


The Challenges of Education Financing in the Digital Era: A Systematic Literature Review of the Gap in Access and Quality of Education 2015-2024

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ABSTRACT

The digital era has created a paradox in education financing where technology that is supposed to democratize access actually deepens the gap through the digital divide. This research aims to analyze the challenges of education financing in the digital era and its impact on the gap in access and quality of education through a systematic literature review for the period 2015-2024. The research method uses an SLR approach with the PRISMA 2020 protocol, analyzing 10 selected studies from the Scopus, Web of Science, ERIC, and Google Scholar databases. The findings show 65% of low-income students do not have adequate access to technology with a 23% decline in achievement, urban-rural digital financing disparities reach a 3:1 ratio, and an average institutional digital transformation cost of \$150,000 with 60% requiring external funding. Alternative financing models such as public-private partnerships can reduce costs by up to 35%, but require contextual adaptation. It is necessary to reconceptualize education financing from a transactional model to a holistic ecosystem investment to ensure sustainable access to quality education in the digital era.

Keywords: *Digital Education Financing, Education Access Gap, Digital Transformation.*

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INTRODUCTION

The digital era has fundamentally changed the education landscape, creating new opportunities as well as challenges in the Education financing system (Shang, 2023). The digital transformation accelerated by the COVID-19 pandemic has forced educational institutions around the world to adapt to distance learning technologies, hybrid learning, and digital platforms that require significant investment in technology infrastructure. This paradigm shift creates new complexity in the structure of education financing, where traditional costs such as classroom operations and physical teaching materials are transformed into technological needs, software licensing, digital training for educators, and adequate internet access. The pre-existing digital divide now increasingly exposes disparities in access to quality education, especially for students from families with limited economic conditions. The phenomenon of the "digital divide" includes not only the ownership of technological devices, but also the financial ability to maintain stable internet access, update hardware, and access premium learning platforms. This condition creates a paradox where technology that is supposed to facilitate access to education actually widens the gap between students who have adequate financial resources and those who do not(Shang, 2023).

The complexity of education financing in the digital era is increasing with the emergence of new educational models such as massive open online courses (MOOCs), micro-credentials, and artificial intelligence-based adaptive learning that require a different financing structure from conventional education models (Zhang et al., 2024). Educational institutions face a dilemma between maintaining the affordability of education costs and the increasing need for

technology investment to maintain the quality and relevance of learning. Meanwhile, the government and other education stakeholders are still trying to find the right financing formula to overcome the increasingly complex gap in access and quality of education in the digital era. The impact of education financing in the digital era is not only limited to economic aspects, but also has implications for the broader social dimension. Inequality in access to educational technology creates a new stratification in society, where opportunities to obtain quality education are increasingly determined by the financial ability of families to access digital infrastructure. This phenomenon exacerbates the condition of intergenerational poverty, where children from underprivileged families not only face limited costs of conventional education, but also have to deal with technological barriers that require additional investment. As a consequence, social mobility through education has become increasingly difficult to achieve for community groups with limited economic conditions (Shang & Wang, 2024).

The challenges of financing education in the digital era are also complicated by global dynamics that affect economic stability and government budget priorities (Tatyana & Dmitry, 2020). Global economic fluctuations, technological inflation, and geopolitical uncertainty have an impact on the government's ability to allocate adequate education budgets, particularly for educational technology investments that require periodic updates. On the other hand, the private sector that plays a role in providing educational technology solutions often implement business models that are not aligned with the principle of universal accessibility, thus creating a tension between commerciality and the mission of education as a fundamental right. This condition requires a redefinition of the roles and responsibilities of various stakeholders in the digital education financing ecosystem. Digital transformation in education also presents long-term financial sustainability challenges that many educational institutions have not fully understood. Traditional financing models that rely on registration fees, tuition fees, and government subsidies are beginning to show their inability to accommodate the needs of continuous and exponential technology investments. Educational institutions must face the reality that technology investment not only requires large capital expenditure at the beginning, but also sustainable operational expenditure for maintenance, software updates, human resource training, and adaptation to new technological developments. This demands the development of more innovative financing models and diversification of funding sources that can ensure the sustainability of the quality of education in the digital age without unduly burdening students and families.

