World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

Check for updates

Creating inclusive AI and Blockchain Curricula in Developing Countries: Frameworks, Strategies and Implementation

Ayomide Arowolo-Ayodeji [1,*] and Osazuwa Efe Ernest [2]

[1] *Harvard Graduate School of Education.*
[2] *Know the Blocks Maven*

World Journal of Advanced Research and Reviews, 2025, 25(02), 2270-2283

Publication history: Received on 03 January 2025; revised on 10 February 2025; accepted on 13 February 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.25.2.0483

Abstract

The research analyzed educational initiatives around AI and blockchain technologies in developing nations. The researcher initiated this investigation because developing countries face ongoing technological adoption barriers for advancing education with AI and blockchain solutions. A detailed interview session with 25 stakeholders representing multiple geographical areas and professional fields allowed researchers to examine modern technological learning practices while revealing crucial barriers like inadequate infrastructure and cultural traditions yet financial constraints preventing substantial education and skill development. The research project incorporated a qualitative methodological framework through virtual semi-structured interviews that served as its primary data collection instrument. As a part of the research method the study used a qualitative approach supported by virtual semi-structured interviews for gathering first-hand data. Virtual semi-structured interviews were chosen as the main data collection method to obtain detailed understandings about AI and blockchain education in developing countries and to generate solutions fitting economic and cultural characteristics. Research findings indicate that developing countries need more than technological transfer to succeed in effective technological education because they require culturally-aware holistic approaches that both validate local settings and deliver globally apt skill development programs. Research results also showed the need for multi-sector partnerships between public entities and educational facilities and technology firms and community support groups to build lasting educational structures which exceed singular organization capabilities. The study identifies strong evidence that suggests AI and blockchain education will act as the base for societal economic development over an extended period. This newly proposed framework represents a transformational system for technological education which strategically dismantles obstacles while establishing comprehensive access pathways for students to engage deeply with advanced technology concepts.

Keywords: Inclusive Education; AI Curriculum; Blockchain Education; Developing countries; Educational Technology; Curriculum Development

1. Introduction

Blockchains alongside artificial intelligence (AI) have emerged as transformative elements for reshaping world economies throughout this twenty-first century. Initially confined to specialized domains these technologies have expanded into multiple sectors such as health care finance and education transportation and governance (Kaplan & Haenlein, 2023). The ability of blockchain technology to safeguard data transparently while offering impenetrable protection becomes more effective through AI capabilities that enable automation together with predictive analytics and better decision systems. These technologies unite to generate unprecedented possibilities for productive innovation which mark a future digital revolution.

* Corresponding author: Ayomide Arowolo-Ayodeji

The social consequences of Blockchain and AI combine in a meaningful way. Artificial intelligence systems which operate through machine learning and natural language processing have boosted productivity by enabling automated repetitive processes alongside precise data evaluations that produce valuable decision-making insights. Blockchain as originally established for Bitcoin cryptocurrencies has evolved into a versatile system that strengthens security features while ensuring transaction data accuracy to support trust building in digital trade (Tapscott & Tapscott, 2022). Blockchain transforms organizational data operations and business operations through its middleman-free structure which reduces fraudulent activities. The combination of security requirements with the need for intelligence shows great promise for these particular industrial sectors.

AI and blockchain applications find exceptional opportunities to transform educational processes within the academic sector. The implementation of AI-enabled technology platforms supplementary to automated grading systems along with predictive learning algorithms has transformed traditional educational pedagogical approaches. Through innovative educational methods educators can now adjust teaching practices according to students' personal requirements which produces increased student interaction and academic success (Smith et al., 2023). Real-time adaptive learning algorithms assess student capabilities for offering specific subject-related recommendations that help students master difficult material. The combination of automated grading technology eliminates teacher workload by streamlining assignment assessments which gives educators more time to deliver instruction and mentor students.

Through its innovative applications blockchain technology solves legacy educational challenges that have long persisted. The critical process of credential verification signals both academic and professional institutions need improvement because it remains complicated and subject to fraud. Blockchain technology establishes an unalterable record system which makes academic credentials as well as certifications and transcripts accessible for secure verification (Chakravarthy & Patel, 2022). This system simplifies bureaucracy while establishing higher levels of stakeholder trust. The secure management of student data becomes possible through blockchain technology which establishes protected systems with transparent audit trails supporting both privacy and regulatory compliance.

Education systems transform into efficient accessible and inclusive systems when AI synchronizes with blockchain technical capabilities. The combination of AI with blockchain technology enables systems to analyze blockchain-stored data so they detect education accessibility gaps and create recommendation strategies for intervention. The micro-credential system generated through blockchain technologies permits students to acquire and display specific skill-based achievements which enhance their workforce adaptability (Nguyen & Zafar, 2023). The combination of these technologies shows promising potential to connect diverse educational opportunities while creating equal educational resources for underserved communities along with sustainable learning throughout life.

Billions of people worldwide experience limited access to AI and blockchain adoption across different geographic domains. Modernized nations lead the way because their advanced technology base and substantial funding permits systematic assimilation of these innovations throughout educational contexts. Advanced AI tools and educational systems from top nations such as the United States and China along with South Korea now operate in schools throughout their respective countries. These regions show real-world implementation of blockchain technology through pilot programs which verify professional credentials and establish secure data exchange networks.

Underdeveloped countries encounter multiple obstacles which block their pathway to implementation. Strategic implementation of AI combined with blockchain solutions remains restricted through limited funding together with insufficient technological infrastructure and an employee skills deficit (Rahman et al., 2024). The difficulties are intensified by European and African socio-political elements which create policy voids while generating uncertain regulations and raise resistance to transform educational methods. Educational organizations that maintain traditional classroom practices forego the transformative power which these technological innovations could bring. Building digital connectivity remains vital to distribute the benefits between AI and blockchain technologies using an equal manner while accelerating worldwide advancement alongside economic equality.

