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RESEARCH & PUBLISHING

Priviet Social Sciences Journal

Volume 6
Issue 3 March, 2026

Article 53

31-03-2026

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To cite this article: Asy-Syafi'i, M. I. M. K, Romadhon, M. F., Natia, N., Sitorus, I. R., & Afrillia, Z. (2026). Reconfiguring digital education policy through youth leadership to support the achievement of the Sustainable Development Goals. *Priviet Social Sciences Journal, 6*(3), 666–684. https://doi.org/10.55942/pssj.v6i3.1686

To link to this article: doi.org/10.55942/pssj.v6i3.1686

Priviet Social Sciences Journal
E-ISSN 2798-6314
P-ISSN 2798-866X
https://doi.org/10.55942/pssj.v6i3.1686

Volume 6
Issue 3
March Edition 2026

Reconfiguring digital education policy through youth leadership to support the achievement of the Sustainable Development Goals

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Received 26 February 2026
Revised 27 March 2026
Accepted 31 March 2026

ABSTRACT

Digital education inequality remains a major challenge in achieving the Sustainable Development Goals (SDGs), particularly SDG 4, 9, 10, and 17. Educational technology is viewed as a transformative instrument, yet gaps in access, digital literacy, and policy capacity indicate a weak orientation toward equity. This study aims to analyze the urgency of reconfiguring digital education policy by positioning youth leadership as a strategic actor. The study adopts a qualitative approach with a conceptual analysis based on a literature review. Data are drawn from policy documents and official publications of reputable international institutions, such as UNESCO, OECD, UNICEF, and the World Bank. Analysis is conducted through thematic analysis and critical policy analysis. The findings show that the digital divide is driven not only by infrastructure limitations, but also by low digital literacy, policy asynchrony, and minimal youth involvement. This study formulates youth leadership–based conceptual solutions, including strengthening the edutech ecosystem, equity-oriented adaptive learning, digital skills credentials, and expanding access in vulnerable regions. Reconfiguring digital education policy based on youth leadership is a strategic prerequisite for the sustainable contribution of digital education to the achievement of the SDGs.

Keywords: digital education policy; digital inequality; Edutech; Sustainable Development Goals; youth leadership

1. INTRODUCTION

Digital education inequality remains a fundamental issue in the global education system. Although educational technology is developing rapidly, access to devices and connectivity is still uneven. UNESCO emphasizes that technology adoption actually reveals structural gaps between different social groups and geographical regions (UNESCO, 2026). This condition hinders the function of digital education as an instrument of equity.

These disparities have a significant impact on the younger generation. UNICEF reports that the majority of children and youth in low-income countries remain on the disadvantaged side of the digital divide. These barriers are not only technological in nature, but also social and institutional. As a result, opportunities for youth participation in the economy and sustainable development become limited (UNICEF, 2021).

Within the framework of global development, digital education has a direct connection to the achievement of the Sustainable Development Goals. Studies indicate that digital transformation contributes to improving education quality, innovation, and the reduction of inequality. However, these benefits are highly dependent on inclusive and adaptive policy design (Unterhalter, 2019; Tikly, 2019). With out appropriate policy approaches, technology instead has the potential to widen inequality gaps.

The digital education literature also highlights that the digital divide is multidimensional in nature. Gaps occur not only in terms of access, but also in digital literacy, pedagogical capacity, and policy support. Van de Werfhorst show that digital skills determine the extent to which individuals can benefit from educational technology (van de Werfhorst, Kessenich & Geven, 2022). This reinforces that technological solutions alone are insufficient.

In this context, the role of the younger generation becomes increasingly strategic. Youth are not only positioned as technology users, but also as innovators and drivers of social change. Studies on youth agency emphasize that youth engagement can strengthen the relevance and sustainability of digital education policies (Checkel, 2017; Cahill & Dadvand, 2018). However, this dimension remains insufficiently integrated into formal policy frameworks.

A number of studies affirm that digital education policies tend to be top-down and lack participatory elements. Williamson shows that global edutech policies are often driven by technocratic and market logics, with limited space for young actors in decision-making processes (Williamson, 2017). As a result, the solutions produced are frequently misaligned with local needs and vulnerable groups.

Inequality in digital readiness expands the dimensions of the digital divide beyond mere technical access. Studies show that disparities in the digital readiness of students and schools affect the quality of participation in online learning, even when infrastructure is available (van de Werfhorst, Kessenich & Geven, 2022). This confirms that improving physical access alone is insufficient without a systemic enhancement of digital capacity. This condition has implications for the formation of learning outcome inequalities across various educational contexts.

Empirical investigations identify that the digital divide has a strong association with socio-economic variables, including migration background, economic status, and gender. Variations in digital readiness are often not evenly distributed across social groups and schools (van de Werfhorst, Kessenich & Geven, 2022). This reflects structural inequalities that require systemic and sustainable policy interventions. Policies must consider aspects of digital readiness inclusively in order to minimize these structural disparities.

In the context of edutech implementation, recent studies show that cross-sector collaboration among multiple actors—including educators, technologists, and local communities—can expand digital inclusion. This cross-disciplinary approach helps design solutions based on local contexts that are more responsive to the needs of vulnerable groups (Pandey, 2025). These findings strengthen the position that digital education policy must involve multiple stakeholders, not only central authorities. Such collaboration also contributes to increased accountability and the sustainability of educational technology programs.
Strengthening digital literacy is one of the key determining factors in bridging the digital divide, especially for the younger generation that will participate in the future digital economy. Literature reviews affirm that

empowering digital literacy through education policy enhances youth readiness to face the challenges of the digital era (Suratno, Nursidi & Cahyanto, 2025). The integration of digital literacy into formal policy can strengthen the competency foundation of the younger generation. Without this integration, the risk of digital knowledge inequality will continue.

Digital transformation in education not only affects access to learning but also the structure of education management at the organizational level. The implementation of education management that is adaptive to digitalization affects operational efficiency and the quality of learning services (Adam & Ummah, 2025). This shows that digital policy must include managerial and structural aspects, not merely hardware and software. A holistic approach will enable more comprehensive improvements in system quality.

When digital education policy does not pay attention to equity implications, technology can reinforce or widen existing inequalities. Studies show that although educational technology has inclusive potential, without pro-equity policies, the digital divide persists in ESL and other educational contexts (Yousofi, Golzar & Yacoub, 2025). This underscores the importance of explicit policy orientation toward equity and justice. Policies designed without integrating equity principles risk generating new disparities.

Finally, structural bias toward access to technology in remote areas also exacerbates digital education inequality. Research on rural communities shows that technological solutions that do not consider local contexts continue to fail in achieving educational justice (Syed Hamid & Sueb, 2025). This indicates that digital education policy must be based on contextual regional needs, rather than a single universal model. Tailored approaches will be more effective in addressing gaps with differing characteristics in each region.