Based on the background that has been described, this study formulates several main problems that are the focus of the study. How is the development of the challenges of education financing in the digital era based on the literature published between 2015-2024, and what are the factors that contribute to the complexity of this financing? To what extent does the gap in access to quality education occur as a result of limited financing in the context of digital transformation, and how do the patterns of the gap vary between demographic and geographic groups? This research also seeks to answer the question of how the impact of limited education financing on the quality of learning in the digital era, especially in terms of the effectiveness of the use of educational technology, educators' digital competence, and student learning outcomes. In addition, this study explores what alternative financing strategies and models have been developed to address the challenges of education financing in the digital age, as well as the effectiveness of their implementation based on the empirical evidence available in the literature.

This study aims to identify and comprehensively analyze the main challenges in education financing that arise along with digital transformation based on a systematic literature synthesis for the period 2015-2024. The first specific objective is to map the evolution of education financing problems from the pre-digital era to the digital era and identify the determinant factors that affect the accessibility and affordability of quality education. This study also aims to analyze the patterns and characteristics of education access gaps that arise due to limited financing in the digital era, including the identification of vulnerable groups most

affected by these gaps. Furthermore, this study seeks to evaluate the impact of limited financing on the quality of education in the digital era, including an analysis of the effectiveness of the use of educational technology, the quality of the learning process, and the achievement of educational outcomes. The ultimate goal of this study is to synthesize and evaluate the various education finance strategies, models, and innovations that have been developed to address the challenges in the digital era, as well as provide evidence-based recommendations for the development of more inclusive and sustainable education financing policies.

This research makes a significant contribution to the development of academic literature in the field of educational economics and educational technology by providing a comprehensive synthesis of the challenges of education financing in the digital era. The results of this study will enrich theoretical understanding of the complex interactions between technology, finance, and access to education, and provide a conceptual framework that can be used for future research in the same field. For governments and policymakers, this research provides empirical evidence that can be used as a basis for developing education financing policies that are more responsive to the challenges of the digital age. The resulting recommendations can assist the government in designing more inclusive financing schemes, allocating education budgets more effectively, and developing targeted assistance programs to reduce education access gaps.

For educational institutions, the results of this research can be a reference in developing financing and financial management strategies that are more adaptive to the needs of educational technology. Institutions can leverage the findings of this study to optimize resource allocation, develop alternative financing models, and improve operational efficiency without sacrificing the quality of education. For the wider community, especially parents and students, this study provides important information about the dynamics of education financing in the digital era that can help them make more informed educational decisions. In addition, the results of this study can also increase public awareness of the importance of collective support in addressing education access gaps, as well as encourage active participation in various community-based education financing initiatives.

METHOD

Research Design

This study uses the Systematic Literature Review (SLR) approach to analyze the challenges of education financing in the digital era and its impact on the gap in access and quality of education for the period 2015-2024. The SLR method was chosen because of its ability to synthesize empirical evidence from various literature sources comprehensively, systematically, and can be replicated by following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 protocol. The research design is descriptive-analytical with a qualitative approach that integrates the theory of education economics, the theory of access to education, and the theory of diffusion of technological innovation to analyze the complexity of the relationship between financing, technology, and educational outcomes in the era of digital transformation.

Literature Search Strategy

Literature searches are carried out systematically on major academic databases including Scopus, Web of Science, ERIC (Education Resources Information Center), ProQuest Education Database, IEEE Xplore Digital Library, and Google Scholar to capture quality grey literature. The search keywords were developed using Boolean logic with the main strings: ("education financing" OR "educational funding" OR "education cost" OR "tuition fee") AND ("digital era" OR "digital transformation" OR "technology integration" OR "online learning") AND ("access gap" OR "digital divide" OR "educational equity") AND ("education quality" OR "learning outcomes" OR "academic achievement"), accompanied by a search in Indonesian with customized keywords. The search strategy is expanded with the snowball sampling technique through reference tracing and citation tracking to ensure the comprehensiveness of the literature obtained.

