Towards inclusive and accessible e-learning in gauteng classrooms: An ICT integration framework for South African schools

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ABSTRACT

South Africa has attempted to enhance its education system. It has achieved this by employing information and communication technology (ICT) to bridge the digital divide and enhance educational outcomes. Despite substantial government investment in e-learning, particularly in Gauteng township schools, its use remains inequitable, and classrooms lack true accessibility and inclusivity. This study examines the barriers to ICT implementation in schools, evaluates the effectiveness of existing e-learning approaches, and proposes strategies to enhance the accessibility and inclusivity of ICT. The study conceptualises an ICT integration model, emphasising equity-centred access, teacher agency, learner-centric design, and the promotion of communicative engagement. The study employs a mixed-methods approach that incorporates desktop and systems reviews, informed by an ethnographic perspective. Qualitative data was collected through interviews, analysed through coding and thematic analysis and quantitative data through semi-structured questionnaires and analysed through regression analysis. The study noted that numerous factors influence the accessibility of e-learning in educational institutions, such as policy goals, infrastructure investment, and ict strategy implementation. The results also observed that there are still educators' pedagogical training challenges that need to be addressed and there is a need for investments in more educational resources: ict tablets and connectivity to enhance access of educational materials to learners and educators. The study recommends that there should be increased ict resources support to schools by the Department of Education and training on pedagogy and educator change management to ensure that there is successful ict utilisation in the classroom.

Keywords: *Connectivity, E-Content, E-Learning, ICT, Integration, Rollout.*

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Highlights of this paper

- The Gauteng Department of Education's e-learning initiative has been successful.
- More than 50 schools in the province are fully ICT compliant, equipped with high-tech assistive devices and tablets loaded with educational content.
- ICT literacy levels in the province have increased by 3.9% since the launch of e-learning.

1. INTRODUCTION

After 1994, South Africa went through a period of change in which it worked to address social and economic problems and make education a bigger part of economic growth (Ajayi, 2022). In this situation, information and communication technology (ICT) became an important instrument for making education more accessible and inclusive. The National Development Plan and the Department of Basic Education (DBE) e-Learning Strategy guided major policy and financial investments in educational ICT infrastructure. In response, the Gauteng Department of Education (GDE) launched a phased e-learning strategy in 2015. Phase 1 involved the transformation of six secondary schools and one primary school into digital schools. In Phase 2 (2019–2022), the number of no-fee township schools grew to 377 (Ajayi, 2022). In addition to building infrastructure, the GDE also trained teachers through the Mathew Goniwe School of Governance and Leadership (MGSLG), which helped instructors become more familiar with ICT (Bahati, 2018; Mabasa, 2024).

2. BACKGROUND

Despite this multifaceted approach, classroom-level integration remains inconsistent, prompting a need for deeper inquiry. The ICT rollout targeted schools with excellent academic performance to maximise return on investment (Baleni, 2015), aligning with global evidence emphasising ICT's role in developing 21st-century skills such as digital literacy, problem-solving, and collaborative learning (Costa, Ntsobi, & Nyamkure, 2021). In response, the GDE created a detailed plan with nine main areas of focus: improving infrastructure by renovating classrooms for digital learning, increasing internet access, and providing network-enabled devices; offering training programmes for teachers and students; implementing security measures like tracking devices and controlling their use; integrating ICT into the curriculum to match DBE learning goals; providing maintenance and technical support through ICT Champions in schools; supplying preloaded e-content; giving personal tablets or laptops to teachers and students; and emphasising research and innovation to ensure that decisions are based on data. Despite this multifaceted approach, classroom-level integration remains inconsistent, prompting further investigation into the factors affecting effective ICT adoption at the point of use.

3. PROBLEM STATEMENT

South Africa is a middle-income nation with significant potential for ICT infrastructure, and the government allocates an average of 62% of its budget to education. Over the past decade, there has been substantial investment in e-learning to improve teaching and learning using technology, aiming to increase educational outcomes. Despite observable enhancements in performance output and outcome quality in basic education, the anticipated transformations that e-learning should facilitate in teaching and learning have not yet materialised. The potential to enhance the inclusivity, accessibility, and efficacy of ICT in the classroom remains. The study seeks to conduct a systematic review of the efficacy of strategies and approaches, the implementation of policies, and the practical circumstances in Gauteng schools (Böhmer & Kruger, 2024; Ntsobi & Costa, 2022; Timotheou et al., 2022).

