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Economic Impact of Media in Educational Settings: A Comprehensive Review of costs, Efficiency, Equity Human Capital and Emerging Technologies

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ABSTRACT
Educational media including digital learning platforms, online courses, open educational resources (OER), social and communication media, learning management systems, and emerging generative artificial intelligence (AI) has become an important component of educational production and delivery. Its economic significance extends beyond the price of devices and software to include institutional productivity, teacher time, household expenditure, learning outcomes, equity, labour-market preparation, and the long-term formation of human capital. This review synthesizes research published from 2020 through 2026 to examine how educational media changes the cost structure and economic value of education. Evidence indicates that online and digitally mediated instruction can reduce marginal instructional costs and generate economies of scale, while OER can reduce student expenditure on learning materials. However, these gains are conditional on infrastructure, maintenance, training, technical support, content quality, and effective implementation. The review also finds that educational media can either reduce or reproduce inequality. In Nigeria, socioeconomic status, electricity access, connectivity, school type, and parental education have shaped learners' ability to benefit from remote education. Recent evidence on generative AI suggests substantial potential for improving learning and productivity, but benefits depend on whether AI augments rather than replaces human judgment and whether access and skills are broadly distributed. The article argues that the economic impact of educational media should therefore be evaluated through a total-cost-of-ownership and cost-effectiveness framework that connects investment to learning, equity, resilience, and long-term productivity. Sustainable educational media policy requires evidence-based procurement, inclusive infrastructure, teacher development, open content, and continuous evaluation.
Keywords: Educational media; educational technology; economic impact; digital divide; open educational resources; online learning; generative artificial intelligence; human capital; Nigeria; cost-effectiveness

I. INTRODUCTION

Education is simultaneously a social institution, a production system, and an investment in human capital. Its economic performance depends not only on how much is spent, but also on how effectively resources are transformed into learning, skills, completion, and later productivity. Educational media increasingly affects this transformation. Digital platforms, recorded lectures, electronic textbooks, online assessment, social communication tools, and AI-supported learning can alter who teaches, where instruction occurs, how content is distributed, and how quickly feedback is generated.

The economic question is therefore broader than whether a particular technology is "cheap" or "expensive." A device may have a high purchase price but lower the recurring cost of distributing content to thousands of learners. Conversely, a seemingly inexpensive platform may generate substantial costs through connectivity, maintenance, subscriptions, training, replacement, cybersecurity, and technical support. UNESCO (2023) emphasizes that the initial investment in educational technology can represent only a fraction of eventual total costs, making total cost of ownership essential to economic evaluation.

Recent evidence also shows that digital education can generate efficiency without automatically improving equity. Chirikov et al. (2020), for example, found that online college STEM instruction could produce equivalent learning outcomes at lower cost under appropriate conditions. Yet research from Nigeria demonstrates that access to remote learning was strongly shaped by socioeconomic circumstances and infrastructure (Azubuike et al., 2021). Thus, educational media can function as both an efficiency technology and a distributional mechanism.

This review examines the economic impact of media in educational settings from 2020 through 2026. It considers direct and indirect costs, productivity, learning outcomes, equity, household expenditure, institutional efficiency, human capital, labour-market preparation, and emerging AI applications. Particular attention is given to Nigeria and other low- and middle-income contexts where infrastructure constraints make the economic trade-offs especially visible.

Conceptualizing Educational Media

For this review, educational media refers to the tools, channels, and systems through which educational information is created, stored, communicated, accessed, practiced, and assessed. The category includes conventional audiovisual resources as well as digital platforms, online courses, learning management systems, electronic books, OER, social and communication media, mobile learning, and generative AI.

This broad definition is economically useful because different media technologies change different parts of the educational production process. A recorded lecture can reduce repeated delivery time. An OER textbook can reduce household expenditure. A learning management system can automate distribution and assessment workflows. An AI assistant can potentially reduce the time required for drafting explanations or generating practice activities. At the same time, each technology can introduce new expenditures and risks.

The economic impact of educational media should therefore be treated as a multidimensional outcome rather than a single financial measure. At minimum, analysis should distinguish capital costs, recurring operating costs, opportunity costs, productivity effects, learning effects, distributional effects, and longer-term human-capital outcomes.

Objectives of the Review

The review has five objectives. First, it examines how educational media changes the direct and indirect costs of education. Second, it evaluates evidence on productivity, learning outcomes, and economies of scale. Third, it analyzes the distributional effects of digital access and the digital divide. Fourth, it considers the implications of OER, online learning, and generative AI for households, institutions, and labour markets. Fifth, it develops a policy-oriented framework for evaluating educational media investment in sustainable and equitable ways.

Review Methodology

This article uses an integrative narrative review approach. Research and major institutional reports published between 2020 and 2026 were prioritized, with emphasis on peer-reviewed empirical studies, systematic reviews, randomized experiments, and authoritative international reports. The evidence was organized thematically around costs, efficiency, learning, equity, resilience, productivity, and human capital.