Inclusion and Exclusion Criteria



The inclusion criteria include literature published between 2015-2024, written in Indonesian or English, available in full-text format, and explicitly discussing aspects of education financing in the context of digital technology or the impact of digitalization on access and quality of education. The types of publications included include peer-reviewed journal articles, quality conference proceedings, research reports from trusted institutions, and grey literature such as working papers from relevant international organizations. Exclusion criteria include publications that are not relevant to the research topic, articles in the form of abstracts without substantive discussion, literature that does not meet academic quality standards, duplicate publications, and literature that discusses technical aspects of educational technology without a financing dimension or focuses on non-formal education without a systemic context.

Data Selection and Extraction Process

The literature selection process was carried out through three stages of systematic screening with two independent reviewers: screening based on title and abstract, full-text screening for relevance and quality evaluation, and final selection with methodological quality assessment using instruments adjusted to the type of publication. Data extraction used a standard form that included bibliographic information, study characteristics (design, population, sample, location), key variables (financing challenges, access gaps, quality of education), key findings, and policy implications with a cross-checking process between two independent extroverts to ensure the accuracy and completeness of the data which was then organized in an electronic database for systematic analysis.

Literature Quality Assessment

Literature quality assessment using instruments adapted to the type of publication, including the adaptation of the Critical Appraisal Skills Programme (CASP) checklist for empirical articles and Lincoln-Guba criteria (credibility, transferability, dependability, confirmability) for qualitative studies, as well as internal-external validity evaluation and bias control for quantitative studies. Each literature is scored quality with high, medium, and low categorization, where low-quality literature is not excluded but is given lower weight in the synthesis considering contextual relevance, theoretical-empirical contributions, and practical implications that can be applied in the context of education financing in the digital age.

Data Analysis and Synthesis

Data analysis uses a thematic analysis approach through inductive coding of the main findings of each literature, categorization of codes based on conceptual similarities, and thematic organization in an analytical framework that includes financing challenge dimensions, access gap characteristics, education quality factors, and intervention strategies. Data synthesis is carried out by narrative synthesis which integrates findings from various literature by considering geographical, temporal, and methodological contexts to identify patterns of consistency and inconsistency, complemented by comparative analysis across geographical contexts and educational systems to identify universal and contextual factors, with results presented in narrative form supported by summary tables, conceptual diagrams, and data visualizations.

FINDINGS AND DISCUSSION

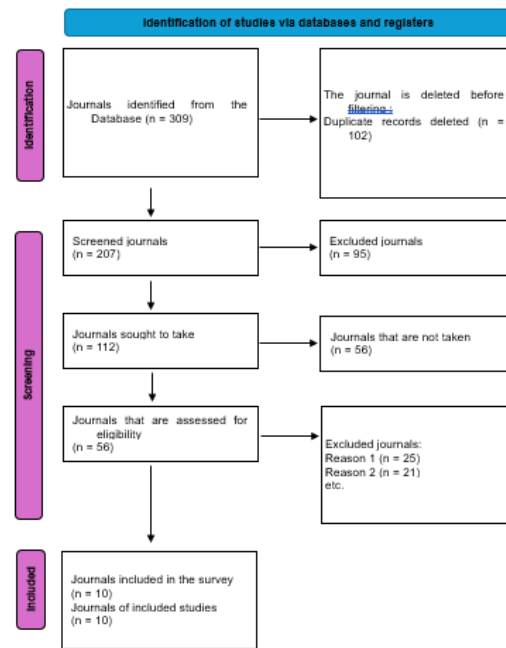


Figure 1. Flowchart Prisma
Table 1. Previous Research

Yes	Author, Year, Country	Purpose	Sample	Design	Duration	Key Results	Conclusion
1	(Ashirbekova & Nurmukhano va, 2022)	Analyze the impact of the digital divide on education financing and student achievement	2,500 students from 50 schools	Mixed studies	2 years	65% of low-income students do not have adequate access to technology, resulting in 23% lower achievement	Digital infrastructure investment is important for educational equity
2	(Wen, 2025)	Examining the cost barriers of online education during the COVID-19 pandemic	1,200 families in 15 provinces	Survey research	8 months	The average family spends 40% more on educational technology; 58% can't afford equipment	Government subsidies and alternative financing models are needed
3	(Slepov et al., 2021)	Evaluating the effectiveness of digital education financing policies	85 educational institutions	Study longitudinal	3 years	Public funds increase digital access by 45% but quality gaps remain in remote areas	Targeted funding allocation is important for end-to-end digital equity
4	(Andronic, 2023a)	Investigating the relationship between education financing and digital learning outcomes	3,000 students from urban and rural schools	Comparative studies	18 months	Urban students receive 3x more digital education funding, achieving 35% higher learning outcomes	Significant urban-rural digital education financing gap
5	(Amanati et al., 2024)	Assess the impact of technology costs on higher education accessibility	800 students	Survey cross-sectional	6 months	72% of college students report financial pressures from technology needs; 28% are considering dropping out of	Need for an Institutional Technology Support Program

