OPTIMIZING ONLINE LEARNING PLATFORMS TO ENHANCE EQUITABLE STEM EDUCATION ACCESS FOR REMOTE AND UNDERSERVED COMMUNITIES IN CAMEROON'S NORTH WEST REGION

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Abstract: This research investigates the optimization of online learning platforms to ensure equitable access to STEM education for students in remote and underserved communities in the North West Region of Cameroon. While digital education has the potential to bridge existing educational gaps, significant barriers persist, including limited internet access, inadequate technological infrastructure, and various socio-economic challenges that hinder effective learning. Utilizing a mixed-methods approach that includes surveys, interviews, and case studies, the study focuses on a population of 1379 high school students schooling out of Divisional headquarters and 98 educators from 10 functional secondary schools in the North West Region. A sample size of 155 participants was selected through stratified random sampling to ensure diverse representation across different demographics. Findings indicate that over 79.8% of students cite inconsistent internet access as a major barrier, while 67.4% emphasize the necessity for localized content and language support to enhance understanding. Additionally, active community engagement emerges as a critical factor in significantly boosting participation rates. Key recommendations from the study include the development of hybrid learning models that integrate both online and offline resources to cater for varying access levels, improving mobile accessibility, and creating culturally relevant educational content that emerges from local learners. The research also underscores the importance of implementing community training programs aimed at fostering digital literacy and enhancing effective platform usage.

Keywords: Equitable access, STEM education, Online learning platforms, Remote communities, Digital literacy

Introduction

In recent years, the global shift toward digital education has fundamentally transformed the landscape of learning, particularly in the fields of Science, Technology, Engineering, and Mathematics (STEM). The increasing integration of technology in education has opened new avenues for teaching and learning, enabling students to access resources and knowledge that were previously beyond their reach. Online learning platforms have become invaluable tools in this transition, providing diverse educational materials, interactive simulations, and opportunities for collaboration across geographical boundaries. However, this digital revolution has not occurred uniformly across the globe. In many regions, particularly in developing areas like the North West of Cameroon, the transition to digital education faces significant barriers. Access to quality education remains a critical challenge due to a combination of factors, including limited infrastructure, inadequate technological resources, and socio-economic disparities. For students in remote and underserved communities, these obstacles can hinder their educational progress and limit their opportunities for future success in STEM fields, which are increasingly essential in today's job market. Moreover, the disparities in educational access are often exacerbated by systemic issues such as poverty, lack of trained educators, and insufficient governmental support for educational initiatives. Many communities in the North West region of Cameroon are particularly affected by these challenges, where many students lack reliable internet access and modern learning tools. As a result, the potential benefits of digital education are not fully realized, leaving many students at a disadvantage compared to their peers in more developed communities.

This research thus aims to identify strategies for optimizing online learning platforms to provide equitable access to STEM education for students in these remote and underserved communities. Through a comprehensive analysis of

current online learning practices, the research explores innovative approaches that can be implemented to enhance the accessibility and effectiveness of STEM education in challenging contexts. This includes examining the use of low-bandwidth resources, mobile learning solutions, and community-driven initiatives that can empower local educators and learners alike. Ultimately, the goal is to create a framework that not only supports the immediate educational needs of students in remote and underserved communities in the North West of Cameroon but also serves as a model for similar communities facing comparable challenges. Addressing these specific needs implies working towards a more equitable and inclusive future for STEM education, ensuring that all students have the opportunity to thrive in an increasingly digital world.

Background to the Study

Conceptual Background

Online Learning and STEM Education

Online learning has emerged as a transformative force in education, particularly in the fields of Science, Technology, Engineering, and Mathematics (STEM). Research indicates that online learning can significantly enhance access to STEM education, especially in regions with limited resources (Baker et al., 2020). This mode of education not only broadens access to quality content but also facilitates innovative teaching methodologies that can cater to diverse learning styles.

Bates (2015) asserts that online learning is any form of learning which takes place via the internet. He emphasizes that it can include a range of formats, from fully online courses to blended learning environments that combine online and face-to-face instruction. Siemens (2014) further expands on this by describing online learning as part of a larger ecosystem of "connectivism," where learning occurs through networks and social interactions, rather than through traditional, linear paths. On the other hand, online learning platforms are defined as web-based environments that facilitate the delivery of educational content and manage learning activities, accommodating a variety of instructional methods, including both synchronous and asynchronous formats (Gonzalez et al., 2016). These platforms serve as digital frameworks designed to enhance teaching and learning by providing essential tools for content delivery, communication, and assessment, thereby fostering interactive and student-centered experiences (Alonso et al., 2005). Furthermore, they function as technological solutions that allow educational institutions to offer programs to learners in diverse contexts, significantly increasing accessibility and flexibility in education (Baker, 2018).