The review does not treat all technologies as economically equivalent. Instead, it synthesizes evidence across technologies and settings while identifying contextual conditions that influence economic returns. Because the literature varies in design, outcome measures, and institutional context, the article does not calculate a single pooled monetary return for educational media. Rather, it identifies recurring mechanisms through which media investment produces costs, savings, or broader economic effects.

Theoretical Foundations

The economic analysis rests primarily on human-capital theory, production theory, and the economics of innovation and diffusion. Human-capital theory treats education as an investment that can raise skills, productivity, and future earnings. From this perspective, educational media has economic value when it increases the quantity or quality of learning for a given resource commitment.

Production theory adds attention to how educational inputs are combined. Teachers, classrooms, textbooks, devices, platforms, electricity, connectivity, and administrative systems are complementary inputs. Technology may substitute for some inputs while increasing the productivity of others. A recorded lecture can substitute for repeated live delivery, for example, while an AI tool may complement teachers by reducing routine preparation work.

Innovation economics highlights diffusion and scale. Once digital content is created, the marginal cost of distributing an additional copy can be very low. This creates potential economies of scale that are less available with physical materials. However, scale does not guarantee quality or equity. The economic value of innovation depends on adoption, implementation capacity, and the distribution of benefits.

Direct Costs of Educational Media

The most visible economic effects of educational media are direct expenditures. These include devices, computers, projectors, servers, connectivity, software licenses, platforms, digital content, electricity, repairs, technical support, and training. Institutions may also incur costs for cybersecurity, data protection, accessibility, and system integration.

The key economic distinction is between one-time capital expenditure and recurring operating expenditure. Purchasing devices is a capital cost, but keeping those devices functional requires electricity, maintenance, replacement parts, technical personnel, and eventual renewal. Similarly, a platform may be inexpensive during a pilot but become costly when subscriptions, storage, integration, and support are scaled across an institution.

UNESCO (2023) warns that technology investment should be evaluated through total cost of ownership rather than acquisition price alone. This is particularly important in low-resource settings where infrastructure reliability and replacement costs can determine whether a technology remains useful after initial donor or government financing ends.

Total Cost of Ownership

Total cost of ownership (TCO) includes the full lifecycle cost of an educational technology investment. It can be represented conceptually as:

TCO = acquisition + connectivity + electricity + maintenance + training + technical support + content + replacement + administration + security.

This framework changes the way institutions compare technologies. A low-cost tablet that requires frequent replacement and expensive data access may have a higher long-run cost than a more durable device supported by stable infrastructure. Similarly, free software is not necessarily costless if staff must spend substantial time configuring, training, and maintaining it.

For decision makers, TCO should be calculated over a defined period, such as three, five, or seven years, and expressed per learner or per successful learner. This allows institutions to compare alternatives according to the actual educational service delivered rather than the purchase price alone.

Technology Maintenance as an Economic Issue

Maintenance is often underestimated because it occurs after the initial investment decision. Yet broken devices, unreliable networks, obsolete software, and inadequate technical support can convert nominal technology investment into underutilized capacity. UNESCO (2023) stresses that maintenance and replacement are central to the sustainability of educational technology.

Maintenance also has an opportunity-cost dimension. Teachers who troubleshoot devices are not spending that time on lesson preparation or learner support. School administrators who repeatedly manage technical failures are diverted from educational leadership. Consequently, maintenance should be treated as a productive input requiring appropriate staffing and budgeting rather than as an incidental expense.

Cost Reduction Through Digital Content

Digital content can reduce the recurring cost of reproduction and distribution. Once a high-quality digital resource has been developed, it can often be copied and distributed at relatively low marginal cost. This is especially valuable for large student populations or geographically dispersed learners.

The strongest savings occur when digital content replaces repeated physical production and distribution without creating equally large new costs. However, content creation itself requires skilled labour, instructional design, quality assurance, accessibility work, licensing, and updating. The economic benefit therefore depends on the ratio between content development cost and the number of learners who use the content effectively.

Open Educational Resources and Economic Benefits

OER are educational materials that can be accessed and, subject to their licenses, reused, adapted, and redistributed. Their economic significance lies in reducing barriers associated with commercial learning materials. Cho and Permzadian (2024), in a meta-analysis of 26 studies, found positive associations between OER use and student achievement, including completion and grades. The combination of lower material expenditure and positive academic outcomes makes OER particularly relevant to cost-effective education.

OER also create institutional flexibility. Teachers can adapt materials to local curricula and contexts rather than repeatedly purchasing new commercial editions. However, adaptation requires staff time and quality control. OER should therefore be evaluated not only by whether materials are free to access, but by whether they are accurate, current, accessible, culturally relevant, and actually used.