Future educational transformation through AI and blockchain technology remains widely documented yet these technologies encounter major obstacles when developing nations attempt their implementation. The progress towards implementation is hindered by resource limitations alongside deficient technological frameworks accompanied by shortages of adequately trained technical staff. Locally-run educational facilities in these regions encounter multiple challenges to obtain both technological hardware and professional expertise required to run AI and blockchain-based services successfully (Rahman et al., 2024). Developing countries currently operate education curricula that do not correspond to vital skills needed for an AI-driven and blockchain-enabled future. Future-oriented teaching practices remain absent from numerous education systems thus ensuring students lack essential digital economic participation

skills. The problem becomes worse because technology-driven educational access is unevenly distributed between different socioeconomic classes (Kaplan & Haenlein, 2023).

Inclusivity is another pressing concern. Existing programs that merge AI and blockchain training into education systems often ignore the diverse economic and social components and cultural aspects of developing countries. Due to their failure to align with local conditions these initiatives achieve limited success thereby creating ongoing discrepancies in both digital literacy and future workforce readiness (Nguyen & Zafar, 2023). Creating educational programs calls for an all-encompassing method which gives priority to incorporating accessibility alongside inclusivity while prioritizing context-specific materials.

These continuing differences in educational outcomes between developed and developing countries motivate the researcher to conduct this research. Developing nations face key obstacles which prevent the integration of AI and blockchain applications in education thus proving that strategic answers are necessary. A key goal of this research examines what challenges stand in the way of educational systems embracing these transformative technologies alongside applicable solutions for these obstacles. Nevertheless, the specific objectives of the study are to:

- Determine the primary barriers and prospects in the current state of blockchain and AI education in developing nations.
- Develop a framework for designing curricula that integrate AI and blockchain concepts, tailored to the socio-economic and cultural contexts of developing countries.
- Propose strategies for overcoming infrastructural and resource-related barriers to the adoption of AI and blockchain education.
- Advocate for policy interventions and stakeholder collaborations that promote the inclusion of underrepresented groups in AI and blockchain education.
- Evaluate the potential long-term impacts of accessible AI and blockchain education on economic development and social equity in developing countries.

2. Literature Review

In an effort to improve data security, administrative effectiveness, and learning experiences, developed countries have been deploying blockchain technology and artificial intelligence (AI) in their educational institutions more and more in recent years. This study of the literature looks at these programs, emphasizing their results and the lessons they teach about international education. This literature review examines these initiatives, highlighting their outcomes and the lessons they offer for global education.

2.1. Global Trends in AI and Blockchain Education

The use of AI-powered educational technologies to customize instruction and expedite administrative duties has been led by developed nations. AI-powered platforms, such as Khan Academy's "Khanmigo," which functions as a virtual teacher offering instant feedback and facilitating individual practice, have been implemented in the United States, for example. Such tools are intended to assist instructors, parents, and students by serving as tutors rather than substitutes for human educators, according to Kristen DiCerbo, Chief Learning Officer at Khan Academy (Pillay, 2024). The outcomes of pilot programs have been inconsistent, with some students showing reluctance to actively interact with the AI. This suggests that additional training and improvement are necessary to optimize its efficacy.

To help teachers with assignment marking and lessen their strain, the UK government has launched a £4 million effort to create AI tools (Woolcock & Prescott, 2024). These artificial intelligence (AI) systems are trained utilizing lesson plans, curricular guidelines, and anonymous student assessments to provide useful generative AI for teaching. In order to free up more time for teachers to engage with students and use innovative teaching strategies, the program aims to reduce repetitive activities. According to preliminary results, particularly those by Woolcock and Prescott (2024), artificial intelligence (AI) with the right training may mark with an accuracy rate of 92% as opposed to 67% without targeted data, underscoring the potential for AI to improve educational evaluation procedures.

The introduction of AI-powered digital textbooks in classrooms is another step South Korea has taken to incorporate AI into its educational system. With assignments created by AI according to students' learning levels, the effort seeks to encourage student engagement and move away from rote learning. Parents and academics worried about excessive digital gadget use and possible harm to children's development have opposed the idea, despite the fact that many educators support it (Davies & Jung-A, 2024). This emphasizes how crucial it is to strike a balance between the incorporation of technology and the welfare and developmental requirements of pupils.

In developed countries, blockchain technology has been investigated mainly for its ability to simplify and safeguard educational administrative procedures. Several universities in Europe have tested blockchain-based credential verification systems, which enable the safe and unchangeable storage of academic records (Beck, Avital, Rossi & Thatcher, 2017). These programs seek to lower the risk of fraud and increase confidence in digital credentials by streamlining the verification process for employers and other educational institutions. But obstacles like the requirement for defined protocols and worries about data protection keep broad adoption at bay. Blockchain technology has become an innovative tool for building decentralized learning networks in the context of higher education. This innovation gives students more control over their learning paths and academic records, which empowers them. Digital credentials kept on a blockchain, known as "learning passports," are an example of this potential. According to Devecchi and Taeed (2017), these passports would allow students to create an extensive and authentic record of their abilities and accomplishments from several schools, allowing for a more individualized and adaptable educational experience. By enabling employers and educational institutions to confirm credentials without the need for middlemen, these systems could improve transparency and trust in the educational process while expediting the admissions and hiring procedures.

Even with blockchain's bright future in education, many applications are still in the experimental stage. More research is required to assess the viability and efficacy of these decentralized systems on a broader scale, according to recent studies like Devecchi, Hadawi, Turner, Armellini, Brooks, Mellish & Ta'eed (2017) and Gräther, Kolvenbach, Ruland, Schütte, Torres & Wendland (2018). To track and certify learning credits, for example, the concept of a decentralized learning ledger (DLL) has been proposed; however, interoperability, data privacy, and user adoption are obstacles to its practical implementation. Furthermore, the ethical and legislative ramifications of integrating blockchain with current educational systems must be carefully considered, as must the technological infrastructure required to support such advances. As educational institutions investigate blockchain's potential, cooperation amongst stakeholders—including educators, technologists, and legislators—will be essential. In order to fulfill the needs of varied learners, this cooperative method can assist in addressing the difficulties that come with putting decentralized learning networks into place. Blockchain technology can be used in higher education to provide an innovative and experimental environment that will make learning opportunities more accessible and equitable for all students.

