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Обзорная статья

Implementing Mobile Learning Technologies in School Education in Developing Countries: Opportunities and Barriers (Scientific Review)

Review article

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Abstract

Introduction. *Despite its potential to enhance educational access and outcomes, m-learning adoption remains hindered by infrastructural limitations, socioeconomic disparities and education policy gaps. Little research examines how these barriers interact to impede implementation of m-learning, which leaves a critical gap in addressing equitable education in developing regions. The purpose of the study is to examine the challenges and prospects of mobile learning technologies use within school education in developing countries. The objectives of this research are to assess current trends in adopting these technologies, evaluate their impact on student engagement and learning outcomes and propose effective recommendations for scalability of applied practices.*

Materials and Methods. *A mixed-method approach was employed, combining qualitative case studies from initiatives such as MobiReach (India), Bridge International Academies (Kenya), Rora Digital Library (Eritrea), CARNET Mobile Learning Project (Croatia), Plan Ceibal (Uruguay), Education Reform for Knowledge Economy (Jordan), and The ReMaLIC project (Nepal) with quantitative data from UNESCO and World Bank reports. To ensure the validity and reliability of sources, Boolean terminology was employed to extract data from various academic databases.*

Results. *Findings indicate that m-learning significantly improves accessibility and performance, particularly in underserved rural areas and within low-income communities. However, barriers such as unreliable internet, high device costs and resistance to pedagogical change limit its widespread implementation.*

Discussion and Conclusion. *The paper underscores the need for coordinated policy interventions, including infrastructure investment, teacher training and localized content development. Practical strategies such as blended learning models and public-private partnerships are recommended to enhance sustainability. The research also highlights the transformative potential of m-learning in overcoming educational inequities while creating a basis for further investigation into long-term academic and socioeconomic impacts.*

Keywords. *Mobile Learning, Developing Countries, Education Technology, Accessibility, Digital Infrastructure, Educational Barriers, Educational Gaps, Learning Outcomes*

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Внедрение технологий мобильного обучения в школьное образование в развивающихся странах: возможности и препятствия (научный обзор)

Обзорная статья

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Аннотация

Введение. *Несмотря на то, что мобильное обучение обладает потенциалом в контексте улучшения доступа к образованию и получаемых результатов, его использование по-прежнему сдерживается инфраструктурными ограничениями, социально-экономическим неравенством и несовершенством политики в области образования. Взаимосвязи данных барьеров уделяется недостаточно внимания, что препятствует внедрению мобильного обучения и оставляет значительный пробел в решении проблемы неравенства образовательных возможностей в развивающихся регионах. Целью исследования является изучение проблем и перспектив в сфере использования технологий мобильного обучения в школьном образовании в развивающихся странах. Задачи исследования заключаются в оценке сегодняшних тенденций внедрения данных технологий, определении их влияния на вовлечённость учащихся и результаты обучения, а также в формулировании эффективных рекомендаций по масштабируемости применяемых практик.*

Материалы и методы. *Был использован «смешанный» подход, объединяющий качественные тематические исследования в рамках таких инициатив, как MobiReach (Индия), Bridge International Academies (Кения), Rora Digital Library (Эритрея), Проект мобильного обучения CARNET (Хорватия), Plan Ceibal (Уругвай), Реформа образования для экономики знаний (Иордания) и проект ReMaLIC (Непал), с количественными данными из отчётов ЮНЕСКО и Всемирного банка. Для обеспечения достоверности и надёжности источников при извлечении информации из различных академических баз данных использовалась терминология булевой алгебры.*

Результаты. *Результаты показывают, что мобильное обучение значительно способствует доступности и повышению эффективности обучения, особенно в сельских районах с ограниченным доступом и среди малообеспеченных групп населения. Однако такие барьеры, как ненадёжный Интернет, высокая стоимость мобильных устройств и сопротивление педагогическим инновациям, ограничивают широкое внедрение данных технологий.*

Обсуждение и заключение. *В статье подчёркивается необходимость скоординированных политических действий, включая инвестиции в инфраструктуру, подготовку учителей и разработку локализованного контента. Для повышения устойчивости вне-*

дрения рекомендуются практические стратегии, такие как смешанные модели обучения и государственно-частное партнёрство. Также в исследовании акцентируется внимание на преобразующем потенциале мобильного обучения в преодолении образовательного неравенства, одновременно создающем основу для дальнейшего изучения долгосрочных образовательных эффектов и социально-экономических результатов.