OER and Household Expenditure

Textbook and course-material costs can be a meaningful household burden, especially for students with limited income. Barnes et al. (2024) found increased use of OER following the COVID-19 period and continued concern about textbook affordability, with some students reporting that cost affected their access to required materials.

The economic benefit of OER is therefore partly distributive. Reducing material expenditure increases the resources available to households for food, transport, connectivity, and other educational needs. This means that the economic impact of educational media should include private household savings, not only institutional budget savings.

Cost-Effectiveness of Online Learning

Online learning can change the cost structure of instruction by separating content delivery from physical location. Chirikov et al. (2020) found that online education platforms could scale college STEM instruction while maintaining equivalent learning outcomes and lowering costs. Their results illustrate a central mechanism of digital education: fixed content and platform costs can be spread across larger numbers of learners.

Nevertheless, online learning is not automatically cheaper. World Bank (2021) emphasizes that technology alone does not produce effective remote learning. Teacher support, suitable technology, learner engagement, and instructional design all matter. If online learning leads to lower completion or learning, apparent financial savings may represent false economy.

Economies of Scale

Digital media can generate economies of scale because the marginal cost of distributing a digital lesson, video, or text is often much lower than the cost of reproducing physical materials or providing repeated live instruction. This is particularly relevant to mass higher education and continuing professional development.

Scale can also improve the economics of specialized instruction. A highly qualified instructor may reach learners across many locations through a digital platform. However, scale can produce congestion, weaker personalization, or increased demand for support. The economic optimum therefore depends on balancing scale with learner needs and instructional quality.

Instructional Productivity

Instructional productivity refers to the amount and quality of educational output generated from a given quantity of teacher and institutional resources. Media can raise productivity by automating repetitive tasks, improving access to reusable content, enabling asynchronous learning, and facilitating rapid feedback.

The World Bank (2021) cautions that productive technology must be integrated with appropriate pedagogy. Technology that adds complexity without improving learning can reduce productivity by consuming teacher time and institutional resources. Thus, productivity should be measured by learning achieved per unit of resource use rather than by technology adoption alone.

Artificial Intelligence and Teacher Productivity

Generative AI introduces a new potential source of productivity because it can assist with drafting lesson plans, generating practice questions, adapting explanations, summarizing materials, and providing formative feedback. Tan (2025), in a scoping review of empirical research, identifies applications of generative AI in teacher development and resource creation.

Evidence also indicates that organizational support matters. Research involving Australian teachers found that in-school support predicted AI self-efficacy and valuing, which in turn were associated with workplace integration (Teachers’ generative AI self-efficacy, valuing, and integration at work, 2024). The economic implication is that AI investment should include professional development and institutional support; software access alone is unlikely to generate the full productivity effect.

Artificial Intelligence and Learner Productivity

AI can also alter the productivity of learners by reducing the time needed to obtain explanations, practice skills, or receive feedback. Contractor and Reyes (2026) report randomized experimental evidence that generative AI improved immediate test performance, although effects differed depending on whether users employed AI as an augmentation tool or relied on it more heavily for task completion.

Fütterer et al. (2026) similarly report randomized evidence on generative AI support for self-regulated learning among school students. These studies suggest that the economic value of AI depends partly on how it is used. Tools that strengthen learner capability may produce more durable human-capital gains than tools that simply automate task completion.

AI and Education-Based Productivity Gaps

One of the most economically significant possibilities of generative AI is that it may narrow skill-based productivity differences. Cruces et al. (2026), using a randomized experiment with 1,174 adults, found that AI assistance improved performance for participants across education levels, with larger gains among less-educated participants in assisted tasks. Their results suggest

that AI can compress education-based productivity gaps when access and effective use are available.
However, some of the gap re-emerged when AI assistance was removed. This indicates that technology-assisted productivity and underlying human capability are not identical. Sustainable economic benefits require investments that help users develop skills alongside AI use rather than becoming permanently dependent on the technology.

The Digital Divide

The digital divide is a major determinant of the economic impact of educational media. Lythreatis et al. (2022), reviewing the literature on digital inequality, show that the divide encompasses more than physical access. It includes socioeconomic resources, infrastructure, digital skills, support, and broader institutional and social conditions.
From an economic perspective, unequal access can create unequal returns to public technology investment. If higher-income learners are better positioned to obtain devices, broadband, quiet study environments, and technical support, the same educational media investment can produce larger benefits for them than for disadvantaged learners. Consequently, equity is not separate from efficiency; unequal adoption can reduce the aggregate return on educational technology.

Economic Inequality and Educational Media

Francis and Weller (2022) connect economic inequality with the digital divide and remote learning. Their analysis highlights how household resources shape the ability to participate in digitally mediated education.
The implication is that educational technology policy must consider complementary household inputs. Providing a platform without affordable connectivity may not create meaningful access. Similarly, providing a device without electricity, digital skills, or suitable learning space may produce limited educational returns. Effective investment therefore requires a systems approach to access.