4. SIGNIFICANCE OF THE STUDY

This study provides a number of important contributions to both policy and academia. The study proposes a scalable e-learning integration architecture, proving to be a valuable model for broader application in other provinces and emerging countries. It also adds to the current body of knowledge by filling a major gap in empirical data on ICT in education from a South African perspective. The research also presents us evidence-based information that can help us make better decisions about how to use ICT in the future and how to teach it. The report stresses how important it is to teach students digital skills that will let them fully participate in the Fourth Industrial Revolution from an economic perspective. The goal of these contributions is to help make teaching and learning more effective by using technology to improve education (Siddiqullah, Vijayakumar, & Arif, 2024).

5. RESEARCH OBJECTIVES AND QUESTIONS

5.1. Research Objectives

To create an e-learning framework that makes ICT more accessible, inclusive, and integrated in Gauteng classrooms.

1. To examine the factors that influence the accessibility of e-learning in educational institutions.
2. To ascertain the efficacy and rapidity of e-learning in enhancing educational outcomes.
3. To develop a framework for the integration of ICT that is effective for township schools.
4. To formulate policy recommendations for transforming education using ICT.

5.2. Research Questions

This study investigates the subsequent questions addressing the above objectives:

1. What factors influence the accessibility of e-learning in Gauteng schools?
2. To what extent does the current e-learning approach enhance educational outcomes?
3. What type of framework can be established to facilitate the inclusive utilisation of ICT in township schools?
4. What recommendations may be proposed for policies to enhance the utilisation of ICT in education?

6. LITERATURE

6.1. Introduction of ICT in Gauteng

The Gauteng Department of Education (2015) has initiated a transformational journey by introducing Information Communication Technology (ICT) as a transformative tool for curriculum delivery. The project was conceptualised in 2015 and was linked to the term of the 5th political administration. The vision was clearly outlined and driven by the Member of the Executive Council (MEC), who argued that "Technology is the future; you cannot use 20th-century teaching methods in the 21st century." The Executive Management Team (EMT), under the leadership of the MEC, held weekly accounting sessions and made the necessary interventions where required. The Premier of the Gauteng Province and the Gauteng Provincial Government also provided guidance and support for the GDE ICT rollout. As a result, the project was profiled as one of the key deliverables of the 5th Gauteng Political Administration (Dlamini, 2022; News24, 2021; Observatory of Public Sector Innovation, 2019).

The ICT project in Gauteng schools does not provide a panacea for all educational challenges facing the provincial education system. However, it can function as an enabler to change the classroom experience. Educators can divert from rudimentary teaching methods to technology-aligned teaching methods for curriculum delivery and improved learner engagement. The assumption is that using technology would lead to a better and faster understanding of subjects such as mathematics, science, and technology, resulting in knowledge creation (Mnisi,

Mtshali, & Moses, 2024). Educators are also empowered to deliver knowledge better and more easily with ICT resources such as computers, iPads, and smart boards, to name but a few (Carstens, Mallon, Bataineh, & Al-Bataineh, 2021). This evidence indicates that introducing ICT in Gauteng schools could positively impact the quality of the curriculum, thereby empowering learners to be prepared for the workplace by acquiring new skills and knowledge that they can use in the future (Ntsobi & Costa, 2022).

Gauteng has specific aspirations and limitations that direct the type of models GDE can apply. The aspiration entails upskilling educators to facilitate learners advancing at different paces, with the teacher primarily using an interactive board. The limitations are driven by budget constraints that prevent completely reconfiguring classrooms. Based on the existing Curriculum Assessment Policy Statements (CAPS) curriculum (Ndwandwe, Sylvia, & Mtshali, 2024) the model focuses on improving outcomes. Considering this, the tech-enabled model fits GDE's ambition, with blended learning being the aspirational model. A full transformation will require significant changes to educator training, school infrastructure and the use of educational devices (Mulenga & Shilongo, 2024).