Williamson (2017) and Unterhalter (2019) show that digital education policy research remains largely dominated by a technocratic approach focused on technology adoption, access, and learning effectiveness, while young people are still primarily positioned as beneficiaries rather than policy actors. In this context, a clear research gap remains, namely the limited number of studies that integrate digital inequality, digital education policy, youth leadership, and the Sustainable Development Goals within a single coherent analytical framework. As a result, youth leadership has not yet been adequately articulated in the literature as a mechanism of policy transformation. Responding to this gap, this article establishes its novelty through the formulation of a conceptual framework of reconfiguring digital education policy through youth leadership, which positions youth as the central axis of policy transformation. Bond et al. (2020) further underline the importance of youth engagement within digital education ecosystems, and on that basis the main theoretical contribution of this article lies in advancing youth leadership as a policy lens for reinterpreting digital education not merely as a technological issue, but as a field of social justice, participation, and sustainable development.

2. METHOD

2.1. Research Design and Approach

This study adopts a qualitative approach with a conceptual analysis and policy analysis design. The qualitative approach is used to examine the meaning, direction, and normative implications of policy in depth without relying on statistical measurement (Creswell & Poth, 2018). Conceptual analysis is employed to develop theoretical reasoning and map the interconnections among concepts in digital education policy (Jabareen, 2009). Policy analysis is applied to examine policy objectives, rationales, and implications within the context of sustainable development (Dunn, 2018). This design enables the positioning of youth leadership as a strategic actor in achieving the Sustainable Development Goals (SDGs).

2.2. Data Sources and Policy References

The data sources consist of policy documents, strategic reports, and conceptual frameworks published by UNESCO, OECD, UNICEF, and the World Bank. Policy documents are used as primary sources because they represent the normative and strategic foundations of digital education policy (Bowen, 2009). To ensure relevance and analytical rigor, the documents were selected using a purposive approach,

focusing on sources that directly address digital education policy, youth participation, and Sustainable Development Goals (SDGs). The selection process involved identifying key institutional publications and policy-oriented documents that are widely recognized in the field of global education policy. The inclusion criteria applied in this study are as follows: (1) Documents that discuss digital education, policy transformation, or youth engagement, (2) Official reports and policy frameworks issued by international organizations, (3) Documents that are accessible in full text and relevant to the research objectives Documents that do not meet these criteria or are not directly related to the research focus are excluded.

The analytical procedure was conducted systematically through several stages. First, all selected documents were carefully reviewed to understand their key arguments and policy contexts. Second, relevant information was identified based on recurring issues such as digital inequality, access, policy gaps, and youth participation. Third, these issues were organized into broader themes to capture the main patterns across documents. Finally, the identified themes were used as the basis for further policy analysis and interpretation. In this context, documents are treated as analytical sources that provide insights into policy structures, priorities, and challenges, rather than merely descriptive materials (Bowen, 2009).

2.3. Analytical Techniques

The analysis employs critical and comparative policy approaches. These techniques are applied in a structured manner to deepen the interpretation of the themes identified in the previous stage. Critical analysis is used to identify underlying assumptions, policy problem representations, and power relations embedded in digital education policies (Bacchi, 2009). In this study, critical analysis is applied after the identification of key themes to examine how policy documents frame issues such as digital inequality, access to education, and youth participation. The comparative approach is applied to examine policy objectives and strategies across institutions and to assess their implications for access, equity, digital literacy, and youth participation (Ragin, 2014). This approach allows for a systematic comparison of how different organizations prioritize and address digital education challenges. Documents are treated as argumentative foundations rather than coded data units to support systematic policy evaluation. Through the integration of critical and comparative approaches, the analysis moves beyond description toward a more structured and interpretive evaluation of digital education policies.

2.4. Conceptual Framework

The analytical framework of this study is grounded in the OECD Learning Framework 2030. This framework is used to assess the alignment of digital education policies with future competency development and sustainable well-being (OECD, 2018). The analysis focuses on the dimensions of anticipation, action, and reflection within the context of digital transformation. The structure of the analytical framework is presented in Table 1.

Table 1. Conceptual Mapping Table. Research Analytical Framework

Source of Analysis	Analytical Lens	Evaluation Focus	Conceptual Output
UNESCO, OECD, UNICEF, World Bank	OECD Learning Framework 2030	Access, Equity, Literacy, Youth Agency	Reconfigured Digital Education Policy for SDGs

Source: by Author

2.5. Scope of the Study

The scope of this study is limited to digital education policies at the global and national levels that are directly related to youth issues and sustainable development. The study is conceptual in nature and does not aim to produce empirical generalizations. The primary output consists of policy analysis and conceptual constructions that may serve as references for policy development and future research.

3. RESULT AND DISCUSSION

This discussion section is structured by referring to the OECD Learning Framework 2030 to analyze the interrelationship between digital education inequality, the formation of youth competencies, and support for the achievement of the Sustainable Development Goals.

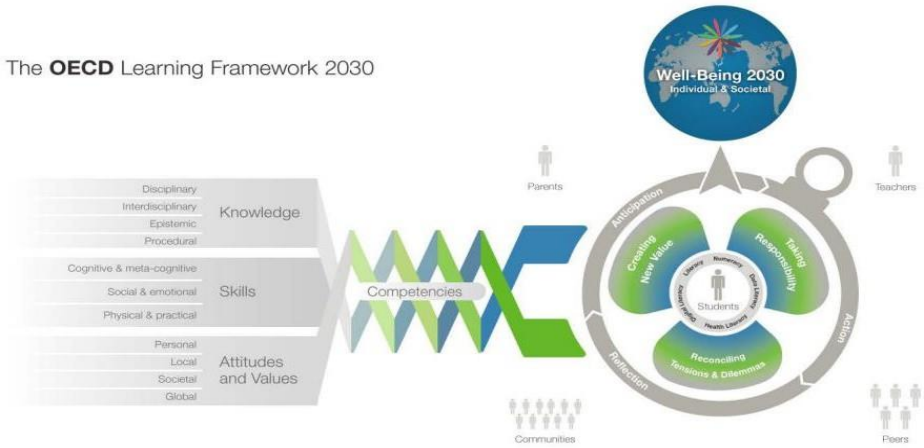

Figure 1. OECD Learning Framework 2030 as a Transformative Competency Framework Toward Well-Being 2030

Source: (OECD, 2018).