Remote Learning and COVID-19

The COVID-19 pandemic accelerated the adoption of remote learning and exposed both the potential and limitations of educational media. World Bank (2021) documents wide variation in remote-learning effectiveness across contexts. The emergency demonstrated that technology can preserve educational continuity, but it also showed that continuity is not equivalent to learning.
The economic value of remote learning during crises extends beyond test scores. Maintaining participation can reduce dropout, protect progression, preserve institutional continuity, and reduce the long-term human-capital losses associated with prolonged school closure. World Bank (2024) emphasizes that learning continuity and resilience should be incorporated into education-system planning after the pandemic.

The Economic Value of Educational Continuity

Educational interruption has opportunity costs. Learners who lose months or years of effective instruction may experience lower future productivity and earnings, while institutions may incur costs associated with remediation and delayed graduation. Educational media can therefore function as a form of economic resilience infrastructure.
The value of continuity is especially high when the alternative is complete interruption. Even imperfect remote learning may preserve some learning and social connection. However, the quality and distribution of that continuity remain important: unequal remote access can shift the burden of disruption toward already disadvantaged learners.

Evidence From Nigeria

Nigeria provides an important context for evaluating educational media because the country combines a large and youthful population with significant variation in connectivity, electricity, income, and school resources. Azubuike et al. (2021), studying remote learning during COVID-19, found that socioeconomic status, school type, and parental education were associated with learners' access and support for remote education.
The findings demonstrate that technology-mediated education is embedded in household and institutional conditions. The economic return to a digital program can therefore vary substantially across learners even when the software or content is identical. Policy must address these complementary conditions if digital investment is to generate broad-based human-capital gains.

Rural Nigeria and Digital Infrastructure

Rural and remote communities face especially strong constraints in electricity, broadband, devices, and technical support. Research on Nigerian rural secondary schools during the pandemic documented digital gaps associated with poverty, weak internet access, electricity limitations, and inadequate policy support (Left behind? The effects of digital gaps on e-learning in rural secondary schools and remote communities across Nigeria during the COVID19 pandemic, 2021).
These constraints have direct economic implications. High infrastructure costs can make digital learning more expensive in underserved

areas even when the marginal cost of digital content is low. Public policy may therefore need to subsidize the complementary infrastructure that makes digital content economically productive.

Household Costs in Digital Education

Digital education can transfer costs from institutions to households. Learners may need smartphones or computers, data subscriptions, electricity, headphones, printing, and sometimes private tutoring to compensate for weak instructional support. Such costs are often invisible in institutional budgets.

A full economic evaluation should therefore distinguish provider costs from user costs. A program that saves a university money but increases student expenditure may not improve total social efficiency. Conversely, OER and shared digital infrastructure may reduce both institutional and household costs when implemented well.

Private Versus Public Costs

Educational media creates a mix of public, institutional, and private costs. Governments may finance broadband and devices; institutions may pay for platforms and content; households may pay for data and equipment. The distribution of these costs affects participation.

From a public-economics perspective, cost shifting can produce inefficient exclusion. If private costs are high relative to household income, learners who would generate high social returns through education may be unable to participate. Targeted subsidies, device-lending schemes, community access points, and affordable connectivity can improve both equity and the social return on educational investment.

Opportunity Costs

Opportunity costs are often more important than cash costs. Teachers spend time learning new platforms; students spend time troubleshooting; institutions devote staff to procurement and support. These resources could otherwise be used for teaching, research, counseling, or administration.

The correct comparison is therefore between alternative ways of producing learning. A technology that costs more in absolute terms can still be economically efficient if it generates sufficiently greater learning, retention, access, or productivity. Conversely, a low-cost technology can be inefficient if it generates little educational value.

Educational Media and Institutional Efficiency

Media can improve institutional efficiency through centralized content distribution, automated assessment, digital records, scheduling, communication, and learning analytics. These functions can reduce repetitive administrative work and improve information flow.

However, efficiency gains depend on system integration. Multiple disconnected platforms can create duplicated data entry, training burdens, and interoperability problems. Educational technology procurement should therefore consider the whole institutional ecosystem rather than individual products (Educational Technology Procurement at Canadian Colleges and Universities, 2024).

Underutilization of Educational Technology

A major risk is underutilization. Institutions may purchase devices or subscriptions that are used infrequently because teachers lack confidence, content is unsuitable, electricity is unreliable, or technical support is weak. In economic terms, underutilization lowers the return on invested capital.

UNESCO (2023) argues for evidence-based procurement precisely because technology adoption can outpace evidence of educational value. Before large-scale investment, institutions should establish intended use cases, expected utilization rates, learning outcomes, maintenance requirements, and exit or replacement strategies.