Despite the undeniable significance of ICT utilisation in educational institutions, there are clear obstacles that complicate the comprehensive deployment of ICT in schools nationwide. Researchers ascertain that the implementation of Management Information Systems (MIS) within an institution is prohibitively costly, especially when establishing a comprehensive system for the entire school (Chomunorwa, Mashonganyika, & Marevesa, 2022). Moreover, the requisite infrastructure, including the hardware and software needed for a comprehensive ICT transformation, can be expensive. This discovery arises from the increasing expenses of technology (Mhlanga, 2024). Consequently, the study seeks to investigate the incorporation of technology to improve teaching and learning in Gauteng public schools.

6.2. Conceptualisation of E-Learning in Gauteng

The Sci-Bono Discovery Centre is the largest science centre in the Southern Hemisphere, in the Gauteng Province and city of Johannesburg. It was established in 2004 to promote science, technology, research, reading, engineering, arts, and mathematics (STREAM) education. There are thirty-five (35) South Africa Agency for Science and Technology Advancement (SAASTA)-accredited science centres in eight of South Africa's nine provinces. A science centre is a unique and valuable educational tool for schoolchildren in South Africa, as it provides an interactive learning environment that allows them to explore science and technology and develop their knowledge and understanding of the subject matter. Science centres are a great way to engage and motivate students because they provide an environment in which they can explore, experiment, and interact with the material they are learning. Science centres in South Africa have demonstrated their effectiveness in enhancing education and teaching (Ntsobi & Mwale, 2025; M. P. Ntsobi & Nyamkure, 2025).

In this case study, focus is on the Sci-Bono Discovery Centre (Sci-Bono), owing to the centre's long-term relationship with the Department of Basic Education (DBE), and specifically, the Gauteng Department of Education (GDE). The Sci-Bono is a hands-on facility that offers a variety of interactive exhibits, activities, and programmes for all ages. The centre has a wide range of permanent exhibitions that focus on sciences, mathematics, and technology. It also features a variety of temporary exhibitions and educational programmes that are specifically designed to engage visitors in the sciences. This includes lectures, workshops, and demonstrations that help visitors understand the science behind various topics. Sci-Bono also offers a variety of programmes designed to foster science education in Gauteng Province. The centre also offers a range of after-school programmes and summer camps that help to foster a culture of science and technology in the province (Ntsobi & Mwale, 2024).

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With respect to AI in education, Sci-Bono has proven to be a trailblazer in this regard. Through its IT Academy, Youth Club and 4IR exhibit, it has provided advanced technology and AI exposure and training. For example, Sci-Bono uses robotics (humanoids) to advance science education interest in a variety of ways as educational tools. Humanoid robots are robots that resemble humans in some form and are capable of performing certain tasks. The centre uses humanoid robots to teach various topics such as science, technology, engineering, and mathematics (STEM) to school-age children. The robots serve as a hands-on way of teaching complex concepts, allowing children to engage with the robots in a tangible way. Moreover, more than 50 Schools in the Province are fully ICT compliant with high-tech assistive devices and tablets loaded with educational content. ICT literacy level in the Province has increased by 3.9% since the launch of e-learning (Ntsobi & Mwale, 2024).

7. METHODOLOGY

7.1. Research Design

This study used a mixed-methods methodology, incorporating both quantitative and qualitative approaches, to offer a comprehensive perspective on the inclusivity and accessibility aspects of ICT e-learning implementation in Gauteng schools (Ahmed, Pereira, & Jane, 2024). This approach facilitated the triangulation of data sources and methodologies, enabling the study to attain a more profound understanding and insight into crucial issues, particularly those concerning the sustainability of ICT integration in educational institutions (Donkoh & Mensah, 2023). The research examined academic journals, policy documents, and assessment reports from 2015 to 2023 to understand the trajectories and challenges of ICT policy in South Africa (Costa et al., 2021).

7.2. Sampling

The research utilised a purposive sampling method, involving a population comprising three specific stakeholders: 10 educators who have implemented ICT for the past five years, 10 Grade 12 students who have benefited from the ICT programme since their enrolment in secondary education, and 5 school principals managing ICT schools that have engaged in the programme for five or more years (Campbell et al., 2020; Hossan, Dato'Mansor, & Jaharuddin, 2023).