Figure 1 presents the OECD Learning Framework 2030 as the principal conceptual foundation used in this article to systematically interpret the relationship between digital education, the formation of youth capacities, and the pursuit of sustainable well-being. Within this framework, education is not treated as a narrow process of knowledge transmission, but as a strategic arena for developing transformative competencies that determine the ability of individuals and communities to respond to increasingly complex global change. The three core competencies emphasized in the framework, namely anticipation, action, and reflection, provide a critical basis for assessing whether digital education systems are genuinely capable of preparing young people to confront inequality, technological disruption, and the demands of sustainable development. On this basis, the OECD Learning Framework 2030 is employed in this article not merely as a normative reference, but as an analytical instrument to demonstrate that digital education inequality is fundamentally a structural problem that constrains the development of future-oriented competencies. When digital access remains uneven, policy operates in fragmented ways, and social justice is weakly embedded in educational transformation, digital education fails to function as a space for strengthening youth agency, adaptive capacity, and leadership. At this point, the urgency of reconfiguring digital education policy becomes explicit, because what is at stake is not simply the effectiveness of technology in learning, but the capacity of education systems to cultivate young people who are prepared to act, lead, and contribute meaningfully to the Sustainable Development Goals agenda (OECD, 2018).

Building on this framework, the issue of digital education cannot be approached partially or reduced to a merely technical concern, because its underlying causes are distributed across multiple interconnected levels, including access, literacy, institutional capacity, and policy design. For that reason, the analysis developed in this article requires a more systematic mapping to explain how structural challenges, policy limitations, and broader development consequences are linked within a single analytical frame. This step is necessary because fragmented readings of digital inequality have too often produced shallow and corrective responses that fail to address the actual roots of the problem. Digital education does not fall short only because of infrastructural limitations, but also because of weak system readiness, uneven distributions of capacity, and the absence of policy orientations that are substantively grounded in equity and participation. It is on this basis that Table 2 presents a conceptual synthesis of the main forms of digital education inequality and situates them directly within the framework of the Sustainable Development Goals at the global level. This mapping functions as the analytical foundation for the

subsequent discussion, particularly to show that digital education inequality is not a standalone sectoral issue, but a critical structural node that shapes educational quality, equity of opportunity, innovation capacity, and the broader trajectory of sustainable development.

Table 2. Structural Challenges of Digital Education and Their Implications for the SDGs

No	Dimension of Challenge	Analytical Description	Implications for the SDGs
1	Digital Access Gap	Approximately 1.3 billion children aged 3–17 do not have internet access at home, particularly in low-income countries, limiting participation in digital learning from an early age.	SDG 4, SDG 9, SDG 10
2	Digital Literacy and Skills Gap	Vulnerable groups, especially adolescent girls and poor youth, have lower digital skills, reflecting the second-level digital divide.	SDG 4, SDG 5, SDG 10
3	Inequality in Device Ownership	Limited availability of digital devices in poor households hampers sustained online learning and exacerbates learning loss.	SDG 4, SDG 10
4	Uneven Digital Infrastructure	Lagging broadband access, stable electricity, and supporting technologies in rural and remote areas reinforce digital education exclusion.	SDG 7, SDG 9
5	Policy Fragmentation and Weak Implementation	Lack of synchronization between central policies and local implementation capacity, including teacher training and data governance, limits the effectiveness of digital education policies.	SDG 4, SDG 17

Source: adapted from: UNICEF & ITU (2020); UNESCO (2026); OECD (2021); World Bank (2024).

Table 2 emphasizes that the challenges of digital education are multidimensional and interconnected, encompassing aspects of access, literacy, infrastructure, and policy governance. Each dimension shows a direct linkage to the SDG targets, particularly SDG 4, SDG 9, SDG 10, and SDG 17, indicating that digital education issues cannot be separated from concerns of social justice and sustainable development. This synthesis serves as an analytical foundation for further examining the structural roots of the problems and their implications for the formulation of digital education policy in the subsequent subsection.

3.1. Roots of Educational and Technological Challenges within the SDGs Framework

At the global level, one of the most fundamental roots of challenges in technology-based educational transformation is structural inequality in access to digital connectivity. This inequality occurs not only between countries, but also within national education systems, as reflected in variations in the digital readiness of students and educational institutions (van de Werfhorst, Kessenich & Geven, 2022). Data from UNICEF and ITU show that approximately 1.3 billion children aged 3–17 do not have internet access at home, with very sharp gaps based on socio-economic status (UNICEF & ITU, 2020). This condition directly hinders the achievement of SDG 4.1 and SDG 4.3, which target equitable and quality access to education, as well as SDG 9.1, which emphasizes the development of inclusive and sustainable infrastructure.

Furthermore, this digital gap is exacerbated by low digital literacy and exclusive socio-cultural factors. Various studies show that device ownership and internet access do not automatically translate into effective learning utilization if they are not accompanied by adequate digital competencies (Dodel & van Deursen, 2025). This phenomenon aligns with the concept of the second-level digital divide, in which differences in technology-use skills generate significant disparities in learning outcomes (Van Deursen & van Dijk, 2022). This inequality has a direct impact on SDG 4.4 related to the mastery of relevant skills for life and work, as well as SDG 5.b, which emphasizes the use of technology for women's empowerment, given the high level of digital exclusion among adolescent girls in low-income countries.

From a structural perspective, global economic and infrastructure limitations reinforce the reproduction of digital education inequality. Low- and middle-income countries face serious constraints in developing broadband networks and reliable connectivity, particularly in rural and remote areas. Cross-national empirical evidence shows that weak digital infrastructure directly affects the continuity and quality of online learning, even in developed countries during the pandemic period (Passey et al., 2024). This

phenomenon indicates that the achievement of SDG 9.c, which targets increased access to information and communication technologies, still faces significant barriers and has direct implications for the failure to fulfill SDG 4 equitably.

In addition to economic and technical factors, socio-cultural dimensions play an important role in deepening digital inequality in education. Language barriers, the dominance of digital content that is not locally contextualized, and low levels of technological literacy in marginalized communities render educational technology not fully inclusive. Empirical studies in developing countries show that disparities in digital literacy across regions and social groups contribute to gaps in learning opportunities (Widiasanti et al., 2025). Misalignment between education policy and national digital policy further worsens this situation, thereby hindering the achievement of SDG 10.2 related to social and educational inclusion, as well as SDG 4.5, which targets the elimination of disparities in education.

Conceptually, these findings affirm that digital education inequality is a multidimensional issue encompassing physical access, literacy, public policy, and broader socio-economic structures. Without integrated systemic interventions, digital transformation risks reinforcing existing inequalities rather than becoming an instrument of equity (Soomro et al., 2020; Dodel & van Deursen, 2025). Therefore, failure to address these structural roots will hinder the contribution of digital education to the achievement of SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 17 (Partnerships for the Goals), which require cross-sectoral and cross-national collaboration.