Procurement and Evidence-Based Investment

Procurement should be based on total cost, evidence of effectiveness, interoperability, accessibility, security, scalability, and local implementation capacity. The cheapest vendor is not necessarily the most economical option.

A useful procurement rule is to ask: What educational problem is being solved? What evidence shows that the proposed technology solves it? What complementary inputs are required? What will it cost over its full lifecycle? Who benefits and who may be excluded? These questions connect procurement to economic evaluation rather than technology enthusiasm.

Educational Media and Learning Outcomes

The economic value of media ultimately depends on whether it improves learning or another valued educational outcome. Chirikov et al. (2020) provide evidence that online instruction can achieve equivalent learning outcomes at lower cost in selected STEM contexts. Cho and Permzadian (2024) provide evidence that OER can be associated with positive achievement outcomes.

These findings suggest that technology can improve cost-effectiveness when learning is maintained or improved. They also demonstrate why adoption rates alone are weak indicators of economic value. The relevant outcome is learning per unit of total resource use.

Educational Media and Retention

Retention and completion have strong economic implications because students who leave education early may receive less human-capital benefit from prior investment. Digital flexibility can support retention by allowing learners to access materials asynchronously and participate despite geographic or scheduling constraints.

Yet digital learning can also increase disengagement when learners lack support. Economic evaluation should therefore examine completion and persistence alongside test performance. A platform that produces modest gains for enrolled learners but substantially increases dropout may have poor overall returns.

Flexibility and Opportunity Costs

Flexible digital learning can reduce opportunity costs for working adults, caregivers, and geographically distant learners. Asynchronous resources allow learning to occur outside conventional classroom hours, potentially enabling people to combine education with employment or family responsibilities.

This flexibility has economic value because the relevant cost of education includes foregone income and time. Digital delivery can lower these opportunity costs when it genuinely provides scheduling flexibility and reliable access.

Educational Media and Access to Scarce Expertise

Digital media can expand access to scarce expertise. A specialist teacher or lecturer can reach learners beyond a single campus through recorded lessons, live online sessions, or digital resources. This can be particularly valuable in fields where qualified instructors are geographically concentrated.

The economic mechanism is resource sharing. Rather than requiring every institution to employ every specialist, systems can distribute selected expertise across institutions. The challenge is maintaining interaction, assessment quality, and learner support at scale.

Educational Media and Geographic Inequality

Geographic inequality is both a constraint and an opportunity. Digital media can reduce the distance between teachers and learners, but only when connectivity and electricity are reliable. Where infrastructure is weak, the same technology can widen geographic disparities.

This creates a policy paradox: the places that may gain the most from digital access may also face the highest implementation costs. Public investment may therefore need to prioritize underserved regions even when their short-run financial returns appear lower, because the long-run social return from inclusion can be substantial.

Environmental Economic Effects

Digital education can reduce some material use by lowering dependence on printed textbooks, paper assignments, and physical travel. OER and online delivery may therefore have environmental co-benefits. However, digital systems also require electricity, devices, servers, network infrastructure, and periodic replacement.

The economic evaluation of environmental effects should therefore consider the full lifecycle of equipment and infrastructure. Digitization is not automatically resource-free; its benefits depend on energy efficiency, device durability, repairability, and responsible disposal.

Social Media and Educational Economics

Social and communication media can lower the cost of interaction, peer support, announcements, and informal learning. Messaging platforms can allow teachers and learners to exchange information rapidly without requiring physical meetings.

However, social media can also create distraction, misinformation, privacy risks, and additional demands on teachers. The economic value depends on whether communication efficiency exceeds the time and attention costs introduced by the platform.

Educational Media and Information Quality

Information quality is an economic variable because poor-quality content can waste learner time and produce incorrect knowledge. Generative AI creates new opportunities for rapid content production but also raises concerns about inaccurate or misleading outputs.

Consequently, quality assurance is part of the cost of digital education. Institutions may need editorial review, teacher verification, source checking, and AI-use policies. These activities impose costs but protect the value of the educational investment.

The Economics of Digital Literacy

Digital literacy is a complementary input to educational media. Lythreatis et al. (2022) show that the digital divide includes skills and support, not simply access. A learner who owns a smartphone but cannot effectively search, evaluate, create, and communicate information may receive limited educational benefit.

Investment in digital literacy can therefore raise the productivity of other technology investments. The economic logic resembles investment in worker training: equipment becomes more productive when users have the skills to operate it effectively.

Educational Media and Labour-Market Skills

Educational media can influence labour-market outcomes by changing the skills students acquire. Digital platforms expose learners to collaboration, information management, digital communication, and technology-supported problem solving. These capabilities can complement formal subject knowledge.

The economic benefit appears when educational experiences translate into productive workplace behavior. As digital technologies spread through firms, education systems that provide effective digital skills can reduce training costs and improve worker adaptability.