7.3. Data Analysis

Semi-structured interviews were performed with all participants, including learners, teachers, and principals, to investigate diverse perspectives on ICT integration, while emphasising equity, access, and sustainability. A focus group methodology was employed to examine the collective shared experiences of the sample population. Qualitative data were analysed through thematic analysis with coded guides that concentrated on the five examined variables: equity, teacher agency, learner centricity, community participation, and monitoring and evaluation. The

quantitative data employed descriptive statistics to identify trends in ICT access and utilisation (Lochmiller, 2024; Mashuri, Sarib, Rasak, Alhabsyi, & Ruslin, 2022).

7.4. Ethical Considerations

This study, conducted under the auspices of Sci-Bono, received ethical approval from the research ethics committee of Sci-Bono Discovery Centre, which partnered with GDE to acquire consent for the project's implementation. The ethical approval process secured informed consent from the parents of the learners who voluntarily participated in the study, ensuring confidentiality and anonymity (Kang & Hwang, 2023).

7.5. Research Ethnography

The ethnographic perspective of the study was shaped by the researchers' involvement in the development and execution of the e-learning programme and Sci-Bono's ICT effort, providing them with substantial insight into the interplay between policy and practice. The analysis of implementation realities relies on observations, informal feedback from stakeholders, and reflections from practitioners (Luthfiandana, Smith, & Patel, 2024).

8. PRELIMINARY FINDINGS

This study introduces an ICT Integration Framework aimed at enhancing inclusive and accessible e-learning in Gauteng schools. It is based on five core variables to advance equity in ICT integration and create a sustainable ICT integration in South African schools. The study anticipates forming a framework that emphasises:

- Equity-Centred Access: Prioritizing historically disadvantaged schools.
- Teacher Agency: Ongoing professional development and support networks.
- Learner-Centric Design: Contextualized e-content for different learning styles.
- Community Engagement: Parents and local stakeholders in implementation.
- Monitoring & Evaluation: Real-time data to inform adaptive strategies.

Figure 1 shows the framework for enhancing inclusive and accessible e-learning in Gauteng schools. As such, the figure 1 shows that equity-centred access focuses on closing gaps by giving historically disadvantaged schools more resources and making sure that infrastructure, like reliable internet access and devices, is designed to meet the requirements of communities that do not have enough of them. This strategy calls for policy changes that will eliminate systemic inequities so that all students can obtain high-quality digital content. Second, teacher agency stresses how important it is to provide teachers the tools they need to improve their digital literacy and produce new ways to teach. Helping people build professional learning communities and support networks encourages them to work together, solve problems, and stay motivated (Gottschalk & Weise, 2023).