3.2. Impacts of the Challenges on the Next Global Generationa

Inequality in digital access and digital literacy generates micro-level consequences that are directly experienced by families, children, and learners, particularly in the form of disrupted rights to meaningful learning, widening gaps in early competencies, and narrowing opportunities for social mobility. Empirical evidence shows that insufficient digital readiness among students and educational institutions significantly reduces learning engagement and academic achievement, especially among vulnerable groups (de Werfhorst, Kessenich & Geven, 2022). This phenomenon was especially evident during school closures caused by the COVID-19 pandemic, when more than 1.6 billion learners experienced learning disruption and hundreds of millions of students lacked access to computers or internet connectivity at home (UNESCO, 2021; UNESCO, 2026). These conditions increased learning loss and the risk of school dropout, particularly for students from low-income families, thereby directly hindering the achievement of SDG 4.1 and SDG 4.5, which emphasize equitable access to education and equitable learning outcomes.

At the household level, the shift of learning responsibilities to families deepened pre-existing inequalities. Parents from lower socio-economic backgrounds often lacked both pedagogical capacity and digital resources to effectively support their children's learning. As a result, children from poor households experienced a double disadvantage: limited access to devices and minimal learning support at home. Studies on online learning show that these conditions correlate with increased absenteeism and dropout rates, particularly in higher education and online education contexts (Barragán Moreno & Guzmán Rincón, 2025; Rahmani et al., 2024). These impacts underscore that digital inequality has direct implications for SDG 10.2 related to social inclusion, as well as SDG 4 in ensuring equitable and inclusive education.

In the medium and long term, these challenges contribute to the formation of a generation characterized by skill gaps, particularly in digital literacy, technology-based problem solving, and cross-cultural collaboration. Research indicates that inequality in access to and use of educational technology results in significant differences in learning outcomes and workforce readiness, even after controlling for socio-economic factors (KC et al., 2025). Thus, issues that appear technical—such as connectivity and device availability—are in fact rooted in structural inequalities that reproduce intergenerational competency gaps. If left unaddressed, these conditions will constrain social mobility and widen opportunity gaps, thereby threatening the achievement of SDG 4.4, which targets the acquisition of relevant skills for future employment.

At the macro level, the impacts of these disparities are reflected in declining labor productivity, slower economic growth, and the intensification of social inequality. Studies on university students' digital

competencies show that low mastery of basic digital skills weakens graduates' readiness to enter an increasingly digitalized labor market (Burgos et al., 2023). This condition aligns with warnings from the OECD and the World Bank that shortages in digital skills contribute to skills mismatch, structural unemployment, and the predominance of low-quality jobs. Consequently, the achievement of SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) is constrained in the absence of a human resource base with equitable and adaptive digital competencies.

Furthermore, unequal digital access limits the potential for youth-led innovation, including the development of edutech startups, community-based solutions, and technology-driven social innovation. Empirical evidence shows that impactful innovation tends to emerge when young people have access to technology, digital skills, and supportive ecosystems that enable them to test and scale solutions (KC et al., 2025; van de Werfhorst, 2022). Therefore, closing the digital divide should not be understood merely as an infrastructure development agenda, but as a strategic investment in future skills and the formation of global citizenship. This approach constitutes a prerequisite for the integrated achievement of SDG 4, SDG 8, SDG 9, and SDG 10, while ensuring that digital transformation contributes to inclusive and sustainable development.

3.3. Critical Evaluation of Global and National Policies Related to EdTech

Global policies and programs that position technology as a primary instrument for educational transformation—such as UNESCO's education transformation agenda and the OECD's EdTech policy recommendations—provide a strong normative foundation for national education system reform. These global frameworks function as standard references for governance, evidence-based policymaking principles, and an orientation toward educational equity (UNESCO, 2023; OECD, 2021). Recent literature indicates that policies designed within clear frameworks are able to facilitate the systemic adoption of technology, particularly through strengthening data governance, digital literacy, and the integration of technology-based pedagogy in higher education (Chan, 2023; Gašević et al., 2019). From an SDGs perspective, the contribution of these global policies is most directly linked to SDG 4 (Quality Education), especially targets 4.3 and 4.4, which emphasize access to quality education and the strengthening of digital skills relevant to the labor market.

At the national level, many countries have translated these global frameworks into digital learning policies, competency-based curricula, and national learning platforms. Empirical evidence shows that such policies have been effective in increasing the scale of Learning Management System (LMS) adoption, the use of learning analytics, and the integration of digital literacy into formal education, particularly in higher education and urban areas (Gašević et al., 2019; Jayadi et al., 2025). Studies in Indonesia and other developing countries confirm that learning digitalization can improve the efficiency of learning management and expand the variety of learning resources (Laila et al., 2025; Husnul et al., 2025). However, these achievements remain uneven, and their impact on SDG 4.5 (eliminating disparities in education) has therefore not been optimal.

Unequal policy impacts constitute a central issue in the critical evaluation of EdTech. A number of studies show that the benefits of digital learning policies tend to be concentrated in schools and higher education institutions in urban areas and among middle- to upper-income socio-economic groups, while rural regions and marginalized communities lag behind in both access to and quality of technology utilization (Lestari et al., 2024; Drljić et al., 2025). This phenomenon underscores that technology adoption without pro-equity policy design has the potential to widen the digital divide, thereby contradicting the spirit of SDG 10 (Reduced Inequalities). Consequently, the success of EdTech policies cannot be measured solely by the level of technology adoption, but rather by their contribution to reducing learning outcome disparities.

Implementation weaknesses become more evident when analyzed at the level of institutional capacity and human resources. Teacher professional development programs are often short-term and technically oriented, lacking sustained pedagogical mentoring or evaluation of their impact on instructional practices (Hanifah et al., 2025; Bahrodin et al., 2025). In higher education, technology adoption also faces challenges related to data governance, system interoperability, and the ethical use of artificial intelligence

in learning (Chan, 2023). These limitations weaken policy contributions to SDG 4.c, which emphasizes improving teacher quality through relevant and continuous training.

Beyond pedagogical aspects, structural challenges related to digital infrastructure and access costs remain major barriers in many developing countries. Policy studies indicate that uneven broadband coverage, limited device availability, and high data costs result in technology adoption that is exclusive rather than inclusive (Lestari et al., 2024; Drljić et al., 2025). This condition highlights that EdTech policies must be positioned as part of a cross-sectoral sustainable development strategy, rather than merely as educational innovations. Without consistent infrastructure investment, digital learning policies will struggle to contribute to the achievement of SDG 9 (Industry, Innovation, and Infrastructure), which underpins SDG 4 and SDG 10 simultaneously.