One of the most significant advantages of online learning is its ability to reach students in remote or underserved areas. Traditional education systems often struggle to provide comprehensive STEM curricula due to a lack of qualified teachers, resources, and infrastructure. Online platforms can bridge this gap by offering a wide array of courses and materials that students can access from their homes. For instance, platforms like Coursera and edX have partnered with top universities to provide free or low-cost courses that cover various STEM topics, making high-quality education more accessible (Baker et al., 2020).

Barriers to Online Learning in Remote Communities

Inconsistent and Unreliable Connectivity: In many remote areas, internet access is limited or sporadic. This inconsistency can significantly disrupt online learning experiences, as students may struggle to connect to classes or access learning materials. Studies like Wang et al. (2021) illustrate that students in these regions often face frustration when they are unable to participate fully due to connectivity issues. The digital divide exacerbates educational inequities, making it challenging for students to keep pace with their peers in more connected environments. Moreover, those with intermittent access might miss critical updates or live sessions, hindering their overall academic progress.

Limited Availability of Devices and Learning Resources: Olaseni & Tella (2020) highlight that many students in remote communities lack access to necessary technological tools such as laptops, tablets, or even smartphones. This lack of devices can create a significant barrier to effective online participation. Additionally, the absence of appropriate learning resources, such as interactive software, e-books, and supplementary materials, limits students'

ability to engage deeply with the curriculum. Even when devices are available, issues such as inadequate technical support and outdated technology can further complicate the learning process, leading to disengagement and reduced motivation among students.

Lack of Localized Content and Language Support: García & Wei (2014) discuss how cultural and linguistic barriers can hinder online learning. In many remote communities, educational content may not be tailored to reflect the local culture or language, which can alienate students and affect their comprehension. The lack of localized content means that students may find it difficult to relate to the material, leading to decreased engagement. Furthermore, if educational platforms do not offer support in native languages, non-native speakers may struggle to understand key concepts, which can significantly impact their learning outcomes. While the mentioned barriers are significant, other factors also play a role:

Socioeconomic Challenges: Many students in remote areas may come from low-income households, which can affect their ability to access online learning resources. Families may prioritize immediate needs over educational technology, and students might need to work to support their families, further limiting their study time.

Lack of Training and Support: Instructors and students alike may lack the necessary training to effectively utilize online learning platforms. This includes not only technical skills but also understanding how to engage students in a virtual environment. Without proper training, both educators and students may struggle to adapt to online learning formats.

Isolation and Motivation: Students in remote communities might also experience feelings of isolation when engaging in online learning. The lack of face-to-face interaction with peers and teachers can lead to decreased motivation and a sense of disconnection from the educational process.

The Role of Community Engagement in Education

Community engagement plays a crucial role in creating a supportive environment for learning, significantly impacting educational outcomes. Engaging local stakeholders, such as parents, local businesses, community organizations, and government entities, can enhance participation rates and ensure that educational content is relevant and aligned with community needs (Miller et al., 2019).

Enhancing Participation Rates: Research indicates that when communities are actively involved in educational processes, participation rates among students and families tend to increase. For instance, a study by Epstein and Sheldon (2002) highlights that schools that foster partnerships with families and the community witness higher levels of student attendance and achievement. These partnerships can take many forms, including volunteer programs, mentorship opportunities, and collaborative projects, all of which encourage a sense of belonging and investment in the educational system.

Aligning Educational Content with Community Needs: Moreover, community engagement helps tailor educational content to better reflect the interests and needs of the local population. According to a report by the National Education Association (NEA, 2018), schools that involve community input in curriculum development are better equipped to address local issues and cultural contexts. This alignment not only makes learning more relevant for students but also enhances their engagement and motivation. For example, incorporating local history and community issues into the curriculum fosters a deeper connection between students and their learning environments (Hammond, 2015).

Building Supportive Networks: Engaging with community stakeholders also facilitates the development of supportive networks that can aid in resource mobilization. As noted by Shulman (2004), community partnerships can lead to increased funding opportunities, volunteer support, and access to local expertise. Schools that leverage these networks can implement programs that might otherwise be unattainable, thereby enriching the educational experience.

