI in education is frequently gradual [15]. Lack of professional development and training options that address the pedagogical and practical aspects of integrating AI is another factor contributing to resistance. Conventional educational institutions typically use outdated teaching strategies, and the transition to AI-enhanced learning necessitates not only technical proficiency but also a change in mindset and culture [42]. Inequality in the adoption of AI is further exacerbated by differences in digital exposure between institutions in urban and rural areas. Targeted digital literacy initiatives, infrastructure spending, and inclusive policies that support the ethical and efficient application of AI in education at all levels are required to close these gaps [3]. Therefore, targeted digital literacy initiatives, infrastructure spending, and inclusive policies that support the ethical and efficient application of AI in education at all educational levels are required to close these gaps.

5.4 Content relevance

Another problem is content relevance; a lot of AI tools are created in dominant global languages and cultural contexts, which frequently means they don't represent the social and linguistic reality of varied learners [56]. Children may become estranged and become less involved as a result. AI runs the risk of becoming a tool that only a few people can use if intentional measures are not made to ensure affordability and inclusion [57]. Therefore, to guarantee that AI fairly supports kids' educational growth in all contexts, these issues must be resolved [18].

6.0 The way forwards by 2030

In order to properly utilize and fully harness artificial intelligence (AI) in children's education by 2030, it is imperative that a strategic, inclusive, and ethical approach should be considered. The following major considerations need to be adhered to:

6.1 Equal access to digital infrastructure

It is crucial that everyone has equal access to digital infrastructure in order to keep the digital divide from widening, governments and other stakeholders must make investments in low-income areas' access to inexpensive internet, devices, and electricity [23]. [60] noted that to guarantee that all users can interact with AI technologies in a meaningful way, digital literacy initiatives for parents, teachers, and students are essential in addition to infrastructure [49].

6.2 Data privacy and autonomy should be protected

The privacy and autonomy of children must be protected via the establishment of ethical frameworks and data protection policies [4]. Surveillance and improper use of personal data can be hindered with clear policies on data collection, consent, and use should be implemented [35]. Therefore, artificial intelligence systems ought to respect children's rights and be open, understandable, and transparent [2].

6.3 Teacher capacity building and training should be provided

According to [24], capacity building and teacher training are essential. In addition to using AI tools, educators should be able to evaluate their instructional value critically and modify them for local circumstances [25]. AI should support human connection and comprehensive education, not take their place [13]. According to [59], one of the key components of increasing the use of artificial intelligence (AI) in children's education is the provision of training and capacity building for teachers. Teachers are the ones who use educational technology on a daily basis, and their proficiency with AI tools has a direct impact on adoption success [13]. Building capacity enables teachers to use AI in lesson preparation, assessment, and personalized learning by giving them the digital literacy, pedagogical techniques, and self-assurance they need [27]. Teachers can use AI to find learning gaps, customize lessons to meet the needs of each individual student, and improve classroom engagement by receiving specialized training.[42] noted that teachers with proper training are also more equipped to handle ethical issues, handle AI sensibly, and help students use these technologies in a safe and efficient manner, AI projects run the risk of underutilization or failure if teachers are not empowered [15]. Therefore, sustained investment in

professional development is essential to bridge the knowledge gap, foster innovation, and ensure that AI enhances not replaces human-centered, inclusive education for children.

6.4 Provision of all-inclusive and culturally relevant AI

According to [41], it is critical to prioritize AI design that is inclusive and culturally relevant; to guarantee relevance and engagement for every child, tools should take into account a variety of languages, situations, and learning requirements. AI can become a revolutionary force that enables every child to learn, develop, and thrive by 2030 if a cooperative, rights-based approach is taken [20].

7.0 Conclusions

This paper highlights how AI can revolutionize children's education as we approach 2030. AI technologies have enormous potential for improving engagement, personalizing learning, and closing inequalities in educational performance and access. Digital inequality, data privacy threats, surveillance concerns, and a growing digital literacy gap are some of the equally important obstacles that confront this potential. In order to guarantee that AI does not perpetuate current inequalities but rather serves as a tool for inclusive and moral learning, these crucial intersections require immediate attention. The way forward calls for a well-rounded, kid-centered strategy that puts equity first, protects children's rights, and gives teachers more authority. Developing digital competency, bolstering regulatory frameworks, growing digital infrastructure, and making sure AI design is transparent and culturally appropriate are all important tactics. The most crucial role of AI in children's education should be to support, not to replace, the fundamentally human components of care, teaching, and creativity. The future of AI in education ultimately rests on the collective accountability and deliberate action of communities, educators, governments, and technologists. By 2030, we must make sure AI is utilized to provide meaningful, equitable, and empowering learning experiences for all children worldwide, not only to improve algorithms.

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