Opportunities for improvement emerge through the strengthening of international and multi-actor collaboration. Partnerships among governments, EdTech private sectors, academia, and civil society organizations have proven effective in developing digital public goods, open educational resources, and locally contextualized learning models (Kadian & Rose, 2025). This approach enables the transfer of best practices across countries while maintaining sensitivity to social and cultural contexts. Within the SDGs framework, such collaboration directly contributes to SDG 17 (Partnerships for the Goals) as a prerequisite for achieving inclusive educational transformation.

Finally, the evaluation of EdTech policies requires more comprehensive and outcome-oriented indicators. Several studies emphasize the importance of developing equity-oriented indicators—such as a digital learning equity index that integrates access, digital skills, and learning outcomes—to assess the real impact of policies (Gašević et al., 2019; Drljić et al., 2025). Accordingly, the strength of global and national policies lies in their normative capacity and knowledge support; their weaknesses lie in implementation and governance; while their challenges are pragmatic in nature but can be addressed through pro-equity policies, sustained infrastructure investment, and evidence-based evaluation. This approach reaffirms EdTech as a strategic instrument for accelerating the achievement of SDG 4 and SDG 10 simultaneously, rather than merely an agenda of educational digitalization.

The analysis in the preceding subsection has identified three key findings that constitute the root causes of digital education challenges. First, structural inequality is not limited to infrastructure access but also encompasses uneven digital literacy, policy fragmentation, and weak implementation capacity at the local level. Second, the impact of this inequality is cumulative and intergenerational, widening digital competency gaps, limiting social mobility, and hindering youth contributions to sustainable development. Third, critical evaluation of global and national policies reveals that technocratic, top-down approaches tend to marginalize youth participation as strategic actors, resulting in solutions that lack contextual relevance and sustainability. Together, these three findings lead to a fundamental conclusion: restructuring digital education policy cannot be achieved through technical adjustments alone; it requires a paradigm shift that positions youth leadership as the axis of transformation. In other words, young people must no longer be positioned merely as beneficiaries or objects of policy intervention, but as subjects who design, manage, and drive digital education innovation in alignment with the needs of their communities.

Building on this justification, the following section formulates four innovative policy models that directly respond to the root problems identified. These four models are designed on the principle that youth leadership serves as the core driver across all stages of implementation, while simultaneously addressing the multidimensional challenges of access, literacy, institutional capacity, and equity. Thus, the policy recommendations presented are not stand-alone technical interventions but represent a logical operationalization of the preceding analytical findings within the framework of achieving the Sustainable Development Goals (SDGs).

3.4. Youth EdTech Innovation Hubs (YEIH) — AI- and Data-Based Youth Innovation Ecosystem

Theoretical basis: UNESCO (2023) emphasizes that impactful innovation emerges from ecosystems providing access to technology, mentors, and collaborative spaces. OECD (2021) also shows that innovation hubs increase the likelihood of developing locally relevant solutions.

Problem Linkage: YEIH directly targets the root problems of policy fragmentation and lack of local relevance (Table 2, dimension 5) and innovation gaps between regions. Current EdTech policies tend to be top-down and technocratic, producing solutions misaligned with the specific needs of vulnerable communities. YEIH addresses this by building innovation capacity at the grassroots level.

Intervention Logic: Change does not begin with technology deployment but with strengthening youth agency through AI-and data-driven collaborative spaces. The intervention logic is to create an endogenous innovation cycle: local needs are identified by youth, solutions are co-developed and tested in hubs, and the results feed back into curriculum and policy development. This shifts the role of youth from policy objects to subjects who shape innovation direction.

Systemic Implication: The systemic implication is decentralisation of policy innovation. When such hubs are widely distributed, they function as living labs that generate contextual evidence. This enables national digital education policies to become more adaptive, grounded in local data, and directly contributes to reducing inter-regional innovation gaps (SDG 9, SDG 10), while simultaneously building sustainable youth leadership (SDG 4, SDG 8).

Youth EdTech Innovation Hubs (YEIH) are designed as a strategic approach to address the limitations of digital education, which have traditionally focused on technology adoption without strengthening the innovative capacities of youth. This model positions youth as key actors within the digital education ecosystem by providing collaborative spaces based on AI and data, enabling the development of contextual, adaptive, and locally needs-based edutech solutions. Theoretically, this approach aligns with the innovation ecosystem frameworks of UNESCO (2023) and OECD (2021), which emphasize the importance of integrating technology, mentoring, and cross-actor collaboration to foster sustainable educational innovation.

In its implementation, YEIH integrates mini AI laboratories, co-creation of digital curricula, youth startup incubation, and global mentoring into a unified policy based on digital public goods. This scheme has the potential to accelerate youth leadership development, strengthen local problem-solving in education, and reduce innovation disparities across regions. With multi-stakeholder support—including schools, governments, international organizations, and the technology industry—YEIH functions as a policy instrument relevant for promoting the integrated achievement of SDG 4, SDG 8, SDG 9, and SDG 17.

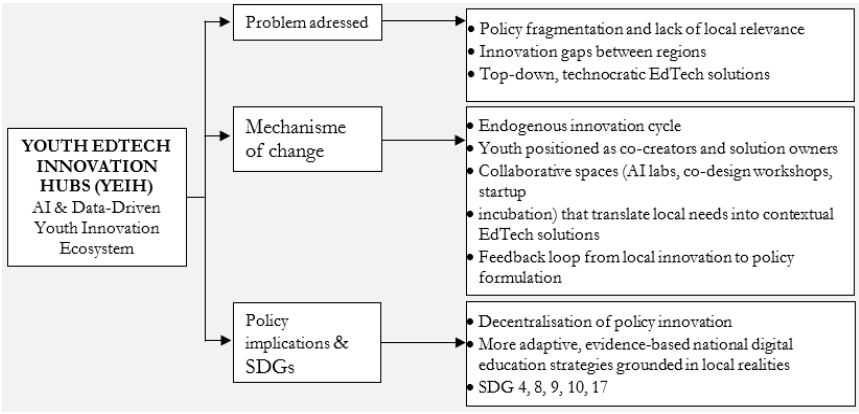

Figure 2. Implementation and Youth Roles in Youth EdTech Innovation Hubs (YEIH)

Source: by Author

In Figure 2 Within the scope of implementation, YEIH emphasizes governance and ethics principles, including transparency in data usage, inclusivity, and social responsibility in innovation. Evaluation indicators include the number of innovations produced, quality of co-created curricula, level of cross-national participation, and impact on reducing digital education gaps. Thus, youth are positioned as strategic actors driving the entire innovation cycle—from design to implementation—making them key agents of systemic change within the digital education ecosystem.