Generative AI and Skills Substitution

Generative AI complicates the traditional human-capital model because some cognitive tasks can now be partially automated. If learners use AI to perform tasks they would otherwise need to learn, short-term productivity may increase while long-term skill formation could weaken.

This creates a substitution-versus-learning trade-off. Educational institutions should distinguish between AI use that scaffolds reasoning and AI use that replaces reasoning. Assessment design, AI literacy, and explicit expectations for human contribution become economically important because they determine whether AI generates durable capability or temporary task assistance.

Human-AI Complementarity

The strongest economic case for AI in education may be complementarity rather than replacement. Teachers provide judgment, context, motivation, pastoral support, and professional responsibility. AI can assist with routine information processing, personalization, and resource creation.

Recent experimental evidence supports the possibility of productivity gains when AI augments human work (Contractor & Reyes, 2026; Cruces et al., 2026). The policy objective should therefore be to design workflows in which technology increases the productivity of teachers and learners without removing the human functions that sustain quality and accountability.

AI and Educational Inequality

AI can reduce inequality if disadvantaged learners gain access to high-quality personalized support. Cruces et al. (2026) provide evidence that AI assistance produced larger gains among less-educated adults in an experimental setting.

Yet unequal access to premium tools, devices, connectivity, and AI literacy could produce the opposite effect. The distributional outcome will depend on affordability, public provision, teacher guidance, and the quality of the tools available to different groups. AI policy should therefore be evaluated as both a productivity policy and an equity policy.

Economic Resilience and Educational Technology

Educational technology can strengthen resilience by enabling learning to continue during pandemics, conflict, disasters, strikes, or other disruptions. World Bank (2024) emphasizes the importance of learning continuity and system adaptability.

Resilience has an option value: infrastructure built for remote learning may appear underused during normal periods but become highly valuable during crises. Economic appraisal should therefore consider the probability and cost of disruption rather than judging infrastructure only by routine utilization.

Educational Media as Public Infrastructure

Broadband, digital identity, platforms, content repositories, and device ecosystems increasingly resemble public infrastructure. Their benefits extend beyond individual institutions because they can support multiple educational providers and learner groups.

Public infrastructure investment can address coordination problems that individual schools cannot solve efficiently. Shared platforms and connectivity can reduce duplication, improve interoperability, and spread fixed costs. However, governance, privacy, procurement transparency, and long-term financing are essential to prevent infrastructure from becoming stranded or inequitable.

Economic Externalities

Education produces external benefits when better-educated individuals contribute to productivity, health, civic participation, innovation, and social stability. If educational media improves access or learning, part of its return may accrue beyond the individual learner.

These externalities justify public investment when private households or institutions would otherwise underinvest. They also explain why cost-benefit analysis should consider social returns rather than tuition savings alone.

Cost-Benefit Analysis

Cost-benefit analysis converts educational costs and benefits into monetary terms where feasible. Benefits may include increased earnings, reduced dropout, lower institutional operating costs, improved productivity, and avoided losses during disruptions.

The challenge is attribution. Learning gains do not automatically translate into earnings, and technology is rarely the only intervention operating at the same time. Consequently, monetary estimates should be transparent about assumptions and uncertainty.

Cost-Effectiveness Analysis

Cost-effectiveness analysis is often more practical than cost-benefit analysis in education. Instead of monetizing learning, it compares the cost required to achieve a defined educational outcome, such as a standard-deviation increase in test scores, a percentage-point improvement in completion, or an additional successful learner.

The basic measure can be expressed as:

Cost-effectiveness ratio = total program cost / educational outcome achieved.

This framework is particularly useful when comparing alternative media strategies that pursue the same learning objective.

Return on Investment

Return on investment (ROI) compares net benefits with investment costs. For educational media, ROI should be calculated over an appropriate time horizon because human-capital benefits may emerge years after initial expenditure.

A simple conceptual expression is:

ROI = (present value of benefits − present value of costs) / present value of costs.

Sensitivity analysis is essential because results depend on assumptions about utilization, learning effects, retention, earnings, maintenance, discount rates, and technology replacement.

Evidence-Synthesis Matrix

The major evidence reviewed can be summarized as follows.

Integrated Economic Impact Framework

The economic impact of educational media can be represented as a chain:

Structural Conditions

Income + socioeconomic status + infrastructure + electricity + connectivity + institutional capacity

Technology Investment

Devices, platforms, content, connectivity, OER, AI

Direct Costs

Capital expenditure, subscriptions, maintenance, training, technical support

Productivity Mechanisms

Automation, economies of scale, teacher productivity, reduced material costs, administrative efficiency

Educational Mechanisms

Access, engagement, feedback, personalization, learning

Distributional Mechanisms

Digital inclusion, digital exclusion, household expenditure, inequality

Long-Term Economic Outcomes

Human capital, employability, labour productivity, earnings, economic growth

The framework emphasizes that technology does not directly create economic growth. It operates through institutional and educational mechanisms that transform investment into learning and productive capability.