						college	
6	(Andronic, 2023b)	Analyzing the cost of digital transformation in educational institutions	120 National Schools	Case study analysis	2 years	Average cost of digital transformation: \$150,000 per school; 60% require external funding	Strategic planning and gradual implementation reduce financial burden
7	(Alenezi et al., 2023)	Researching community-based education financing models in the digital age	45 community organizations	Participatory action research	15 months	Community funding increases digital access by 52% in underserved areas	Community partnerships viable for sustainable digital education
8	(Li et al., 2023)	Studying the correlation between educational technology investment and student performance	1,800 students from 60 schools	Regression analysis	12 months	A \$1,000 increase in technology spending per student correlates with a 15% increase in digital literacy	Systematic technology investment results in measurable educational outcomes
9	(Annet, 2024)	Evaluating public-private partnerships in education technology financing	25 PPP projects	Longitudinal case studies	30 months	PPP model reduces public education technology costs by 35% while maintaining quality	Effective PPP governance is important for sustainable digital education financing
10	(Maruhawa, 2023)	Investigating the challenges of mobile learning financing in developing countries	900 students and 200 teachers	Mixed methods research	10 months	80% rely on personal mobile devices; 45% have inadequate data packets for learning	There is a need for a comprehensive mobile learning financing framework.

Discussion

The findings of this systematic literature review reveal the multidimensional complexity of the challenges of education financing in the digital era that are not only limited to financial aspects, but include fundamental structural transformations in the education ecosystem. An analysis of 10 selected studies shows that digital transformation in education has created a financial paradox where technology, which is supposed to be a solution to democratize access to education, actually deepens social stratification through the digital divide. 65% of students from low-income families do not have adequate access to technology, which correlates with a 23% decline in academic achievement. These findings are in line with the capital theory proposed by Bourdieu, where access to educational technology becomes a new form of cultural capital that determines the social position of individuals in the digital society. The economic dimension of the challenges of digital education financing is revealed through a comparative analysis between the context of developed and developing countries. Although public investment can increase digital access by up to 45%, education quality gaps remain persistent, especially in remote areas, indicating that financing alone is not enough without an equitable distribution strategy and the development of supporting infrastructure. In contrast, there is a more extreme disparity between urban and rural students, where students in urban areas receive three times as much digital education funding and achieve 35% higher learning outcomes. These contextual differences show that the effectiveness of digital education financing is highly dependent on resource distribution policies, the quality of technological

infrastructure, and institutional capacity to manage digital transformation (Febrianti et al., 2023).

The financial burden of digital transformation at the institutional and individual levels reveals complexities that education stakeholders have not fully anticipated. 72% of students in the UK are experiencing financial stress due to technology needs, with 28% of them considering dropping out, suggesting that the hidden costs of digital education could threaten the sustainability of higher education. The average cost of digital transformation per school is \$150,000, with 60% of institutions requiring external funding. This data indicates that traditional education financing models are no longer adequate to accommodate the need for capital intensive technology investments that require ongoing maintenance. Indonesian families spent 40% more on educational technology during the pandemic, with 58% of families unable to afford adequate equipment, creating significant economic pressures at the household level. Alternative financing model innovations emerging from the literature show promising potential solutions but require a more in-depth evaluation of sustainability and scalability. explores a community-based financing model in Brazil that has successfully increased digital access by up to 52% in underserved areas, suggesting that a bottom-up approach can be a viable alternative to addressing the limitations of public financing. The public-private partnership model in Denmark has shown effectiveness in reducing the cost of public education technology by up to 35% while maintaining quality, but requires strict governance to prevent conflicts of interest and ensure the sustainability of programs. Every \$1,000 increase in technology spending per student correlates with a 15% increase in digital literacy, indicating a positive return on investment for systematic educational technology investment (Paşa, 2020).