3.5. Adaptive Learning Equity Network (ALEN) — AI-Based Adaptive Learning Platform for Vulnerable Areas

Theoretical Basis: UNESCO (2023) shows that adaptive technology can improve learning outcomes by adjusting content in real time to students' abilities and needs. The World Bank (2024) also emphasizes that AI-based personalization can help reduce learning loss and narrow educational disparities. Therefore, adaptive platforms should be positioned as strategic instruments for improving learning quality while advancing educational equity.

Problem Linkage: ALEN addresses three challenge dimensions simultaneously: access gaps (dimension 1), digital literacy gaps (dimension 2), and infrastructure inequalities (dimension 4). The model acknowledges that physical access to devices is insufficient without pedagogical approaches capable of accommodating students different starting points.

Intervention Logic: ALEN's intervention logic is to shift the paradigm from uniformity to equity-driven personalisation. The adaptive platform serves as a tool to diagnose and respond to individual student needs in real time. Youth, recruited and trained as local facilitators, play a crucial role in bridging technology with socio-cultural contexts, ensuring that algorithmic personalisation remains relevant and non-discriminatory. Thus, the mechanism of change is the coupling of artificial intelligence and local intelligence.

Systemic Implication: The policy implication is a shift in focus from merely providing infrastructure (SDG 9) toward guaranteeing equitable learning outcomes (SDG 4). ALEN's success is measured not by the number of distributed devices but by the reduction in learning outcome gaps between urban and remote areas. The model demands new policy indicators that measure technology's effectiveness in achieving educational justice (SDG 10).

Adaptive Learning Equity Network (ALEN) is an AI-based adaptive learning platform designed to minimize educational gaps in vulnerable regions. The system adjusts content to student ability in real time, allowing personalized learning for thousands of students. UNESCO (2023) shows content adaptation can improve learning outcomes by 25–30%. The World Bank (2024) confirms that adaptive AI effectively closes learning loss of 20–40% in 3T schools. ALEN positions youth as strategic actors in platform design and learning facilitation, making them local change agents and digital data managers.

ALEN implementation is phased and measurable. Phase one involves surveying digital needs in 50–100 3T schools while distributing 500–1,000 digital learning devices and local content. Phase two trains around 200–300 teachers and 150–200 youth volunteers as digital learning facilitators over 4–6 intensive weeks. Phase three applies the adaptive platform to 3,000–5,000 students per school with AI dashboard-based monitoring. Lightweight servers support adaptive AI and digital curriculum integration. Youth act as co-designers, local facilitators, and content managers. Quarterly evaluations assess student progress, teacher engagement, and data quality. Multi-stakeholder collaboration ensures scalable and realistic implementation.

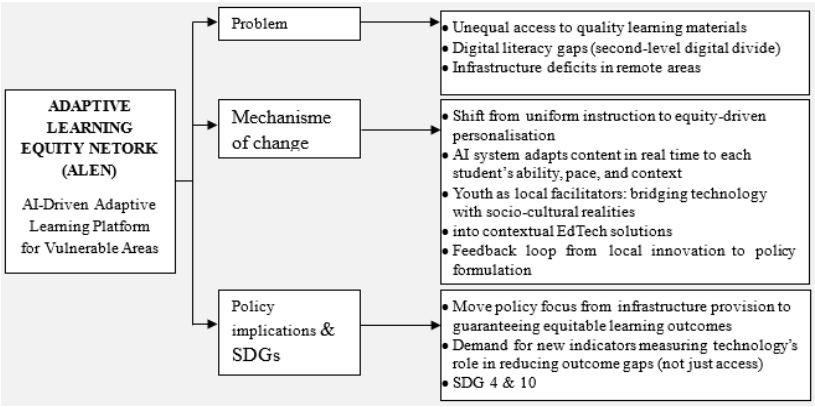

Figure 3. Implementation Stages of Adaptive Learning Equity Network (ALEN) and Youth Roles

Source: by Author

In Figure 3 the benefits of ALEN can be measured quantitatively. Student learning gaps are estimated to decrease by 30–40% within 3–5 years. Student engagement is expected to increase by up to 50%, while teacher digital literacy improves by at least 40%. These impacts demonstrate that adaptive interventions have tangible effects on the quality of education in vulnerable regions.

Governance and ethical principles form the foundation of ALEN. All student data are encrypted to ensure privacy. Adaptive algorithms are evaluated for fairness and accuracy. Platform access is inclusive, and technology use is conducted responsibly. Impact evaluation is carried out quarterly with measurable indicators, ensuring program effectiveness and minimizing risks. This approach positions ALEN not merely as technology, but as a sustainable intervention that strengthens local capacity and educational equity.

Youth occupy a strategic role within ALEN. They manage and facilitate the platform for 3–5 thousand students, monitor learning progress, and adjust content according to local needs. This role builds community leadership and technological capacity. Youth not only implement the program but also innovate and optimize solutions. Thus, their presence ensures sustainability, enhances digital literacy, and makes ALEN a strategic instrument for educational equity and youth empowerment.

3.6. Blockchain Credential for Youth Skills (BCYS) — Global Competency Certification Based on Blockchain

Theoretical Basis: OECD (2021) highlights the importance of portable digital credentials that can be verified to strengthen skills mobility and equity. Blockchain enables anti-fraud certificates that are easily verifiable across countries.

Problem Linkage: BCYS targets the root problem of low digital literacy and limited work readiness (Table 2, dimension 2), which has long restricted young people's social mobility. Fragmented, easily counterfeited traditional certification systems cannot provide broadly recognised competency guarantees, thereby widening inequality.

Intervention Logic: The intervention logic is giving young people full control over their competency identity. With blockchain technology, each individual owns a verifiable skills portfolio that can be transparently accessed by educational institutions or employers anywhere. The mechanism of change is eliminating information asymmetry between job seekers and employers, and strengthening incentives for youth to accumulate credibly documented digital and non-technical competencies (global citizenship, green skills).

Systemic Implication: The systemic implication of BCYS is reforming competency recognition structures. Education and employment policies must become integrated. The model encourages the creation of a more transparent and meritocratic labour market where recruitment is based on verified competencies rather than institutional background or social connections. This directly strengthens contributions to SDG 8 (Decent Work) and SDG 17 (Global Partnerships) by establishing cross-border credential standards.

Blockchain Credential for Youth Skills (BCYS) is a global competency certification scheme based on blockchain that provides youth with portable, transparent, and internationally verifiable digital credentials. This approach explicitly emphasizes skills equity and labor mobility, in line with OECD (2021) findings, through an anti-fraud system and a digital portfolio autonomously managed by youth. BCYS positions young people as strategic competency managers, making them active subjects within the global skills ecosystem rather than mere recipients of certification.