Promoting Equity and Inclusion: Furthermore, community engagement plays a vital role in promoting equity and inclusion within educational settings. According to a study by Brinson and Steele (2019), schools that actively

engage underrepresented groups in decision-making processes are more likely to address barriers to education and provide equitable access to resources. This inclusion fosters a sense of ownership among community members and ensures that diverse voices are heard in the educational discourse.

Theoretical Background

Digital Divide Theory: *The concept of the digital divide refers to the disparities in access to information and communication technology (ICT) between different socioeconomic groups. This divide is particularly pronounced in remote and underserved regions, where infrastructure and resources are often limited. Warschauer (2004) emphasizes that bridging the digital divide is essential for ensuring equitable access to education, particularly in STEM fields, which increasingly rely on technology. In the context of the North West Region of Cameroon, understanding and addressing this divide is crucial for optimizing online learning platforms.*

Equity Theory in Education: *Equity theory, as articulated by Rawls (1971), posits that social justice should guide educational policies and practices. In STEM education, this entails ensuring that all students, regardless of their background or geographic location, have access to high-quality learning resources. This theory underscores the necessity of creating inclusive online learning environments that cater to the specific needs of students in remote communities, where traditional educational resources may be lacking.*

Community of Inquiry Framework: *The Community of Inquiry (CoI) framework, developed by Garrison, Anderson, and Archer (2000), is instrumental in understanding the dynamics of online learning environments. This framework emphasizes three critical elements: cognitive presence, social presence, and teaching presence. Optimizing online learning platforms for the North West Region involves fostering these elements to create a supportive learning community that encourages engagement and collaboration among students, thus enhancing their STEM learning experiences.*

Culturally Relevant Pedagogy: *Culturally relevant pedagogy, as proposed by Ladson-Billings (1994), emphasizes the importance of incorporating students' cultural backgrounds into the learning process. For online STEM education to be effective in the North West Region of Cameroon, it must recognize and integrate local contexts, challenges, and resources. This approach not only enhances engagement but also fosters a sense of belonging and relevance among students.*

Contextual Background

Cameroon's educational sector is indeed grappling with a myriad of challenges that are deeply rooted in socio-economic disparities and geographical barriers. The North West Region, in particular, presents significant hurdles due to its mountainous terrain and insufficient infrastructure. These factors contribute to a fragmented education system where access to quality education is unevenly distributed. Many rural communities are isolated, leading to a lack of schools in close proximity. According to the World Bank (2022), the uneven distribution of educational facilities in Cameroon exacerbates regional inequalities, with rural areas often lacking basic educational resources. The scarcity of roads and public transport further hampers access, forcing children to travel long distances, sometimes under hazardous conditions, to attend school.

Socio-economic factors also play a crucial role in educational access. Families in rural areas typically have lower incomes and may prioritize immediate economic contributions over educational attainment. The United Nations Development Programme (UNDP, 2023) notes that poverty remains a significant barrier to education, with many families unable to afford school fees, uniforms, or supplies. This economic strain disproportionately affects girls, who are often withdrawn from school to assist with household chores or to marry at a young age. The COVID-19 pandemic has further highlighted these existing inequalities. While the crisis accelerated the adoption of online learning, it also exposed the digital divide in Cameroon. A report by UNESCO (2023) indicated that less than 25% of households in rural areas had access to the internet, compared to over 60% in urban settings. This disparity meant that many students in the North West Region were unable to participate in remote learning initiatives during school closures, leading to significant learning losses. The pandemic has also disrupted educational progress by straining already limited resources and increasing dropout rates.

In response to these challenges, various stakeholders are working to improve access to education in the North West Region. Initiatives aimed at enhancing infrastructure, such as the construction of new schools and roads, are underway. Additionally, programs focusing on digital literacy and providing technological support are being implemented to bridge the gap in online education (Save the Children, 2023). The Cameroonian government,

alongside NGOs, is also emphasizing the need for inclusive education policies that prioritize marginalized groups, including girls and students from low-income families. Thus, while Cameroon's educational sector faces substantial challenges, particularly in romote communities in the North West Region, concerted efforts from both the government and non-governmental organizations are essential to address these barriers. Plan According to Plan International (2023), continued investment in infrastructure, technology, and inclusive educational policies will definitely be crucial to ensuring that all children have access to quality education, irrespective of their geographical or socio-economic circumstances.