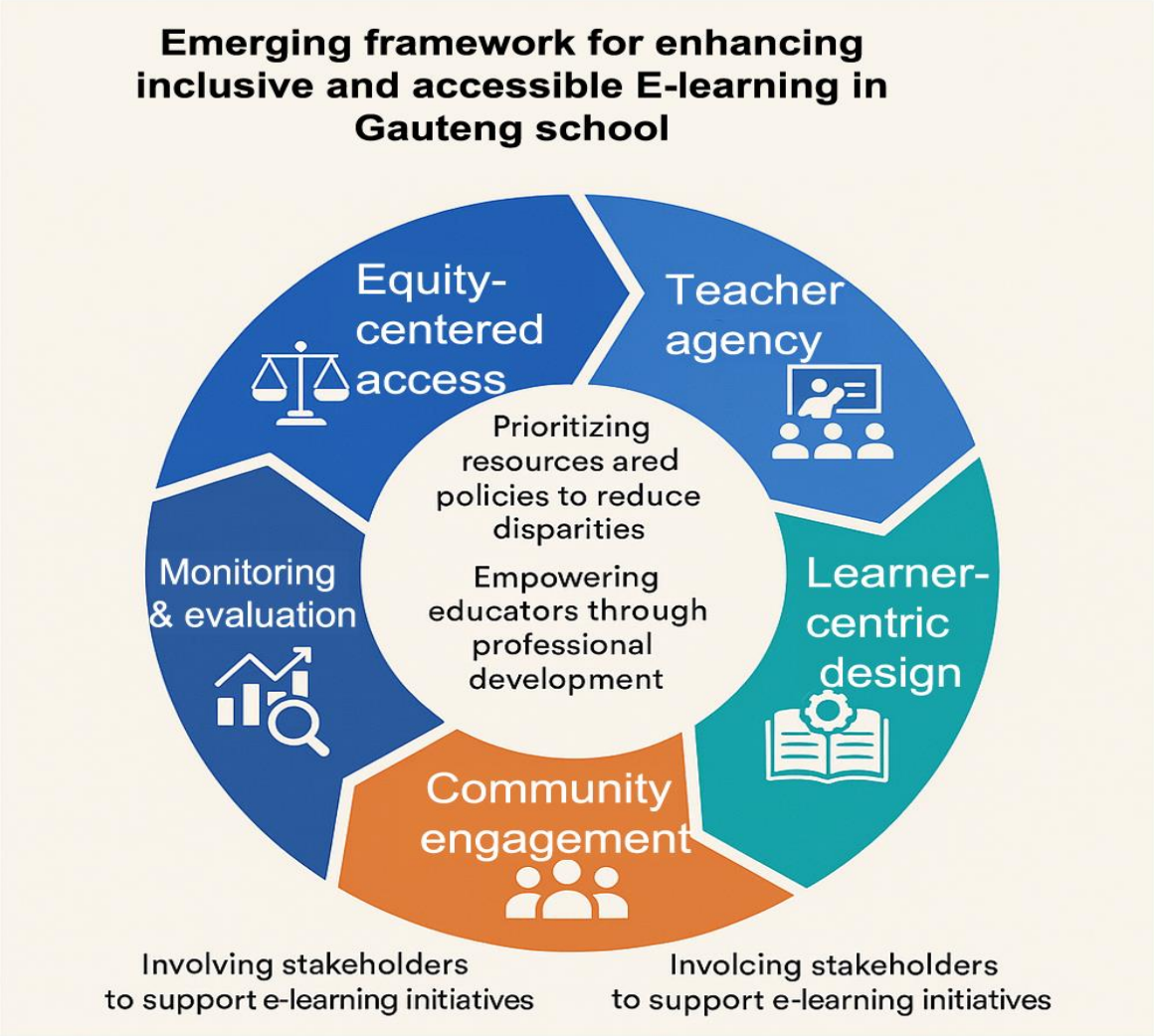

Figure 1. Framework for enhancing inclusive & accessible e-learning in gauteng schools.

Third, the paradigm encourages a learner-centric design, which means making e-content that is relevant to different backgrounds and learning styles. Adaptive learning technology can make the learning experience more personal, and accessible features like audio descriptions, subtitles, and flexible interfaces aim to ensure that all learners, including those with disabilities, can participate. Fourth, community engagement shows how important it is to include parents, guardians, and other local stakeholders to create a conducive environment for e-learning. To get people in the community to support the program and keep it going beyond school, it is important to hold awareness events and work with local groups (El-Sabagh, 2021; González-Betancor, López-Puig, & Cardenal, 2021).

Finally, monitoring & evaluation uses real-time data collection and analysis to record how well students are doing and how well the technology is working. This data-driven method makes it possible to make quick changes, make smart choices, and improve policies to achieve the best results. The study illustrate development of a visual model that illustrates the interconnectedness of these components. This model will help stakeholders see the route to an inclusive, accessible, and sustainable e-learning environment in Gauteng schools (Gustafsson-Wright, Osborne, & Aggarwal, 2022).

9. DISCUSSION AND ANALYSIS

The results of this study show that there are many different factors that make it hard to promote inclusive and accessible e-learning in Gauteng township schools. These include policy goals, infrastructure investment, and problems with putting policies into action. Even if the DBE and GDE ICT plans have made a lot of progress, there are still some structural, pedagogical, and contextual problems that keep ICT from reaching its full potential in education.