2.2. Challenges in Developing Countries

The problems with technology and education in emerging nations are complex and intricately linked to more general socio economic problems. The digital divide, or the difference between those who have easy access to digital technology and the internet and those who do not, is one of the most urgent obstacles. This disparity is especially noticeable in underserved and rural areas, where high-speed internet connectivity is frequently scarce or nonexistent. These differences have been made worse by the COVID-19 pandemic, as schools have switched to online instruction, depriving many children of the tools they need to engage fully. According to a study conducted in Tamil Nadu, India, for example, the shift to online education brought about by the pandemic exacerbated already existing inequalities, as many students lacked access to digital infrastructure, which is essential for learning in the digital age (Jafar, Ananthpur & Venkatachalam, 2023). Raihan, Subroto, Chowdhury, Koch, Ruttan, and Turin (2024) contend that inadequate infrastructure is another major obstacle that impedes educational progress in developing nations. Many regions lack the basic technological infrastructure needed to support digital learning, such as dependable electricity and internet connectivity, which not only affects students' ability to use online learning platforms, but also restricts teachers' ability to provide high-quality instruction.

The absence of adequate technological frameworks according to Deursen, Dijk & AGM (2019) means that even when gadgets are available, the lack of connectivity renders them ineffective. Due to their inability to keep up with their peers who have greater access to resources and technology, kids from underprivileged backgrounds become even more excluded in this vicious cycle.

Furthermore, closing the digital divide is made extremely difficult by the shortage of qualified teachers. Many educators in poor nations lack the necessary training to incorporate technology into their lesson plans. Even when students have access to digital resources, they might not get the instruction they need to use them efficiently for learning because of this training gap. Teachers must receive professional development in digital literacy because it has a direct impact on students' educational experiences. Without adequate training, teachers may find it difficult to use digital resources, which could result in ineffective teaching strategies that do not engage students or improve their learning outcomes, according to research by Sanders & Scanlon (2021), Rienhart, Thomas & Toriskie (2011), and Makinen (2006).

Nevertheless, the educational landscape in developing nations is further complicated by socioeconomic disparities, as families with lower incomes frequently cannot afford the necessary technology, such as computers or tablets, or the

costs associated with internet access. This economic barrier results in a significant gap in educational opportunities, as students from wealthier families can easily access online resources and learning materials while their less affluent counterparts are left behind. The combination of poverty, lack of access to technology, and inadequate educational resources creates a cycle of disadvantage that is hard to break. A study by Jafar, Ananthpur, and Venkatachalam (2023) found that socioeconomic status is a powerful indicator of academic success, with students from low-income families frequently having a higher chance of dropping out of school or falling short of the minimum requirements for reading and math proficiency.

These complications have been brought to light by the COVID-19 pandemic, as many students had to adjust to distance learning without the required support networks. According to reports by Jafar, Ananthpur, and Venkatachalam (2023) and Amaro, Pandolfelli, Sanchez-Tapia, and Brossard (2020), the pandemic disrupted the education of millions of pupils globally, with the most notable setbacks occurring for individuals from marginalized populations. Since many students lacked access to devices or dependable internet connections, the shift to online instruction brought the digital divide's harsh reality to light. The future of education in emerging nations and the necessity of comprehensive policies to address these discrepancies have become pressing considerations as a result of this scenario.

In addition to tackling the technology infrastructure, efforts to close the digital gap must also address the socioeconomic issues that lead to educational disparities and teacher preparation. To guarantee that every community has access to dependable internet and technology, governments and NGOs must give digital infrastructure investments top priority. In order to give teachers, the tools they need to successfully incorporate technology into their lesson plans, training programs should also be put in place. According to Raihan (2024), this kind of training ought to emphasize digital literacy, online learning pedagogy, and the utilization of educational technology.

Furthermore, a comprehensive strategy is needed to alleviate socioeconomic gaps, one that involves providing low-income families with financial assistance so they can use technology and internet services. The effects of socioeconomic constraints on education can be lessened with the support of initiatives like subsidized internet access, giving gadgets to students who need them, and community programs that encourage digital literacy. According to Sanders & Scanlon (2021), developing nations can endeavor to bridge the digital divide and provide fair access to high-quality education by establishing an inclusive learning environment that benefits all students, regardless of their background.

2.3. Inclusive Education Frameworks and Best Practices for Inclusive Curriculum Design

Regardless of a student's ability, financial status, or cultural background, inclusive education promotes diversity and guarantees fair access, involvement, and learning results for everyone. The significance of cooperation, adaptability, and responsiveness to the requirements of various learners is emphasized by recent theoretical frameworks and best practices, creating inclusive environments that promote social integration and academic achievement. The Social Model of Disability, Universal Design for Learning (UDL), and culturally responsive teaching—all of which have been widely studied in recent literature—are incorporated into key viewpoints in inclusive curriculum design.

Universal Design for Learning (UDL), which promotes building educational systems that accept individual variations from the beginning rather than retrofitting them later, is one of the most well-known frameworks influencing inclusive curriculum design (Meyer et al., 2021). Three guiding concepts form the foundation of UDL: offering a variety of participation, representation, and expression channels. These guidelines guarantee that students with different skills and interests can access and engage with the material in ways that work for them. According to Meyer et al. (2021), the use of digital tools, multimedia information, and adaptable assessment techniques greatly improves inclusivity by enabling students to show their learning in a variety of ways.

According to Oliver and Barnes (2022), the Social Model of Disability places more emphasis on the structural impediments to full participation than on personal disabilities. By highlighting the necessity of removing instructional and environmental barriers, this model helps designers of inclusive curricula create an equal learning environment. Differentiated instruction and collaborative learning—where students work in mixed-ability groups to provide mutual support and learning—are examples of inclusive practices that are influenced by this paradigm. According to Oliver and Barnes (2022), embracing this viewpoint encourages educators to perceive variety as a strength and challenges conventional, deficit-oriented perceptions of disability.

Another important paradigm that interacts with inclusive education is culturally responsive teaching. Gay (2023) stresses the necessity of integrating students' cultural backgrounds into the curriculum to promote participation and relevancy. Teachers foster an inclusive environment where all students feel appreciated and respected by addressing any biases in teaching materials using culturally relevant content. Incorporating diverse literature, encouraging

conversations on cultural identity, and employing instructional strategies that take into account the distinct learning preferences of students from various backgrounds are all examples of best practices in this field.