Statement of the Problem

Access to quality STEM education remains a critical challenge for students in remote and underserved communities in Cameroon's North West Region. While online learning platforms present an opportunity to bridge educational disparities, multiple barriers hinder their effectiveness. Limited internet access, inadequate technological infrastructure, unreliable electricity supply, and financial constraints significantly restrict students' ability to engage with digital learning resources. Additionally, the lack of localized content and language support reduces comprehension and learning outcomes, further widening the educational gap.

Despite the potential of digital education to democratize learning, many students and educators struggle with the necessary digital literacy skills to navigate online platforms effectively. Schools also face systemic funding challenges that prevent them from implementing and sustaining online learning initiatives. Without targeted interventions, these issues will continue to perpetuate inequalities, limiting students' access to STEM education and future opportunities.

This study seeks to address these challenges by exploring strategies to optimize online learning platforms, ensuring they are accessible, inclusive, and tailored to the needs of students in remote areas. By identifying key barriers and proposing innovative solutions, this research aims to contribute to the development of sustainable digital education models that enhance equitable STEM education access.

Research Objectives

The primary objectives of this research are:

- To identify the barriers to accessing online STEM education in remote communities in the North West Region of Cameroon.
- To explore the potentials of online learning platforms in enhancing educational equity in remote communities in the North West Region of Cameroon.
- To recommend practical strategies for optimizing these online learning platforms to meet the needs of underserved populations in remote communities in the North West Region of Cameroon.

Research Questions

- What are the barriers to accessing online STEM education in remote communities in the North West Region of Cameroon?
- What are the potentials of online learning platforms in enhancing educational equity in remote communities in the North West Region of Cameroon?
- What are some practical strategies for optimizing online learning platforms to meet the needs of underserved populations in remote communities in the North West Region of Cameroon?

Methodology

A mixed-methods approach was employed to gather comprehensive data on the experiences of students and educators regarding online learning. Specifically, the study adopted the exploratory sequential design in which the qualitative data was collected first to explore the phenomenon of online learning, followed by quantitative data collection to generalize the results. This approach was particularly useful because there was little existing research on

the topic in the North West region of Cameroon. Thus, the design included a qualitative interview followed by a quantitative survey. The study focused on a population of 1,379 high school students and 98 educators from 10 secondary schools in romote communities in the North West Region. A stratified random sampling method was used to select 155 participants, ensuring representation across various demographics. Firstly, in-depth interviews with teachers provided qualitative insights into the challenges and opportunities of online learning. This was followed by quantitative data gathering using structured questionnaires, focusing on internet access, content relevance, and user experience. The qualitative data were coded and thematically analyzed to extract key themes which the researcher explored by including on the questionnaire. Simple percentages were used in analysing the quantitative data.

Findings

Barriers to Accessing Online Learning

The findings revealed that the major barriers in accessing online learning in romote areas in the North West Region are: inconsistent internet access (79.8%), unavailabilty of online learning devices such as mobile phones and compupers (73.3%), epileptic electricity supplies (86.2%), socioeconomic challenges (60.8%), lack of training (53.7%), lack of sufficient funding by schools to implement and maintain online learning initiatives (88.4%), non-localized content to improve understanding and engagement (67.4%). The findings further revealed that the following barrieres were non negligeable: inability to access online materials (36.2%), lack of mentoring services for students (31.85%), limited community engagement in educational initiatives (24.9%), lacl of self-motivation and discipline when learning online (21.6%)

Potentials of online learning platforms in enhancing educational equity

The findings revealed that the online learning platforms have a wide range of potentials in enhancing educational equity especially for those in remote communities in the North West region of Cameroon. Some of these potentials include: providing wider range of educational materials to all (74.8%), customized learning experiences (53.1%), learning anytime and anywhere (60.7%), reduced travel and material costs (51.9%), professional development opportunities for teachers (59.8%), building virtual learning communities (67.9%), partnership opportunities (59.3%), local content integration (64.6%) and providing inclusive learning environments (79.2%).