BCYS implementation is carried out through the integration of a blockchain-based automatic verification system, digital skills passport, AI courses, coding, green skills, and global citizenship, as well as an open API for educational institutions and industry. The scheme is executed via the development of a national education ledger, pilot projects in universities or vocational schools, the launch of digital skills passports for youth aged 15–24, and global partnerships to ensure certificate recognition in international labor markets. Collaboration among governments, industry sectors, global certification bodies, and NGOs positions BCYS as an effective policy instrument to enhance transparency, skills recognition, and cross-border workforce readiness.

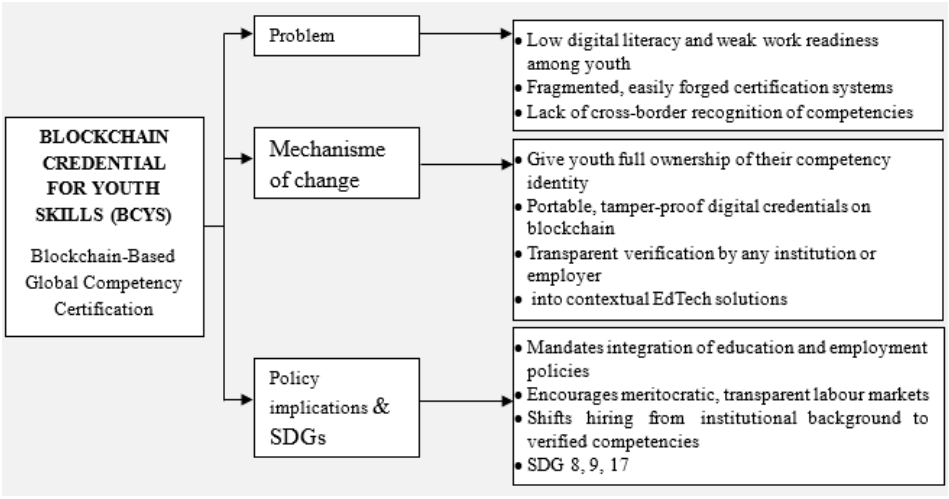

Figure 4. Implementation Stages of Blockchain Credential for Youth Skills (BCYS)

Source: by Author

In Figure 4 within the implementation context, BCYS adheres to strict governance and ethical principles: data security and privacy, validity and reliability of certificates, and inclusive access for all youth. Evaluation indicators include the number of verified certificates, quality of skills portfolios, institutional adoption rates, and impact on international labor mobility. These principles ensure that credentials are not only technically valid but also deliver tangible and sustainable socio-economic outcomes.

Youth are positioned as the primary strategic actors in BCYS, fully responsible for building, managing, and leveraging their competencies to meet the demands of the global market. Thus, BCYS serves as an empowerment instrument that strengthens youth strategic capacities, fosters skills innovation, and accelerates their contribution to sustainable economic and social development.

3.7. IoT-Driven Learning Access Initiative (ILAI) — IoT-Based Education Access for Remote Communities

Theoretical basis: Empirical & theoretical basis:Limited digital infrastructure is a primary cause of learning inequality; UNICEF & ITU (2020) reports that billions of children lack home internet access. IoT can provide micro-connectivity through low-cost devices and mesh networks.

Problem Linkage: ILAI specifically targets the uneven digital infrastructure gap (Table 2, dimension 4). The model recognises that uniform top-down approaches fail to overcome geographical and economic barriers in remote, frontier, and outermost regions.

Intervention Logic: ILAI's intervention logic is providing micro-connectivity that is self-sustaining and locally managed. Instead of waiting for national infrastructure, the model uses low-cost, solar-powered Internet of Things (IoT) technology to build community mesh networks. The mechanism of change is infrastructural subsidiarity: technology management and maintenance are entrusted to locally trained youth, creating an autonomous and resilient digital ecosystem that does not rely on external connectivity. This shifts the paradigm from "connecting remote areas" to "empowering remote areas to connect themselves."

Systemic Implication: The policy implications are broad: integrating digital education agendas with renewable energy development (SDG 7) and strengthening local economies. ILAI demonstrates that digital education policy must be part of a holistic regional development strategy. By creating local technicians, the model not only provides learning access (SDG 4) but also generates technology-based employment in previously marginalised areas, directly reducing structural inequality (SDG 10).

The IoT-Driven Learning Access Initiative (ILAI) is designed as a strategic response to educational disparities in remote regions. Limited digital infrastructure has long been the main barrier to learning

access. Many communities remain behind while technology advances rapidly. IoT offers a cost-effective micro solution, but it must be implemented wisely. Youth are positioned as local managers and primary drivers. They are not merely beneficiaries but actors determining program sustainability. The success of ILAI depends on the integration of technology with adaptive local capacity.

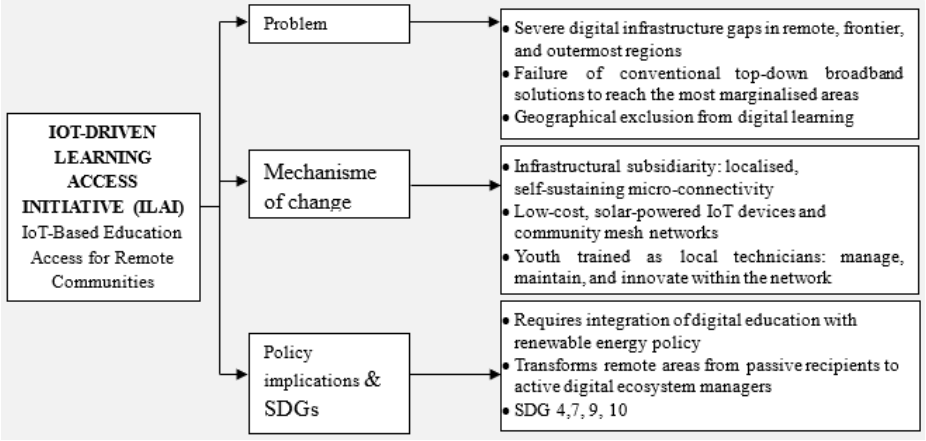

Figure 5. Implementation and Measurable Indicators of the IoT-Driven Learning Access Initiative (ILAI)

Source: by Author

In Figure 5 the implementation of ILAI is planned in a phased and systematic manner. Phase one involves mapping areas without connectivity to accurately target micro-hubs. Phase two entails constructing solar-powered micro-learning hubs that are energy self-sufficient. Phase three focuses on installing IoT routers to establish a resilient local mesh network. Phase four covers the distribution of offline content capsules for LMS and instructional videos. Phase five involves training village youth as local IoT technicians to manage the infrastructure. Phase six integrates learning content with a system for monitoring learning quality. Phase seven emphasizes continuous evaluation and program scaling with support from government, NGOs, and technology providers.

The benefits of ILAI are immediately observable at the community level. Micro-learning hubs provide access to education even without stable internet. The program reduces digital exclusion and opens opportunities for equitable learning for all students.