Ключевые слова: *мобильное обучение, развивающиеся страны, школьное образование, качественное образование, образовательные барьеры, пробелы в образовании, результаты обучения*

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Introduction

Mobile learning or (m-learning), refers to education facilitated by mobile devices, enabling learning anytime and anywhere [1–3]. It involves wireless devices such as smartphones, tablets, laptops, iPods, cameras, USBs, and personal digital assistants [4]. This approach has gained significant attention due to its flexibility and ability to overcome traditional educational barriers [5]. In developing countries, where educational infrastructure is often limited, m-learning offers a promising solution to enhance access to quality education [6].

By leveraging portable devices, students can access instructional materials and content while they're on the go [7; 8]. This modality is a flexible instrument for educational advancement by supporting divers learning styles, including formal, non-formal, and informal education [9–11]. M-learning is seen as a tool to bridge educational gaps, particularly in regions with scarce traditional resources [6]. Furthermore, mobile phones and technological networks can improve access to educational texts, fostering literacy and learning opportunities among underserved populations worldwide [12].

Problem Statement

Despite the potential of mobile learning technologies to transform education, developing countries face significant obstacles to their adoption and implementation [13; 14]. Systemic barriers, such as unreliable electricity, limited internet access, high costs of devices and data, and low digital literacy among teachers and students, persist in many regions. Social inequities further widen the access gap, particularly for rural communities and low-income households [15; 16].

Case studies, such as MobiReach in India, Bridge International Academies in Kenya, Rora Digital Library in Eritrea, CARNET Mobile Learning Project in Croatia, Plan Ceibal in Uruguay, Education Reform for Knowledge Economy in Jordan and The ReMaLIC project in Nepal demonstrate improved engagement and learning outcomes. However, scaling these initiatives is hindered by fragmented policies, resistance to pedagogical change, and a lack of localized content [17; 18]. The COVID-19 pandemic underscored the urgency of addressing these gaps, as education systems in both developed and developing countries struggled to meet demands [19–22]. Without targeted interventions, m-learning's potential to reduce educational disparities and improve quality education in developing countries will remain unrealized [23].

Objectives

This paper aims to examine the adoption and implementation of mobile learning technologies to improve educational access and outcomes in developing countries, guided by the following objectives:

1. To evaluate the current state of mobile learning adoption in developing countries, focusing on policy readiness, infrastructure, and institutional integration.

2. To analyze the impact of m-learning on student engagement, learning outcomes, and access, particularly in underserved rural and low-income communities, using empirical evidence from case studies.

3. To propose practical policy and practice recommendations to overcome key barriers and enhance the scalability and sustainability of m-learning in developing countries.

This study provides a comprehensive analysis of m-learning's potential and challenges in developing countries' education systems, drawing on literature reviews, case studies, and statistical data. The study is limited itself to the feasibility level of implementation (adoption) of mobile learning technology in the education system of developing countries. The discussion is grounded in the TCCM (Theory, Context, Characteristics, Methods) framework and other empirical findings, ensuring a comprehensive analysis [24; 25].