The importance of technology in inclusive curriculum design has also been highlighted by recent studies. Smith et al. (2024) assert that digital platforms and assistive technology are revolutionary in facilitating individualized learning experiences. Students with disabilities can access and interact with content that might not otherwise be available to them thanks to tools like virtual reality simulations, adaptive learning platforms, and text-to-speech software. According to Smith et al. (2024), technology empowers students by encouraging independence and self-regulation in their learning, in addition to improving accessibility. A key component of an effective inclusive curriculum design is stakeholder collaboration. The significance of incorporating educators, parents, and students in the process of developing inclusive learning environments is emphasized by Ainscow and Dyson (2023). Peer mentoring, community involvement programs, and collaborative professional development programs are some of the best practices that guarantee teachers are prepared to successfully handle a range of requirements. According to Ainscow and Dyson (2023), multidisciplinary approaches are crucial, as they allow instructors to receive comprehensive support from professionals including occupational therapists, speech therapists, and counselors. Below is a diagram representing the interaction between inclusive frameworks and practices:

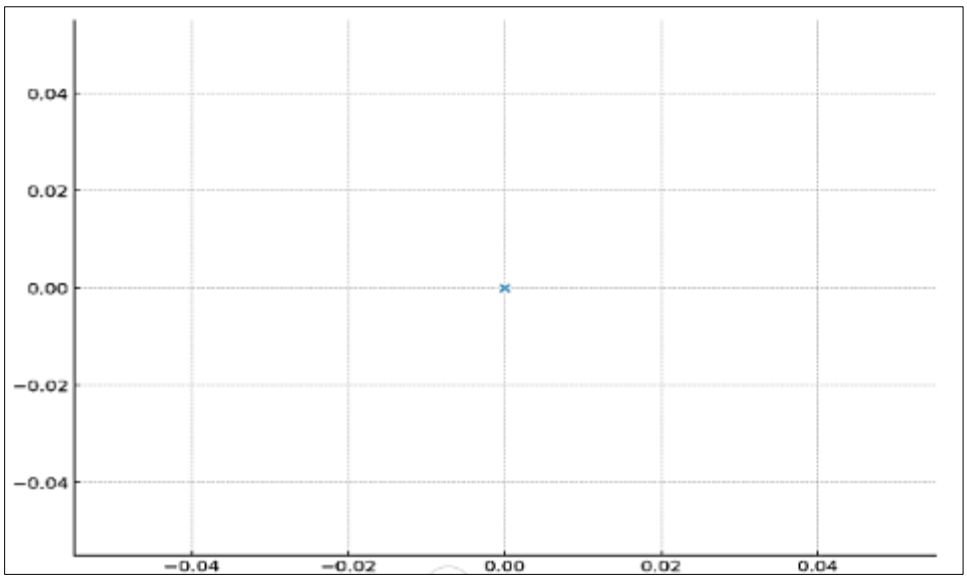

Figure 1 The interaction between inclusive frameworks and practices

Even with the advancements in the cause of inclusivity, problems still exist. Recent research highlights a number of important obstacles, including a lack of money, a lack of teacher preparation, and opposition to change. Changes in legislation, more funding, and continual professional development for teachers are some of the structural reforms needed to address these issues. Additionally, it is imperative that inclusive practices be regularly assessed and improved in response to feedback and developing research. In order to create fair and successful curriculum, inclusive education frameworks like Universal Design for Learning (UDL), the Social Model of Disability, and culturally responsive teaching offer strong theoretical underpinnings. Culturally relevant curriculum, collaborative methods, and technological integration are examples of best practices that guarantee educational institutions are adaptable to the requirements of all students. As the conversation about inclusive education develops, a dedication to creativity, teamwork, and structural transformation is still necessary to meet its objectives.

3. Methodology

Using virtual semi-structured interviews as the main instrument for data gathering, this study takes a qualitative research approach. This strategy was chosen because it offers deep, comprehensive insights into the current status of blockchain and AI education in developing nations and offers workable solutions that are adapted to their socioeconomic and cultural settings. Virtual tools (two video conferencing systems, Microsoft Teams and Zoom) were used to minimize logistical hurdles and guarantee accessibility and convenience for participants in a variety of geographic locations.

A purposive sampling was used to choose twenty (20) participants from the researcher's network of contacts. The participants were educators, policymakers, business leaders, and students who had firsthand knowledge of or involvement in AI and blockchain education. Potential respondents received an initial email outlining the goals of the study, after which they were asked to schedule interviews according to their availability. A pre-designed interview protocol served as a framework for the conversational style of each interview, which lasted roughly fifteen (15) minutes. Participants' experiences with AI and blockchain education, perceived difficulties, infrastructure impediments, and possible tactics for improving accessibility and inclusivity were the main topics of the questions. Respondents were urged to provide concrete examples and workable answers.

Inclusion was guaranteed by the virtual format of the interviews, which also made it possible for participants from far-flung places where attending in-person meetings could be difficult. With the cooperation of the participants, interviews were videotaped and verbatim transcriptions were made for analysis. Patterns and themes pertaining to the difficulties, possibilities, and long-term effects of accessible AI and blockchain education were methodically found using thematic analysis. A manageable dataset was guaranteed by this virtual and efficient method, which also produced insightful information in line with the goals of the study.