Within the implementation context, governance and ethical principles form the foundation. Device and data security must be rigorously maintained. Micro-hub operations should be sustainable and transparent. Access to education must be inclusive and non-discriminatory. The use of data and technology must be responsible. Regular evaluation is crucial to ensure tangible impact. These principles prevent interventions from causing harm to communities.

ILAI's success indicators are clear and measurable. The number of operational micro-hubs, the quality of local mesh networks, and student participation serve as direct measures of effectiveness. The success of training youth as technicians demonstrates the formation of local capacity. The long-term impact on reducing digital disparities between regions serves as a key indicator of program relevance.

Youth occupy a strategic position within ILAI. They act as managers, maintainers, and local innovators. This role builds community technology and leadership capacity. Youth not only operate the program but also assess, adjust, and develop solutions according to local contexts. Their involvement supports long-term sustainability and equitable access to education. ILAI strengthens digital connectivity, creates local capacity, and aligns with the achievement of SDG 4, SDG 7, SDG 9, and SDG 10.

Table 3. Summary Table of Conceptual Policy Models

Policy Model	Problem Addressed	Mechanism of Change (Conceptual)	Policy Implication	Related SDGs
YEIH	Policy fragmentation; lack of local relevance; innovation gaps.	Endogenous innovation: youth as solution creators based on local needs through collaborative ecosystems.	Decentralisation of policy innovation; adaptive policies grounded in local evidence.	SDG 4. 8, 9, 10, 17
ALEN	Access and literacy gaps; infrastructure inequality.	Equity-driven personalisation: coupling artificial intelligence with local facilitation to achieve equitable learning outcomes.	Policy focus shift from infrastructure provision to ensuring equitable learning outcomes.	SDG 4, 10
BCYS	Low digital literacy; limited work readiness; fragmented competency recognition.	Giving youth ownership of their competency identity through portable, transparent blockchain-based credentials.	Integration of education and employment policies; creation of a transparent, meritocratic labour market	SDG 8, 9, 17
ILAI	Uneven digital infrastructure; geographical exclusion.	Infrastructural subsidiarity: provision of self-sustaining micro-connectivity managed locally by youth.	Integration of digital education with renewable energy and local economic development.	SDG 4,7, 9, 10

In Table 3 the four conceptual models above YEIH, ALEN, BCYS, and ILAI are not technical blueprints but analytical abstractions that centre digital education policy on two main principles: equity and youth leadership. Each model addresses a distinct structural bottleneck (innovation fragmentation, rigid pedagogies, non-portable credentials, infrastructural exclusion) through a shared mechanism: positioning young people as policy co-designers, not merely as beneficiaries. Collectively, these models demonstrate that policy reconfiguration must shift from the question of "how to implement technology" toward "how to build educational ecosystems that make technology, guided by youth agency, an instrument of social justice and sustainable development." Their analytical value lies in reframing policy logic, not in technical specifications.

4. CONCLUSION

This article demonstrates that digital education inequality is not an isolated technical issue, but a structural problem rooted in unequal access, weak digital literacy, limited device availability, uneven infrastructure, policy fragmentation, and low implementation capacity. These conditions prevent digital education from functioning as a fair, inclusive, and transformative learning system capable of preparing young people to face increasingly complex global change. Through the analytical lens of the OECD Learning Framework 2030, this article argues that the crisis of digital education cannot be understood merely as a matter of technology provision, but as a policy failure in fostering the transformative competencies of young people, particularly their capacity to anticipate change, act adaptively, and critically reflect on future challenges. Based on these findings, this article asserts that youth leadership must be repositioned from being merely an object of policy intervention to becoming a central axis in the transformation of digital education policy. Accordingly, the main finding of this article shows that reconfiguring digital education policy through youth leadership constitutes an urgent conceptual and policy imperative for bridging the gap between the global agenda of educational transformation and the realities of exclusion, inequality, and youth marginalization within digital education systems.

On this basis, this article proposes four policy models as an interconnected framework for reform that directly addresses the structural problems identified throughout the analysis. The Youth Edutech Innovation Hubs (YEIH) model responds to the limited space for participation and innovation by positioning young people as designers of contextual and locally relevant digital education solutions. The Adaptive Learning Equity Networks (ALEN) model addresses unequal learning conditions by promoting digital learning systems that are more adaptive, responsive, and sensitive to differences in students' abilities

and needs. The Blockchain Credentialing for Youth Skills (BCYS) model responds to the lack of recognition of young people's non-formal and informal competencies within formal education systems and labor markets. Meanwhile, the Inclusive Learning Access Initiative (ILAI) model directly addresses exclusion rooted in inequalities of infrastructure, affordability, and access across marginalized communities. Taken together, these four models demonstrate that the policy interventions required cannot be partial or sectoral in nature, but must be constructed as an integrated, equity-oriented, and long-term policy architecture. In this context, the main theoretical contribution of this article lies in advancing youth leadership as a policy lens for reinterpreting digital education not merely as a technological issue, but as a field of social justice, participation, and sustainable development, while its practical contribution lies in providing a conceptual framework that can guide the reform of digital education policy in closer alignment with the Sustainable Development Goals agenda.

Ethical Approval

This study did not require ethical approval as it relied entirely on secondary data sources, including policy documents, official publications, and conceptual frameworks from reputable international organizations (UNESCO, OECD, UNICEF, World Bank). All sources were publicly accessible or obtained through institutional access, following ethical standards for literature-based research.

Informed Consent Statement

Not applicable, as this study did not involve primary data collection or human subjects. All data were obtained from publicly available secondary sources.

Authors' Contributions

Theoretical Conceptualization, Analytical Framework Development, Methodological Design, Policy Document Investigation, Data Curation & Management, Critical Policy Analysis, Comparative Institutional Analysis, Theoretical Synthesis & Literature Integration, Conceptual Reconstruction, Argumentative Validation & Normative Coherence Assessment, Conceptual Visualization, Writing – Original Draft Preparation, Writing – Critical Review & Substantive Editing, Scholarly Resource Acquisition & Verification, and Academic Project Administration by M. I. M. K. A.
Policy Document Investigation, Data Curation & Management, Critical Policy Analysis, Comparative Institutional Analysis, Theoretical Synthesis & Literature Integration, and Conceptual Reconstruction by M. F. R., N., I. R. S., and Z. A.

Disclosure Statement

The author declares no potential conflict of interest related to this study.

Data Availability Statement

All data analyzed in this study are derived from publicly available sources and documents published by UNESCO, OECD, UNICEF, and the World Bank. Specific references are cited in the reference list. Data can also be provided upon reasonable request to the corresponding author.

Funding

No funding.

Notes on Contributions

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