Materials and Methods

This study employs a mixed-methods research design, integrating qualitative and quantitative approaches to gain a thorough understanding of mobile learning practices in developing countries. The mixed-methods approach offers the depth of qualitative insights alongside the generalizability of quantitative data, providing a holistic perspective [26–28]. The research includes an extensive literature review to establish a theoretical framework and identify key themes and variables related to mobile learning. Data were sourced from academic databases, including JSTOR, ScienceDirect, Open Access, Google Scholar, and Z-library, using Boolean search terms to ensure reliable and valid sources.

Literature Review

1. Definition and Evolution of Mobile Learning

Mobile learning (m-learning) encompasses education across various contexts using personal electronic devices, such as smartphones, tablets, and laptops [41]. Unlike traditional e-learning, which relies on desktop computers and fixed settings, m-learning utilizes the portability of mobile devices to enable flexible learning [9; 30].

Emerging in the early 2000s with the rise of mobile technologies [31], m-learning initially delivered content via SMS and basic applications [32]. These early initiatives demonstrated the potential to reach learners in remote areas with limited access to educational resources [6]. Advances in mobile technology, including smartphones and tablets with high-speed internet and multimedia capabilities, have transformed m-learning into a primary educational mode in many contexts [33; 34]. Modern m-learning platforms feature real-time feedback, adaptive learning paths, and immersive multimedia, enhancing engagement and personalization [35; 36].

The evolution of mobile networks, from 3G to 5G, has improved internet speed and reliability, supporting seamless access to educational content and real-time interactions [37; 38]. Educational applications, ranging from simple flashcards to comprehensive learning management systems, have expanded m-learning's scope [39]. Cloud-based platforms enable storage and access to large volumes of content, benefiting developing countries with limited local infrastructure [40–42].

2. Current State of Mobile Learning in Developing Countries

Adoption and Implementation

The adoption of m-learning in developing countries depends on government policies, technology availability, and socio-economic factors [43; 44]. Countries like India and Kenya have advanced m-learning integration through initiatives like India's Digital India program and private-sector partnerships [45; 46]. However, many developing nations face infrastructure challenges, including unreliable electricity, limited internet coverage, and high costs of devices and data [23]. Innovative solutions, such as low-cost devices and offline content delivery in Sub-Saharan Africa, have emerged to address these barriers [47; 48].

Statistics and Data on M-learning Adoption

Statistical data highlights the growing adoption of m-learning in developing countries. A study by Alsharida et al. projects that global mobile internet penetration will reach 71% by 2025 [49]. The GSM Association reported that 3.8 billion people in developing countries used mobile internet by 2020, with Sub-Saharan Africa's mobile service subscriptions at 45 % in 2019, expected to reach 50 % by 2025 [50]. A UNESCO report noted that m-learning projects in over 100 developing countries have reached millions, particularly benefiting marginalized groups like girls and rural populations [51]. World Bank data indicate that over 70 % of people in many developing regions own mobile devices, providing a foundation for m-learning expansion [52].

3. Benefits of Mobile Learning

Increased Accessibility

Mobile learning significantly enhances educational access, particularly in developing countries with inadequate infrastructure and overcoming geographical barriers [39; 53; 54]. By eliminating the need for physical classrooms, m-learning enables students in rural and underserved areas to access educational materials [47]. Its flexibility allows students to learn at their own pace and schedule, accommodating those with work or family responsibilities [55; 9].

Enhanced Engagement and Interactivity

Mobile learning platforms incorporate gamified learning and multimedia elements, such as videos, animations, and simulations, which increase student motivation and engagement [56–58]. These features make learning more dynamic compared to traditional text-based methods [59]. Interactive quizzes and immediate feedback reinforce learning and provide prompt responses to student queries [37]. Social media integration and communication tools foster collaborative learning, enabling students to share resources, discuss, and connect with peers and educators, creating a supportive environment [60; 39].

Cost-Effectiveness

Mobile learning is often more cost-effective than traditional education, reducing the need for physical infrastructure, making education scalable in resource-constrained settings [61]. Mobile devices also provide ease of access to printed materials, which are costly and difficult to distribute in rural areas [62; 63]. Many educational applications and resources are available for free or at low cost, making them accessible to a wider audience [42].