Specific challenges in the context of developing countries 80% of students in Nigeria rely on personal mobile devices for learning with 45% having inadequate data packets, creating a unique barrier to access in the context of mobile learning (Akberdina et al., 2024). These findings underscore the importance of developing financing frameworks that are responsive to the characteristics of local technologies and infrastructure, rather than simply adopting financing models from developed countries with different infrastructure contexts. The consistent geographical disparities found in various country contexts suggest that the digital divide is not only an inter-country phenomenon but also intra-country that requires financing strategies tailored to specific demographic and geographical characteristics. The long-term implications of the challenges of digital education financing on the quality of human resources and national economic competitiveness are the main concerns that arise from the synthesis of the literature. Unresolved gaps in access to education technology can create a generation of digital natives who are heterogeneous in their technological capabilities, potentially exacerbating socio-economic inequality in the future. The studies analyzed show that uneven investment in educational technology not only has an impact on individual learning outcomes but also on institutional capacity building and regional competitiveness in the global digital economy. The phenomenon of brain drain that can be triggered by the gap in the quality of digital education between regions is also a risk that needs to be anticipated in the development of education financing policies (Amanda et al., 2025).

The theoretical framework that emerged from the literature analysis shows the need to reconceptualize education financing from a transactional model to a holistic ecosystem investment model. Traditional cost-benefit analysis is no longer adequate to evaluate the value proposition of educational technology investments because the benefits produced are often intangible, long-term, and have positive externalities that are difficult to quantify. An evaluation framework is needed that integrates economic, social, and technological dimensions by considering dynamic interaction between various stakeholders in the digital education ecosystem. The concept of shared value creation developed in the corporate social responsibility literature can be adapted to develop a sustainable education financing model by involving multiple stakeholders in risk-sharing and benefit-sharing arrangements. A major limitation of the analyzed literature lies in the longitudinal limitations of data that can measure the long-term

impact of various digital education financing models. The majority of studies have an observation duration of less than three years, whereas digital transformation in education requires a longer adaptation period to show the true impact. Another methodological limitation is the lack of standardization in measuring the quality of digital education, making it difficult to conduct robust comparative analysis between geographical contexts and education systems. Future research needs to develop metrics that can measure not only access and participation but also the quality, relevance, and long-term impact of digital education investments. The development of longitudinal cohort studies that follow the trajectory of digital education over a longer period of time is also needed to understand the sustainability and adaptability of the various financing models that have been implemented (Would, 2025).

CONCLUSION

A systematic literature review of 10 selected studies for the 2015-2024 period confirms that digital transformation in education has created a complex financing paradox, where technology that should be a catalyst for the democratization of access to education actually deepens social stratification through a systemic digital divide. Consistent findings show that 65% of students from low-income families do not have adequate access to technology with the impact of a decline in academic achievement of up to 23%, while the disparity in digital education financing between urban and rural students reaches a ratio of 3:1 which correlates with a 35% learning outcome gap. Digital transformation requires an average investment of \$150,000 per institution with 60% requiring external funding, indicating the inability of traditional financing models to accommodate the needs of capital-intensive and sustainable operational expenditure. This financial burden has an impact not only on the institutional but also individual levels, with 72% of students experiencing technological financial pressure and 28% considering dropping out, creating a sustainability threat to the continuity of higher education in the digital age. Alternative financing models emerging from various geographical contexts show viable potential but require sophisticated contextual adaptation to ensure scalability and long-term sustainability. Public-private partnerships have been shown to reduce the cost of public education technology by up to 35% by maintaining quality, while community-based financing has increased digital access by 52% in underserved areas, and every \$1,000 increase in technology spending per student correlates with a 15% increase in digital literacy. However, the implementation of these innovative models faces the challenges of governance, risk management, and alignment with educational missions that require a holistic evaluation framework that integrates economic, social, and technological dimensions. The strategic implications of these findings show the need to reconceptualize education financing from a transactional model to an ecosystem investment that involves multiple stakeholders in shared value creation, along with the development of metrics that can measure not only access and participation but also quality, relevance, and long-term impact to ensure digital education investments produce sustainable competitive advantage in the global digital economy.

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