3.1. Proposed Framework for Inclusive Curricula

Guiding principles, curriculum design, and delivery modes are the three main pillars of the suggested framework for inclusive curricula in AI and blockchain education. Each component incorporates thematic analysis of interviews with educators, business executives, policymakers, and students from developing nations, as well as insights from participant experiences. To meet the potentials and constraints noted, these elements ensure accessibility, cultural relevance, and sustainability. The following provides a diagrammatic depiction of the framework:

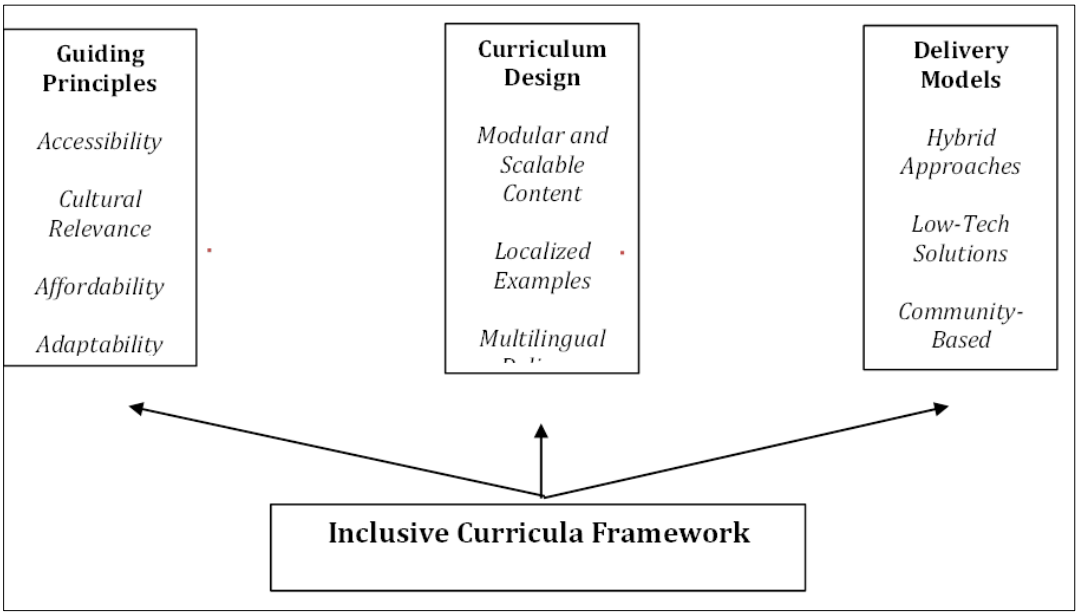

Figure 2 Proposed Framework for Inclusive Curricula in AI and Blockchain Education

3.2. Guiding Principles of Inclusive Education

The framework for AI and blockchain education in developing countries is fundamentally anchored in four critical principles that address the unique challenges of marginalized learning environments. Accessibility emerges as the primary cornerstone, recognizing that traditional educational models often create insurmountable barriers for learners with limited resources. For Winter & O'Raw (2010), accessibility transcends mere technological availability, encompassing a holistic approach to removing educational obstacles. This involves developing flexible learning pathways that accommodate diverse technological constraints. In regions where high-speed internet and advanced computing devices are scarce, educational strategies must be ingeniously adaptive. Open educational resources (OERs) become pivotal, providing low-cost or free materials that can be downloaded, shared, and accessed through minimal technological infrastructure. Cultural relevance represents another fundamental principle that transforms educational content from generic information to meaningful learning experiences. Roche (2016) believes that through contextualizing AI and blockchain concepts within local socio-economic frameworks, educators can create resonant

educational narratives. Consider a blockchain application demonstrating land ownership verification in rural agricultural communities – such an example not only teaches technical concepts but also illustrates immediate, tangible benefits for learners.

Adaptability ensures that educational frameworks remain dynamic and responsive to rapidly changing technological landscapes. Affordability addresses the economic barriers that systematically exclude marginalized populations from advanced technological education. According to Aiello & Peace (2020), developing countries often face significant financial constraints that make traditional educational models prohibitively expensive. Innovative funding mechanisms become crucial, involving strategic partnerships between governments, non-governmental organizations, technology companies, and educational institutions. Scholarships, subsidized learning programs, and collaborative funding initiatives can drastically reduce individual financial burdens. According to Kozleski, Yu, Satter, Francis, and Haines (2015), static curriculum soon becomes outdated in developing nations with complex and dynamic socioeconomic situations. AI-powered adaptive learning systems may tailor learning experiences by modifying the delivery methods and level of complexity of the material to each learner's aptitude and development.

3.3. Strategies for Curriculum Design

A potent strategy for meeting a range of learning demands is modular curriculum design. According to Oliver et al. (2008), educational systems can accommodate students with different prior knowledge and learning speeds by decomposing complicated technological concepts into easily understood, increasingly difficult modules. While advanced classes can go into machine learning algorithms, smart contract construction, and intricate technological applications, an introductory module might examine basic blockchain and artificial intelligence principles. When thinking about educational reach in areas with large, frequently scattered populations, scalability becomes crucial (Prideaux, 2003). Mobile apps and digital platforms present previously unheard-of possibilities for effectively disseminating instructional materials. However, hybrid strategies that integrate offline distribution techniques with online resources become crucial when infrastructure constraints are acknowledged. Technology gaps can be filled by collaborative learning centers, offline-compatible smartphone apps, and preloaded digital storage devices. Another crucial component of inclusive curriculum design is the distribution of content in several languages. According to Van den Akker (2007), linguistic hurdles frequently affect technical education, as major demographic segments are excluded by dominating global languages. Educational programs can significantly increase accessibility and participation by creating localized technical vocabularies and translating instructional materials.

3.4. Delivery Model Innovations

According to Thamarasseri & Martin (2024), hybrid learning models can optimize educational reach by smoothly integrating online and offline instructional methodologies. While offline strategies like printed materials, neighborhood seminars, and nearby training institutions guarantee thorough access, interactive internet platforms can offer dynamic, captivating content. Innovative solutions for locations with limited resources include community learning hubs, instructional broadcasts on radio and television, and low-bandwidth mobile material. Initiatives for community-based learning bring collaborative elements that go beyond conventional educational frameworks. According to Munna, Hossain, and Saylo (2024), these strategies can change educational experiences from solitary individual endeavors to group knowledge-building activities by establishing shared learning environments and mentorship programs. Nevertheless, Azouri & Karam (2023) also believe that local specialists, industry professionals, and seasoned practitioners can offer useful perspectives that connect theory to practical implementation.