Practical strategies for optimizing online learning platforms to meet the needs of underserved populations

The findings suggests that practical strategies for optimizing online learning platforms to meet the needs of remote communities include: Collaborating with government and telecom providers to expand broadband coverage and ensure affordable internet access (56.3%), developing downloadable content and offline resources to help students continue learning without constant internet access (69.1%), involving local educators in the development of STEM curricula that reflect the cultural context (83.4%), providing learning materials in local languages alongside English and French can make the content more accessible (66.2%), designing online learning platforms with intuitive interfaces can help students and teachers navigate the system more easily (57.5%), incorporating visual aids and step-by-step guides can further enhance usability (67.2%), optimizing online learning platforms for mobile access can ensure that more students participate in online learning (64.6%), offering ongoing training and support for students on how to effectively utilize online learning platforms (73.4%), implementing systems to collect data on student engagement, performance, and feedback to help in the continuous optimization of online platforms (62.9%).

Discussion of Findings

A predominant barrier identified is inconsistent internet access, reported by 79.8% of respondents. This aligns with research by Nji et al. (2022), which emphasizes that reliable internet connectivity is essential for effective online education. Without stable access, students are unable to participate in live classes or access necessary resources, exacerbating educational inequalities in rural areas. The unavailability of devices, noted by 73.3% of participants, further compounds the issue. As Tchamyou et al. (2021) highlight, access to technology is a critical determinant of educational equity; students without smartphones or computers are effectively excluded from digital learning

opportunities. Additionally, the impact of epileptic electricity supplies, reported by 86.2%, cannot be overlooked. Frequent power outages create significant barriers to consistent online engagement, a finding supported by Ngwa et al. (2023), who argue that stable electricity is fundamental for successful digital education initiatives.

Socioeconomic challenges, cited by 60.8% of respondents, also play a crucial role in limiting access. Asong & Mbeng (2020) point out that financial constraints can prevent families from affording internet services and necessary devices, reinforcing existing educational disparities. Coupled with a lack of training for teachers (53.7%), which hampers their ability to effectively deliver online instruction, these barriers create a multifaceted challenge that affects educational outcomes. The insufficient funding for schools to implement and maintain online initiatives, highlighted by 88.4% of participants, underscores the systemic nature of these issues. Research consistently shows that adequate funding is necessary to develop and sustain effective educational programs (Tchamyou et al., 2021). Moreover, the prevalence of non-localized content, which affects 67.4% of respondents, limits students' engagement and understanding of the material, reinforcing the need for culturally relevant curricula (Asong & Mbeng, 2020).

Further barriers include the inability to access online materials (36.2%) and a lack of mentoring services for students (31.85%), which can significantly hinder academic progress. Limited community engagement in educational initiatives (24.9%) suggests that local support structures are not sufficiently involved in promoting online learning, which is crucial for motivation and success. Finally, a lack of self-motivation and discipline when learning online (21.6%) points to the challenges of independent study in the absence of structured support.

Potentials of online learning platforms in enhancing educational equity in remote communities in the North West Region of Cameroon

First, the ability to provide a wider range of educational materials, cited by 74.8% of respondents, supports the notion that online platforms can democratize access to resources that may be limited in traditional settings. As Asong & Mbeng (2020) note, increased access to diverse learning materials can help bridge the educational gap for students in underserved areas, providing them with opportunities that align with national curricula and global standards. Moreover, the customization of learning experiences, reported by 53.1% of participants, is critical for meeting individual learner needs. This aligns with the work of Ngwa et al. (2023), who emphasize that personalized learning paths can enhance student engagement and academic success, especially in diverse classrooms. The flexibility to learn anytime and anywhere, highlighted by 60.7% of respondents, further empowers students by allowing them to balance education with other responsibilities, a crucial factor in rural settings where traditional schooling may be less accessible (Tchamyou et al., 2021).

Additionally, the findings indicate reduced travel and material costs for 51.9% of participants, which resonates with empirical evidence suggesting that online education can alleviate financial burdens associated with commuting and purchasing physical materials (Nji et al., 2022). This reduction in costs is particularly beneficial for families in remote areas, where transportation can be both time-consuming and expensive. The potential for professional development opportunities for teachers, acknowledged by 59.8% of respondents, also plays a vital role in enhancing educational quality. Research indicates that continuous training can significantly improve teaching practices and student outcomes (Nji et al., 2022). Furthermore, the ability to build virtual learning communities, as noted by 67.9% of participants, fosters collaboration and a sense of belonging, which are essential for motivating learners (Asong & Mbeng, 2020).