Personalized Learning

Mobile learning platforms often include adaptive technologies that tailor content to in-

dividual student needs and learning styles [64; 65; 61]. This customization supports diverse learning requirements and provides targeted instruction, adjusting exercise difficulty based on performance [66; 67].

An Alternative during Emergency

Mobile learning has proven essential during crises, such as the COVID-19 pandemic and natural disasters like flooding in New Delhi [68; 69]. It enables continued education by providing access to materials and facilitating communication between educators and students [70]. According to Al Breiki and Al-Abri, m-learning supports seamless transitions to remote learning during emergencies, allowing students to access resources from home [22; 71].

4. Challenges and Barriers

Technological Limitations

Despite its benefits, mobile learning faces technological constraints in developing countries. Limited or unreliable internet access in rural areas hinders interactive learning and access to multimedia content [72; 73]. For instance, during the covid-19 in the developed world, it was hard for developing countries to use digital technologies to sustain their education systems [74; 75]. High costs of smartphones, tablets, and data plans are significant barriers for low-income households, despite increasing mobile phone ownership [50; 52].

Socio-Economic Factors

Socio-economic disparities, including unequal access to technology and low digital literacy, exacerbate the digital divide [76; 77; 51]. Marginalized communities often lack devices and connectivity, widening educational gaps [78]. Cultural resistance and skepticism about m-learning's effectiveness, particularly in regions valuing traditional education [79; 80]. Negative perceptions of mobile devices on behaviour of students as distractions and concerns about inappropriate use impede adoption [44].

Educational Infrastructure

Many schools in developing countries lack the necessary infrastructure, such as computer labs and internet access, to support m-learning [81]. Teachers often lack training to effectively integrate mobile learning tools into their teaching [46, 82].

Policy and Regulatory Issues

Inconsistent policies and regulations can impede m-learning implementation. Some countries restrict mobile device use in classrooms or lack clear guidelines for m-learning integration [83]. Data privacy and security concerns, particularly regarding student information, also pose challenges [47].

Results

Adoption Rates of Mobile Learning

Mobile learning adoption in secondary schools in developing countries is increasing, driven by government initiatives and affordable devices. India's Digital India program has significantly integrated mobile devices into classrooms, boosting adoption in urban and rural secondary schools [46]. Kenya's Bridge International Academies use mobile learning to deliver quality education in low-cost private schools, achieving widespread uptake among secondary students [84]. UNESCO reports indicate that m-learning initiatives in over 100 developing countries have impacted millions, with a 30 % increase in adoption in Sub-Saharan African secondary schools over the past five years [51].

Impact on Student Performance and Engagement

Research shows that mobile learning enhances secondary school students' engagement and academic performance. In India, students using m-learning platforms for supplementary instruction exhibit improved reading and numeracy skills compared to those using traditional methods [46]. Interactive features, such as quizzes, games, and multimedia, boost motivation and engagement, leading to better academic outcomes [84; 39]. In subjects like chemistry and biology, interactive simulations aid comprehension of complex concepts [86].

Kenya's Bridge International Academies report improved test scores in English and mathematics due to structured m-learning curricula [85]. However, equitable access remains a challenge, as socio-economic disparities limit device and data affordability, potentially widening the digital divide [51]. Technological issues, such as poor internet connectivity and lack of technical support, can also reduce m-learning's effectiveness [73].

Empirical Case Studies on Mobile Learning Implementation in Developing Countries

Croatia

A UNESCO case study on the CARNET Mobile Learning Project in Croatia examines a school-wide initiative integrating mobile technologies into secondary education [54]. Croatia, an upper-middle-income country, has adopted mobile learning to modernize education, aligning with the European Union's digital education strategies. The Croatian Academic and Research Network (CARNET) supports this through infrastructure development and teacher training, as outlined in the national e-Schools program, which aims to improve digital literacy and access [54].