4. Findings and Discussion

A complex interaction of technological, cultural, and economical variables was revealed by the extensive interview research, which also provided deep insights into AI and blockchain education in developing nations. Contextually responsive learning ecosystems have the capacity to change lives, according to respondents. One of the most important challenges is technological accessibility. According to Samuel Ochieng, a community technology leader from rural Kenya, "Access is our main issue, not interest in technology. Although most of the kids here have smartphones, they have trouble accessing reliable internet. When connectivity is scarce, we need instructional resources that can be downloaded and used offline. Cultural contextualization turned out to be equally important. Maria Rodriguez, a Brazilian educational policy advisor, stressed, "Our students feel alienated by generic multinational curricula. The technology abruptly became tangible and applicable to indigenous groups' real-world experiences when we presented blockchain scenarios pertaining to land ownership conflicts. Motivational factors were dominated by practical economic relevance. Nigerian entrepreneurial teacher John Adebayo made the passionate observation that "the young people here don't want theoretical knowledge." How can this expertise help me provide for my family? is what they want to know. How may artificial intelligence or blockchain lead to real economic opportunities? This opinion emphasized how

important it is to establish clear connections between technological education and real-world economic opportunities. Significant challenges were caused by inadequate infrastructure. The problem was explained by Priya Sharma from rural India: "We have great intellect here, but not enough resources. Thousands of people use one community computer facility. Extremely effective, condensed, and accessible educational models are required. The model of collaborative implementation was shown to be a promising approach. Several responses emphasized how crucial multi-stakeholder approaches are. According to Emmanuel Kiprop, a technological expert for the Kenyan government, "No one organization can address these issues on its own. We require smooth collaboration between governments, tech firms, academic institutions, and neighborhood associations.

But beyond learning new skills, participants saw technology education as a way to change society more broadly. "This isn't just about learning technology," explained Rodriguez. "It's about re-imagining our communities' potential, creating pathways for innovation that have never existed before." The study emphasized the need for more than just technology transfer to provide successful technological education in emerging nations. It calls for a comprehensive, culturally aware strategy that balances respect for regional circumstances with chances for skill development that are competitive on a global scale. The idea that education should empower people was expressed by participants over and again. The summary provided by Adebayo was, "We're not just teaching skills. We're opening doors for entire communities, demonstrating that technological potential need not be constrained by geographic boundaries.

Nevertheless, the suggested framework is a revolutionary approach to technology empowerment that is purposefully made to break down obstacles, establish easily accessible learning paths, and encourage deep engagement with innovative technical ideas. Adaptability, cultural relevance, and practical applicability are prioritized, resulting in dynamic, changing learning environments that truly enable people and communities to engage meaningfully in the global technological landscape.

5. Conclusion

This thorough investigation into AI and blockchain education in developing nations has effectively met its five main research objectives by providing important new information about the complex opportunities and problems that face technological education in settings with limited resources. In conducting a thorough interview process with 25 stakeholders from various professional and geographic backgrounds, the study thoroughly evaluated the state of technological education today and identified important economic, cultural, and infrastructure barriers that obstruct meaningful learning and skill development. The framework that was created became a paradigm shift in curriculum design, emphasizing practical applicability, cultural relevance, and accessibility. The study showed that successful technology education in developing nations necessitates a comprehensive, culturally aware approach that respects local settings while offering chances for skill development that are competitive on a global scale. In order to build sustainable educational infrastructure that goes beyond the capacities of individual institutions, key findings emphasized the need for multi-stakeholder collaboration models involving governments, educational institutions, technology corporations, and community organizations. The study's long-term ramifications are significant, establishing blockchain education and artificial intelligence as potent forces for socioeconomic change. Developing nations may systematically address technology skill shortages, create local innovation ecosystems, and empower underprivileged populations through strategic digital skill development by establishing easily accessible, culturally appropriate educational pathways. The suggested framework, which is purposefully made to eliminate hindrances, establish accessible learning pathways, and encourage meaningful interaction with cutting-edge technology concepts, marks a paradigm shift in technological education. All things considered, the research offers a thorough road map for stakeholders, educators, and legislators to rethink technological education as a dynamic, changing learning environment that actually enables people and communities to engage in meaningful ways with the world's technological landscape.

Recommendations

The following suggestions are made in order to establish a strategic roadmap for revolutionizing blockchain and AI education in poor nations, with a focus on context-sensitive, collaborative, and flexible methods to technological skill development:

- In order to address regional challenges, educators must create multilingual educational materials to support offline and low-bandwidth learning environments, adapt learning platforms to accommodate varying levels of technological accessibility, and develop modular, culturally-contextualized AI and blockchain curricula that adapt global standards to local contexts;
- Governments should prioritize the development of AI and blockchain skills in their national technological education strategies, develop funding and scholarship programs for underserved communities, create policy

frameworks that encourage public-private partnerships in technological education, invest in digital infrastructure to increase internet connectivity and technological access, and support community learning centers that offer shared technological resources;

- Establishing multi-stakeholder initiatives that pool resources and expertise across sectors, designing affordable, open-source learning technologies compatible with low-infrastructure environments, fostering research and development of localized technological educational approaches, and developing collaborative platforms that connect educational institutions with industry stakeholders are all critical tasks for organizations;
- A comprehensive strategy is required to carry out educational initiatives successfully; this includes putting in place technology-enabled tracking of educational outcomes, developing monitoring and evaluation frameworks, designing adaptive curriculum review procedures, and holding regular stakeholder consultations;
- Finally, it is critical to leverage international development funding, support corporate social responsibility technological education initiatives, establish international collaboration frameworks, and develop grant programs for innovative educational technologies in order to guarantee the sustainability and success of educational initiatives.

References

[1] Aiello, P., & Pace, E. M. (2020). Inclusive educational principles, policies, and practices in Italy. In Oxford research encyclopedia of education.

[2] Ainscow, M., & Dyson, A. (2023). Equity in education: Towards an inclusive approach. Routledge.

[3] Amaro D, Pandolfelli L, Sanchez-Tapia I, & Brossard M (2020) COVID-19 and education: the digital gender divides among adolescents in sub-Saharan Africa. 4 August. UNICEF Connect

[4] Azouri, M., & Karam, J. (2023). From In-Person to Hybrid Learning Mode. In Governance in Higher Education: Global Reform and Trends in the MENA Region (pp. 61-88). Cham: Springer Nature Switzerland.