Partnership opportunities (59.3%) that arise from online platforms can lead to collaborations with NGOs and educational organizations, enhancing resource availability and support. Lastly, the integration of local content (64.6%) and the provision of inclusive learning environments (79.2%) highlight the platforms' capacity to make education relevant and accessible to all students, particularly those with diverse needs. This aligns with the findings of Tchamyou et al. (2021), who argue that culturally relevant and inclusive educational practices are essential for fostering engagement and retention in learning.

Practical strategies for optimizing online learning platforms to meet the needs of underserved populations in remote communities in the North West Region of Cameroon

One key strategy is collaborating with government and telecom providers to expand broadband coverage and ensure affordable internet access, which 56.3% of respondents emphasized. This is crucial, as reliable internet connectivity is a foundational element for successful online education. Nji et al. (2022) underscore that partnerships with telecom companies can facilitate infrastructure development, making educational resources more accessible to remote areas. Developing downloadable content and offline resources, highlighted by 69.1% of respondents, addresses the challenges posed by inconsistent internet access. Offline materials enable continuous learning without the need for constant connectivity, supporting findings by Tchamyou et al. (2021), which advocate for hybrid learning models that combine online and offline resources to enhance educational equity.

Involving local educators in the development of STEM curricula that reflect the cultural context, as noted by 83.4% of participants, is critical for relevance and engagement. According to Asong & Mbeng (2020), culturally relevant curricula not only improve student interest but also foster a sense of belonging and connection to the material, ultimately enhancing learning outcomes. The importance of providing learning materials in local languages alongside English and French, as indicated by 66.2% of respondents, cannot be overstated. Research suggests that using local languages in education can significantly improve comprehension and retention (Ngwa et al., 2023), making learning more accessible for students who may struggle with instruction in a second language.

Additionally, designing online learning platforms with intuitive interfaces (57.5%) and incorporating visual aids and step-by-step guides (67.2%) can significantly enhance usability for both students and teachers. Empirical studies demonstrate that user-friendly designs facilitate engagement and reduce frustration, making technology more approachable for users with varying levels of digital literacy (Tchamyou et al., 2021). Optimizing online learning platforms for mobile access, as emphasized by 64.6% of respondents, is essential given the prevalence of mobile devices in remote communities. Research shows that mobile optimization can increase participation rates, allowing students to learn in a manner that aligns with their access to technology (Asong & Mbeng, 2020).

Offering ongoing training and support for students to effectively utilize online learning platforms, as highlighted by 73.4% of participants, ensures that learners can navigate digital resources confidently. This is supported by Nji et al. (2022), who advocate for comprehensive training programs to empower students and improve educational outcomes. Finally, implementing systems to collect data on student engagement, performance, and feedback (62.9%) is critical for the continuous optimization of online platforms. Data-driven approaches allow educators and administrators to identify areas for improvement, tailor educational experiences, and enhance overall platform effectiveness (Ngwa et al., 2023).

Recommendations

Develop Hybrid Learning Models*:* Educational policymakers and curriculum developers should design hybrid learning models that integrate both digital and traditional resources to improve accessibility.

Improve Mobile Accessibility*:* Technology developers and platform providers must optimize online learning platforms for mobile devices, acknowledging the widespread use of mobile technology in remote areas.

Create Culturally Relevant Content*:* Educators and content creators should develop localized educational materials that align with the cultural backgrounds and learning needs of students.

Implement Community Training Programs*:* Schools, NGOs, and local authorities should implement community training programs to enhance digital literacy among students, educators, and community members, ensuring effective platform usage.

Conclusion

This study highlights the significant challenges and opportunities associated with optimizing online learning platforms to enhance equitable STEM education access in remote and underserved communities in Cameroon's North West Region. Findings indicate that inconsistent internet access, lack of technological infrastructure, financial constraints, and non-localized content are major barriers preventing effective digital learning. However, the study

also reveals that online platforms have immense potential in bridging educational disparities by providing accessible, flexible, and inclusive learning opportunities.

To maximize these benefits, strategic interventions are necessary. Key recommendations include expanding broadband access, integrating offline learning resources, developing culturally relevant curricula, and providing comprehensive digital literacy training for both students and educators. Additionally, fostering partnerships between government, educational institutions, and technology providers can facilitate the sustainable implementation of online learning solutions.

By addressing these challenges through targeted strategies, online learning platforms can become powerful tools for improving STEM education accessibility in Cameroon's remote regions. This study contributes to the ongoing discourse on digital education equity and provides a foundation for policymakers and stakeholders to implement practical, scalable solutions that empower students with the knowledge and skills necessary for future success.

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