The project enhanced access by providing tablets to students and teachers, enabling flexible learning. It improved educational quality through interactive digital textbooks and collaborative platforms, fostering critical thinking [54]. Challenges included limited internet connectivity in rural schools and initial teacher resistance due to unfamiliarity with mobile pedagogies. Ongoing professional development was required to sustain implementation. The initiative used blended learning, combining traditional instruction with mobile-supported activities, such as project-based learning and collaborative tasks on platforms like Google Classroom [54].

Uruguay

Plan Ceibal, a government-led initiative in Uruguay, is a notable example of mobile learning in a middle-income country [54]. Launched in 2007, Plan Ceibal seeks to reduce the digital divide and promote educational equity by distributing free laptops and tablets to students. Uruguay's national education policy integrates mobile learning into the curriculum, supported by public-private partnerships. The program expanded access to education in rural areas through device distribution and free internet hotspots. It enhanced quality by providing digital platforms with interactive content and real-time feedback, increasing student engagement [54].

Main challenges faced the initiative included high device maintenance costs and uneven teacher training. Some parents viewed mobile devices as distractions, hindering adoption [77]. Plan Ceibal employs student-centered methods, including inquiry-based learning and flipped classrooms, in which students access content via mobile devices before class discussions [54].

Jordan

A study by Aburub and Alnawas explored mobile learning adoption in Jordanian secondary schools, focusing on urban and rural contexts. Jordan, a lower-middle-income country, has incorporated mobile learning into its Education Reform for Knowledge Economy (ERfKE) initiative to enhance digital skills. The Ministry of Education supports this through pilot projects offering subsidized devices and teacher training [87]. Mobile learning improved access by enabling students in remote areas to use smartphones for online resources. It enhanced quality by supporting English language learning through applications, addressing global competency needs [87].

Low internet penetration and limited Arabic-language educational content are the most identifiable challenges. Cultural resistance, particularly from parents, also posed barriers [88]. The study highlighted collaborative learning via mobile applications like WhatsApp and problem-based learning to promote critical thinking [87].

Nepal

The ReMaLIC project in Nepal investigated mobile learning's impact on secondary school students' access to education. Nepal's education policy promotes information and communication technology (ICT) integration, but mobile learning is primarily supported by non-governmental organizations and international partners, such as UNESCO, due to limited government funding. The School Sector Development Plan (2016–2023) encourages digital tools to improve access [77].

Mobile learning facilitated access to English language resources, crucial for employability, using low-cost feature phones. It supported self-directed learning, particularly during school closures. The study discloses gender disparities in device access, with female students having less access than males, and unreliable electricity in rural areas. Teachers reported distractions from non-educational mobile use. The project used context-aware learning, tailoring content to students' environments, and informal learning through SMS-based quizzes and audio lessons [77].

India

The "Home as a Learning Space" initiative, supported by UNICEF, implemented mobile learning to address educational disruptions during the COVID-19 pandemic in India [89]. India, a lower-middle-income country, has integrated mobile learning into its National Education Policy (NEP) 2020, which emphasizes digital education to achieve inclusive and equitable education under Sustainable Development Goal (SDG 4). The government supports platforms like DIKSHA, providing mobile-accessible educational content [90].

The initiative improved access by delivering SMS-based lessons and mobile app content to rural students, where 70 % of India's population resides. It enhanced quality through interactive quizzes and multimedia resources, promoting engagement in literacy and numeracy. Limited internet access in rural areas and high smartphone costs, gender disparities, with girls having less device access due to cultural norms, were significant barriers [77; 89]. Teachers faced difficulties adapting traditional methods to mobile platforms, underscoring the need for training [91]. The initiative used context-aware learning, tailoring content to local languages, and informal learning through SMS quizzes and audio lessons [89].