Implications for Educational Institutions

Institutions should adopt lifecycle budgeting, evidence-based procurement, interoperability standards, staff development, and continuous evaluation. Technology plans should identify measurable educational problems and define success indicators before procurement.

Institutions should also track utilization. If expensive platforms are used by a small proportion of staff or students, resources may be better allocated elsewhere. Regular cost-per-user and cost-per-successful-learner analyses can help administrators identify underperforming investments.

Implications for Teachers

Teachers should be treated as central economic agents in educational technology implementation. Their time, confidence, pedagogical judgment, and professional development determine whether media investments produce value.

Professional learning should focus not only on technical operation but on instructional design, digital assessment, AI literacy, source evaluation, accessibility, and ethical use. Technology should reduce low-value workload rather than simply add another layer of reporting and platform management.

Implications for Parents and Households

Households should be recognized as co-financiers of digital education. Policies that ignore data costs, devices, electricity, and learning space can overstate the affordability of technology-mediated education.

OER, community connectivity, device-sharing programs, and subsidized access can reduce household burdens. Clear communication about required technology can also help families plan educational expenditure.

Implications for Governments

Governments should treat educational technology as a long-term public investment rather than a series of isolated projects. This requires sustainable financing for connectivity, maintenance, teacher development, content, and evaluation.

Public policy should also emphasize interoperability, accessibility, competition, privacy, and evidence standards. Procurement decisions should consider total cost of ownership and distributional consequences, not only initial price.

Implications for Nigeria

For Nigeria, the evidence suggests that digital education policy should prioritize reliable electricity, affordable broadband and mobile data, device access, teacher support, locally relevant content, and OER. The digital divide identified during COVID-19 demonstrates that technology programs can reproduce socioeconomic inequality when complementary conditions are ignored (Azubuike et al., 2021).

A sustainable Nigerian strategy should also build local technical capacity and support institutions after initial implementation. Partnerships among government, universities, schools, telecommunications providers, and development organizations can spread infrastructure costs while improving reach.

Research Gaps

Important gaps remain. First, many studies measure short-term learning outcomes rather than long-term earnings and productivity. Second, evidence on total cost of ownership is limited, particularly in low-income settings. Third, AI research is developing rapidly, making it difficult to establish stable estimates of long-run educational and labour-market effects.

More research is also needed on household costs, gender and disability dimensions of digital access, rural infrastructure, teacher time savings, and the environmental lifecycle of educational technologies. Comparative studies across countries and education levels would strengthen the evidence base.

Future Research Agenda

Future research should combine randomized evaluations with administrative cost data and longitudinal labour-market outcomes. Studies should report both provider and user costs and distinguish between capital, recurring, and opportunity costs.

For AI, research should compare augmentation and automation, measure durable skill acquisition, and examine whether productivity gains persist after tool removal. Equity analyses should track who receives access, who can use tools effectively, and whether benefits are concentrated among already advantaged groups.

Policy Model for Sustainable Educational Media

A sustainable policy model can be organized around six principles: (a) define the educational problem before selecting technology; (b) calculate total cost of ownership; (c) fund complementary infrastructure and human capacity; (d) prioritize open and reusable resources where appropriate; (e) evaluate learning, equity, and cost simultaneously; and (f) build resilience and replacement planning into investment decisions.

This model treats educational media as part of an education system rather than as an isolated product. Its central objective is not maximum technology adoption but maximum educational value per unit of scarce social resources.

Limitations of the Review

This review is integrative rather than a formal systematic review or meta-analysis of all available studies. The evidence spans different technologies, populations, countries, and research designs, so direct comparisons should be made cautiously. Some recent AI evidence is based on working papers or emerging research and may evolve as replication studies appear.

The review also focuses primarily on economic mechanisms rather than providing a single quantitative estimate of the global monetary value of educational media. These limitations indicate the need for more standardized reporting of costs, utilization, learning outcomes, and long-term economic benefits.

II. CONCLUSION

Educational media has substantial economic potential, but its value is conditional. Digital platforms can lower marginal instructional costs and expand access; OER can reduce household expenditure while supporting learning; online learning can create economies of scale; and generative AI may increase the productivity of teachers and learners. At the same time, infrastructure, maintenance, training, connectivity, digital skills, and quality assurance create significant costs. The digital divide can also distribute benefits unequally.

The central conclusion is that educational media should be evaluated as an investment in an education production system. The relevant question is not whether technology is expensive or inexpensive, but whether total resources devoted to technology produce sufficient gains in learning, completion, access, resilience, and future productivity. Evidence from 2020–2026 supports a balanced approach: invest where technology solves a demonstrated educational problem, calculate full lifecycle costs, strengthen the human and infrastructural complements of technology, and measure both efficiency and equity.