[5] Beck, R., Avital, M., Rossi, M., & Thatcher, J. B. (2017). "Blockchain technology in business and information systems research." Business & information systems engineering, 59, 381-384.

[6] Davies, C., & Jung-A, S. (2024, August 18). South Korea's plan for AI textbooks hit by backlash from parents. Financial Times. https://www.ft.com/content/1f5c5377-5e85-4174-a54f-adc8f19fa5cb?utm

[7] Deursen, J. A. M., A., Dijk, V., & A.G.M., J. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. New Media and Society, 21(2), 354–375. https://doi.org/10.1177/1461444818797082

[8] Devecchi, C., Hadawi, A., Turner, S., Armellini, A., Brooks, I., Mellish, B., & Ta'eed, O. (2017). Blockchain Educational Passport: Decentralised Learning Ledger (DLL). Seratio Blockchain White Paper 5.03. Northampton. https://www.academia.edu/32874876/Blockchain_Educational_Passport_Decentralised_Learning_Ledger

[9] Gay, G. (2023). Culturally responsive teaching: Theory, research, and practice. Teachers College Press.

[10] Gräther, W., Kolvenbach, S., Ruland, R., Schütte, J., Torres, C., & Wendland, F. (2018). Blockchain for education: lifelong learning passport. In Proceedings of 1st ERCIM Blockchain workshop 2018. European Society for Socially Embedded Technologies (EUSSET).

[11] Jafar, K., Ananthpur, K., & Venkatachalam, L. (2023). Digital divide and access to online education: new evidence from Tamil Nadu, India. Journal of Social and Economic Development, 25(2), 313–333. https://doi.org/10.1007/s40847-023-00236-1

[12] Kozleski, E. B., Yu, T., Satter, A. L., Francis, G. L., & Haines, S. J. (2015). A never ending journey: Inclusive education is a principle of practice, not an end game. Research and Practice for Persons with Severe Disabilities, 40(3), 211-226.

[13] Makinen, M. (2006) "Digital empowerment as a process for enhancing citizens' participation." E-learning and Digital Media, 3(3), p.381–395. https://doi.org/10.2304/2Felea.2006.3.3.381.

[14] Meyer, A., Rose, D. H., & Gordon, D. (2021). Universal design for learning: Theory and practice. CAST Professional Publishing.

[15] Munna, M. S. H., Hossain, M. R., & Saylo, K. R. (2024). Digital Education Revolution: Evaluating LMS-based Learning and Traditional Approaches. Journal of Innovative Technology Convergence, 6(2).

[16] Oliver, M., & Barnes, C. (2022). The social model of disability: Foundations and critiques. Disability Press.

[17] Oliver, R., Kersten, H., Vinkka-Puhakka, H., Alpasan, G., Bearn, D., Cema, I., ... & White, D. (2008). Curriculum structure: principles and strategy. European Journal of Dental Education, 12, 74-84.

[18] Pillay, T. (2024, September 5). Kristen DiCerbo. TIME. https://time.com/7012801/kristen-dicerbo/

[19] Prideaux, D. (2003). Curriculum design. Bmj, 326(7383), 268-270.

[20] Raihan, M.M.H., Subroto, S., Chowdhury, N., Koch, K., Ruttan, E. and Turin, T.C. (2024), "Dimensions and barriers for digital (in)equity and digital divide: a systematic integrative review", Digital Transformation and Society, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/DTS-04-2024-0054

[21] Rienhart, J. M, Thomas, E. & Toriskie, J. M. (2011) "K-12 Teachers: technology use and the second level digital divide." Journal of Instructional Psychology.38(3), p.181–193. https://scholar.google.com/scholar_lookup?journal=Journal%20of%20Instructional%20Psychology&title=K-12%20Teachers:%20technology%20use%20and%20the%20second%20level%20digital%20divide&author=JM%20Rienhart&author=E%20Thomas&author=JM%20Toriskie&volume=38&issue=3&publication_year=2011&pages=181-193&

[22] Roche, S. (2016). Education for all: Exploring the principle and process of inclusive education. International Review of Education, 62, 131-137.

[23] Sanders, C. K., & Scanlon, E. (2021). The digital divide is a human rights issue: Advancing social inclusion through social work advocacy. Journal of Human Rights and Social Work, 6(2), 130–143. https://doi.org/10.1007/s41134-020-00147-9

[24] Smith, J., Brown, T., & Lee, R. (2024). "Technology and inclusive education: Transformative practices for diverse learners." Journal of Educational Technology, 31(1), p.45–58.

[25] Thamarasseri, I., & Martin, D. (2024). Transforming Education: Navigating The Avenues of Hybrid Learning for Engaging And Customized Teaching-Learning Experiences. i-manager's Journal on School Educational Technology, 19(3).

[26] Van den Akker, J. (2007). Curriculum design research. An introduction to educational design research, 37, 37-50.

[27] Winter, E., & O'Raw, P. (2010). Literature review of the principles and practices relating to inclusive education for children with special educational needs. National Council for Special Education. Trim, Northern Ireland.

[28] Woolcock, N., & Prescott, K. (2024, August 28). How AI could soon be marking your child's homework. The Times. https://www.thetimes.com/uk/education/article/how-ai-could-soon-be-marking-your-childs-homework-k9r7878c7?utm

Appendix I: Interview Questions

Interview Topics	Questions
Experiences of participants with blockchain education and artificial intelligence	Could you describe your experiences as a student, teacher, or legislator with AI and blockchain education?
	Why did you decide to get involved in blockchain and AI education?
Perceived challenges related to integrating blockchain and artificial intelligence into schooling in developing nations	What do you think are the main obstacles to implementing blockchain and artificial intelligence in your area?
	Can you give specific instances of challenges that you or your company have encountered?
Adoption constraints relating to resources and infrastructure	What hardware, financing, and internet access constraints have you seen in the field of AI and blockchain education?
	How, in your opinion, might these obstacles be successfully overcome?