Other initiatives, like MobiReach and mGuru have significantly impacted rural and underserved secondary school students. MobiReach delivers educational content in local languages via mobile applications, improving literacy and numeracy, with users showing great-

er proficiency in reading and arithmetic. mGuru provides interactive lessons, quizzes, and games aligned with the Indian curriculum, enhancing student engagement and motivation, as reported by teachers [46].

Kenya

Kizilcec et al. examined Eneza Education, a mobile learning platform providing SMS-based lessons during school disruptions caused by election violence in Kenya in 2017 [61]. Kenya, a lower-middle-income country, has a National ICT Policy promoting mobile learning to enhance access, particularly in rural areas [92]. The government supports initiatives like Eneza Education through partnerships with NGOs and private sectors. Eneza Education expanded access using SMS on low-cost feature phones, enabling students in remote areas to continue learning. It improved quality through interactive quizzes and real-time feedback, fostering self-directed learning in mathematics and English [61]. Obstacles with m-learning initiatives include unreliable electricity and limited device ownership in rural areas. Teachers noted concerns about non-educational phone use, and parental support was inconsistent due to work commitments [44]. The platform used self-regulated learning, with students accessing SMS-based quizzes independently, and collaborative learning, encouraging peer interaction through group tasks [61].

Additionally, Bridge International Academies in Kenya use mobile technology to deliver standardized lesson plans and assessments to teachers in low-cost private schools. This approach has improved student performance in English and mathematics, demonstrating m-learning's potential to enhance educational quality in resource-constrained settings [85].

South Africa

A study by Molapo et al. explored a hybrid natural language processing (NLP) peer-assessment system using mobile phones for second-language learning in South African secondary schools [93]. South Africa's Department of Basic Education promotes mobile learning, with e-safety guidelines ensuring responsible use [94; 95]. The NLP system improved access by enabling students in high learner-to-teacher ratio classrooms to receive peer feedback via mobile phones, reducing teacher workload. It enhanced quality by supporting English language learning through real-time feedback, improving writing skills [93].

The system's scalability was cost-effective for resource-constrained settings [77]. The initiatives were characterized by limited access to modern devices and poor internet connectivity in rural schools. Negative attitudes from teachers and parents, associating phones with bullying or distractions, posed barriers [44; 95]. Inadequate teacher training limited effectiveness [93].

Another m-learning initiative in South Africa, is the "MobiLiteracy" program, uses mobile phones to teach reading to children in the early grades. The program provides interactive reading materials and literacy-improving activities to young students in rural locations. According to program evaluations, students who take part in "Mobile Literacy' are more involved in their studies and exhibit greater reading competency than their counterparts who do not use the program. The program demonstrates how well mobile learning works to solve literacy issues in underdeveloped nations [96; 97].

Eritrea

Empirical studies focus specifically on mobile learning in Eritrea are very limited, but Hennessy et al. include Eritrea among low-income African countries implementing mo-

bile-based educational interventions during school disruptions [98]. Eritrea's ICT policy emphasizes technology to improve educational access in remote areas [99], but formal mobile learning policies are limited due to resource constraints and restricted internet access [98]. The Ministry of Education collaborates with NGOs like UNICEF to pilot mobile-based interventions, aligning with SDG 4 [77]. Mobile learning provided access to literacy and numeracy resources via feature phones, supporting learning continuity during disruptions.

The Rora Digital Library Initiative, under the Eritrean Research and Documentation Center, provides offline content via tools like the RACHEL server, supporting mobile learning without internet access [100]. Students and educators with limited or no internet connectivity can access materials including textbooks, videos, and interactive content [101]. Since June 2023, *Rora* has introduced open repositories and workshops to manage multilingual content, supporting lifelong learning and inclusive education [100]. Interventions used informal learning through SMS-based lessons and context-aware learning, adapting content to local languages [98].

The most prominent barriers included restrictive internet policies, limited mobile network coverage, and gender disparities in device access [77]. Additionally, lack of teacher training hindered pedagogical integration [82].