For Nigeria and other settings with substantial infrastructure and income disparities, this approach is especially important. Educational media can help overcome geographic and resource constraints, but only when policies address the conditions that determine who can actually benefit. Sustainable digital education is therefore not simply a matter of purchasing devices or platforms. It is an economic strategy for building inclusive human capital.

Table 1: Evidence-Synthesis Matrix

Evidence area	**Economic benefit**	**Main cost/risk**	**Key evidence**
Online learning	Lower marginal instructional costs; scale	Infrastructure and support costs	Chirikov et al. (2020)
OER	Lower student expenditure; positive achievement	Content quality/adaptation costs	Cho & Permzadian (2024)
Digital access	Expanded educational opportunity	Socioeconomic exclusion	Lythreatis et al. (2022)
Remote learning	Educational continuity	Unequal access and variable effectiveness	World Bank (2021)
Nigerian digital learning	Expanded remote access	Poverty, electricity, connectivity barriers	Azubuike et al. (2021)
AI-assisted learning	Potential learning gains	Overdependence; quality risks	Contractor & Reyes (2026); Fütterer et al. (2026)
Generative AI	Productivity and gap-narrowing potential	Skill substitution; unequal access	Cruces et al. (2026)
Digital procurement	Potential institutional efficiency	High lifecycle costs	UNESCO (2023)

REFERENCES

[1]. Azubuike, O. B., Adegboye, O., & Quadri, H. (2021). Who gets to learn in a pandemic? Exploring the digital divide in remote learning during the COVID-19 pandemic in Nigeria. International Journal of Educational Research Open, 2, 100022. https://doi.org/10.1016/j.ijedro.2020.100022

[2]. Barnes, C. A., Vine, S., & Nadeau, R. (2024). Assessing textbook affordability before and after the COVID-19 pandemic: Results of student and faculty surveys. The Journal of Academic Librarianship, 50(2), 102864. https://doi.org/10.1016/j.acalib.2024.102864

[3]. Chirikov, I., Semenova, T., Maloshonok, N., Bettinger, E., & Kizilcec, R. F. (2020). Online education platforms scale college STEM instruction with equivalent learning outcomes at lower cost. Science Advances, 6(15), eaay5324. https://doi.org/10.1126/sciadv.aay5324

[4]. Cho, K. W., & Permzadian, V. (2024). The impact of open educational resources on student achievement: A meta-analysis. International Journal of Educational Research, 126, 102365. https://doi.org/10.1016/j.ijer.2024.102365

[5]. Contractor, Z., & Reyes, G. (2026). Experimental evidence on the learning impact of generative AI (IZA Discussion Paper No. 18792). IZA Institute of Labor Economics.

[6]. Cruces, G., Fernández Meijide, D., Galiani, S., Gálvez, R. H., & Lombardi, M. (2026). Does generative AI narrow education-based productivity gaps? Evidence from a randomized experiment (NBER Working Paper No. 34851). National Bureau of Economic Research. https://doi.org/10.3386/w34851

[7]. Francis, D. V., & Weller, C. E. (2022). Economic inequality, the digital divide, and remote learning during COVID-19. Review of Black Political Economy, 49(1), 41–60.

https://doi.org/10.1177/00346446211017797

[8]. Fütterer, T., Bardach, L., Kuhn, J., Keller, S. D., & Gerjets, P. (2026). Enhancing school students' self-regulated learning through generative AI support: A randomized controlled trial. Educational Psychology Review, 38, Article 42.

[9]. Left behind? The effects of digital gaps on e-learning in rural secondary schools and remote communities across Nigeria during the COVID19 pandemic. (2021). International Journal of Educational Research Open, 2, 100092. https://doi.org/10.1016/j.ijedro.2021.100092

[10]. Lythreatis, S., Singh, S. K., & El-Kassar, A.-N. (2022). The digital divide: A review and future research agenda. Technological Forecasting and Social Change, 175, 121359. https://doi.org/10.1016/j.techfore.2021.121359

[11]. Tan, Q. (2025). Reimagining teacher development in the era of generative AI: A scoping review. Teaching and Teacher Education, 168, 105236. https://doi.org/10.1016/j.tate.2025.105236

[12]. Teachers' generative AI self-efficacy, valuing, and integration at work: Examining job resources and demands. (2024). Computers and Education: Artificial Intelligence, 7, 100333. https://doi.org/10.1016/j.caeai.2024.100333

[13]. UNESCO. (2023). Global education monitoring report 2023: Technology in education—A tool on whose terms? UNESCO.

[14]. World Bank. (2021). Remote learning during COVID-19: Lessons from today, principles for tomorrow. World Bank.

[15]. World Bank. (2023). EdTech toolkit for remote learning. World Bank.

[16]. World Bank. (2024). Learning continuity during crises: Applying lessons from the COVID-19 pandemic to shape resilience and adaptability. World Bank.