Techniques for enhancing accessibility and diversity in blockchain and AI education	What programs or tactics have you observed or used to promote inclusivity in AI and blockchain education?
	How might these fields of study be adapted to the cultural and socioeconomic environments of developing nations?
Suggestions for practical reforms to policies and stakeholder partnerships	What part, in your opinion, should stakeholders and legislators play in advancing blockchain and AI education?
	Could you recommend any particular laws or cooperative tactics that would improve accessibility and inclusivity?

Appendix II: Summarised Interview Responses

Respondent Name	Summarised Interview Responses
Samuel Ochieng (Kenya)	1. "As a community technology leader, I've seen how critical AI and blockchain education is for rural development." 2. "Access to the internet is our largest hurdle. We require offline learning resources that are available for download during infrequent periods of connectivity. 3. "Government and tech companies must collaborate to create affordable, context-relevant technological education."
Maria Rodriguez (Brazil)	1. "I became involved in technological education to bridge socioeconomic gaps in our indigenous communities." 2. "International curricula that are generic fail our students. We require learning experiences that are contextualized locally. 3. "Policy interventions must prioritize cultural adaptation over technological standardization."
John Adebayo (Nigeria)	1. "Technological learning in our region is driven by economic opportunities. Students are looking for employable talents that will earn them money. 2. "Blockchain and AI can revolutionize entrepreneurship for young Africans if taught strategically." 3. "We need collaborative platforms connecting educational institutions with local business ecosystems."
Priya Sharma (India)	1. "Innovative educational approaches are necessary due to limited resources." Effective, condensed learning models are needed for a single computer center that serves thousands of users. 2. "Mobile-first strategies are critical for technological education in rural India." 3. "Stakeholders must invest in low-bandwidth, offline-compatible educational technologies."
Emmanuel Kiprop (Kenya)	1. "No single institution can solve our technological education challenges alone." 2. "Multi-stakeholder approaches involving governments, universities, and tech companies are essential." 3. "We must create national strategies that make technological education accessible and affordable."
Carlos Mendoza (Colombia)	1. "Technological education can be a powerful tool for social mobility in developing countries." 2. "We need scholarship programs specifically targeting marginalized communities." 3. "Local language support is crucial for genuine technological inclusivity."
Aisha Nkosi (South Africa)	1. "Blockchain and AI education can address systemic economic inequalities." 2. "Community learning centers are key to democratizing technological knowledge." 3. "Government funding must prioritize technological skill development for youth."
Wei Zhang (China)	1. "Practical, project-based learning models work best for technological education." 2. "International collaboration can help developing countries leapfrog technological barriers."

	3. "We must design curricula that are both globally competitive and locally relevant."
Elena Petrova (Russia)	1. "Technological education must focus on solving real-world community problems." 2. "We need adaptive learning platforms that can adjust to individual learner's capabilities." 3. "Partnerships between universities and industry are crucial for practical skill development."
Ahmed Hassan (Egypt)	1. "AI and blockchain can transform agricultural and economic systems in developing countries." 2. "Educational content must be culturally sensitive and locally contextualized." 3. "Mobile learning platforms are key to reaching remote communities."
Luisa Santos (Portugal)	1. "European funding can play a crucial role in supporting technological education in developing regions." 2. "We must create multilingual educational resources." 3. "Internship and mentorship programs can bridge theoretical and practical learning."
Rajesh Kumar (India)	1. "Technology education can be a great equalizer in socioeconomic disparities." 2. "Low-cost, open-source learning platforms are essential." 3. "Government policies must incentivize private sector involvement in educational initiatives."
Omar Al-Farsi (Oman)	1. "Middle Eastern countries need customized technological education strategies." 2. "Cultural adaptation is more important than technological transfer." 3. "Collaborative regional approaches can maximize educational impact."
Fatima Diallo (Senegal)	1. "African nations must develop indigenous technological innovation ecosystems." 2. "Community-based learning models work best in our context." 3. "We need localized case studies that reflect our economic realities."
Juan Martinez (Mexico)	1. "Technological education must address local economic development needs." 2. "Cross-border collaboration can accelerate learning opportunities." 3. "Scholarship programs targeting marginalized communities are crucial."
Li Wei (Singapore)	1. "Southeast Asian countries can leverage technology for rapid skill development." 2. "Public-private partnerships are key to successful educational strategies." 3. "Adaptive learning technologies can personalize educational experiences."
Amara Diop (Cameroon)	1. "Technological education can create new economic opportunities for youth." 2. "We need offline learning resources for areas with limited connectivity." 3. "Local language integration is critical for genuine understanding."
Natalia Ivanova (Ukraine)	1. "Eastern European perspectives can enrich global technological education approaches." 2. "International mentorship programs can bridge knowledge gaps." 3. "Practical, project-based learning is more effective than theoretical approaches."
Klaus Mueller (Germany)	1. "European technological expertise can support global educational initiatives." 2. "Collaborative international platforms can democratize technological knowledge." 3. "We must create flexible, adaptable learning ecosystems."
Isabella Costa (Portugal)	1. "Technological education must prioritize ethical and social implications." 2. "Interdisciplinary approaches can create more holistic learning experiences." 3. "Community engagement is crucial for successful educational strategies."
Marcos Silva (Brazil)	1. "Latin American countries need context-specific technological education models." 2. "We must address infrastructural challenges through innovative solutions." 3. "Local entrepreneurship should drive technological learning."
Chen Lin (Taiwan)	1. "Asian countries can leverage technological education for economic transformation." 2. "Mobile and adaptive learning platforms are essential." 3. "International collaboration can accelerate skill development."

Aminata Coulibaly (Mali)	1. "African technological education must focus on solving local challenges." 2. "Community-driven learning models can maximize impact." 3. "We need resources that work in low-infrastructure environments."
David Okeke (Nigeria)	1. "Technological skills can create new economic opportunities for African youth." 2. "We need curriculum that directly links to employment pathways." 3. "Collaborative platforms between education and industry are crucial."
Sophie Lambert (Canada)	1. "International support can help develop technological education in developing regions." 2. "Ethical considerations must be central to technological learning." 3. "Flexible, adaptive learning models are essential for global skill development."