Synthesis of Policies and Teaching Methods

Policies across these regions aim to integrate mobile learning to bridge digital divides and enhance educational equity. Croatia, Uruguay, India, and Kenya have national policies supported by infrastructure investments or partnerships, while Jordan, Nepal, South Africa, and Eritrea rely on pilot projects or external support due to resource constraints [87; 98; 90; 54].

Common teaching methods include:

– Blended learning, combining mobile-supported activities with traditional instruction, as seen in Croatia, Uruguay, India, and South Africa [93; 89; 54].

– Collaborative and peer-assessment learning, using platforms like WhatsApp and NLP systems for group work and feedback, prevalent in Jordan, Kenya, and South Africa [87; 61; 93].

– Inquiry-based and problem-based learning, encouraging critical thinking, as in Uruguay and Jordan [87; 54].

– Self-regulated learning, promoting independent study through SMS-based quizzes, common in Kenya and Eritrea [98; 61].

– Context-aware and informal learning, tailoring content to local contexts via SMS or audio, practiced in India, Nepal, and Eritrea [77; 98; 89].

Discussion

Interpretation of Findings

The findings suggest that mobile learning can significantly enhance education in developing countries, particularly in secondary education. Its accessibility and flexibility address barriers like geographic isolation and inadequate infrastructure [61; 73; 9]. Positive impacts on student engagement [58] and performance in secondary schools highlight m-learning's effectiveness as a supplementary or primary teaching method [66; 61; 85].

However, secondary schools in developing countries often rely on m-learning as an additional resource due to limited infrastructure [102; 82]. Challenges, including technological limitations, socio-economic disparities, and resistance to pedagogical change, hinder widespread adoption, requiring collaborative efforts from governments, institutions, and technology providers [77; 44; 51].

Policy Implications

Effective m-learning implementation requires supportive policies addressing identified challenges. Governments should prioritize digital infrastructure development, ensuring reliable internet and affordable devices for all students. Public-private partnerships can leverage resources to expand access [73]. Policies should promote digital literacy training for teachers and students, equipping educators with technical and pedagogical skills to integrate m-learning effectively [46]. Educational policies must encourage the development of high-quality, culturally relevant content aligned with national curricula and accessible to diverse socio-economic groups [47].

Practical Implications

Educational institutions should develop engaging m-learning platforms with interactive tools like simulations, quizzes, and collaborative features, designed for varying digital literacy levels [39]. Blended learning approaches, combining m-learning with traditional methods, can accommodate diverse schedules and learning preferences, particularly for working students [102]. Establishing communities of practice for educators to share experiences can enhance m-learning initiatives [42]. Continuous evaluation of student performance, engagement, and satisfaction is essential to assess program effectiveness and guide improvements [84].

Conclusion

Mobile learning offers transformative potential for education in developing countries, enhancing accessibility, flexibility, and engagement in school education. Case studies from India, Kenya, South Africa, Eritrea, Croatia, Uruguay, Jordan and Nepal illustrate its practical applications. However, technological limitations, socio-economic disparities, and resistance to change impede widespread adoption. While schools share benefits like improved engagement, differences in resource availability and curricular integration persist. Policies that prioritize infrastructure, teacher training, and equitable device access, alongside innovative teaching methods like blended and collaborative learning, are critical for success.

Recommendations

To maximize mobile learning's impact in developing countries, future efforts should focus on:

1. Researching affordable technologies to improve connectivity and access for low-income households.
2. Developing comprehensive training programs for teachers and students to enhance effective use of m-learning resources.
3. Analyzing policy frameworks to identify best practices for governments and institutions to support m-learning adoption and effectiveness.
4. Conducting longitudinal studies to evaluate m-learning's long-term effects on academic achievement and socio-economic development in developing countries.

Автор прочитал и одобрил окончательный вариант рукописи.
The author has read and approved the final manuscript.

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