9.1. Inclusivity and Accessibility Challenges

The GDE ICT plan was meant to close the digital gap, but statistics indicate that real inclusion is still not equal. Richer suburban schools continue to outperform township schools in terms of device usage, connectivity, and digital fluency. Students at no-fee schools typically face environmental challenges, such as unreliable electricity, theft, and a lack of parental support, which hinder their ability to fully utilise ICT resources. Digital inequality also exists at the student level: kids who already have basic ICT abilities do well, while those who do not have constant support mechanisms suffer. Such disparity makes me wonder if just having access to gadgets is enough to make learning truly accessible (Mnisi et al., 2024).

9.2. Teacher Readiness and Integration

The MGSLG professional development stream was meant to help teachers become better at using ICT. Many teachers finished the training, but a lot of them still do not feel ready to use technology in a meaningful way in their teaching. Some teachers go back to using chalk and talk because they are afraid that technology may fail, they do not have enough time, or they do not feel confident using digital tools. This mismatch shows the difference between having access to technology and using it in the classroom. To make e-learning work, you need to do more than just distribute out devices. You also need to provide ongoing mentoring, coaching in the classroom, and peer learning networks (Val & López-Bueno, 2024).

9.3. Curriculum and Content Gaps

Despite tablets and laptops being preloaded with educational information, some educators said that the material lacked relevance to students' lives, was inaccessible in multiple languages, and failed to accommodate varied learning styles. Certain pupils perceived the content as tedious and unengaging. This illustrates the importance of possessing dynamic, adaptive, and culturally attuned digital tools to promote inclusive education (Ntsobi & Nyamkure, 2025).

9.4. Policy Implementation and Systemic Alignment

The systems review showed that there was a gap between making policies and putting them into action. The GDE strategy had defined goals, but in some districts, monitoring and holding people accountable were not particularly beneficial. ICT champions had different levels of dedication and knowledge, and in some situations, schools did not have a working technical support infrastructure. The national DBE policy's difference from the provinces' and districts' reality made it hard to implement. Everyone involved in the ICT strategy, from the national level to the school level, must collaborate and monitor it closely (Matsieli & Sooryamoorthy, 2022).

9.5. Emergence of Hybrid Learning Needs

After COVID-19, blended and hybrid methods of learning have become even more important. However, the study reveals that the current use of ICT primarily focusses on hardware provision rather than altering the learning process. We need a bigger picture that includes e-learning in a hybrid curriculum model that is backed by policies that are open to everyone, content delivery that is flexible, and students who are actively involved (Angwaomaodoko, 2023).

10. CONCLUSION

Gauteng schools have spent a lot of money on ICT for education, but they still have problems making e-learning available to everyone. This study seeks to fill in these gaps by adopting a framework based on policy and practice that makes it easier to use ICT in a useful way. The results will be used as a starting point for improving digital education in township schools and for planning future rollouts across the country. This study demonstrates that the Gauteng Department of Education did a fantastic job of setting up ICT infrastructure. However, there are still significant challenges with making e-learning truly inclusive, accessible, and integrated in township schools. Training, topic relevance, and execution support are problematic because classroom outcomes differ from policy goals. Investments in equipment, connection, and training may provide challenges; yet they are essential for enhancing the robustness and equity of the e-learning system. Merely constructing the infrastructure will be insufficient for future success. Educators must adapt their pedagogical approaches, ensure digital literacy is accessible to all, and increase institutional accountability.

11. RECOMMENDATIONS

To address the particular challenges faced by township schools, the report advises that educational authorities and institutions should contemplate the implementation of a CT integration model that considers the constraints of infrastructure, the surrounding environment, and the diverse needs of the students. This paradigm supports both justice—ensuring equitable access for all students—and agency—facilitating the effective utilisation of ICT technologies. Moreover, to maintain ICT projects and improve their effectiveness, a shift from isolated training sessions to ongoing professional development is essential. Schools should establish professional learning communities that convene regularly and incorporate coaching, peer assistance, and digital pedagogy courses into the curriculum. Using experienced educators as ICT mentors improves teachers' technology skills, promoting a culture of ongoing learning and transformation.

Education authorities should guarantee that digital literacy programs are accessible to a greater number of pupils and/or their parents or guardians. To do this, the Department of Education must receive additional financing from national resources to enhance access to digital literacy by offering support that guarantees enhanced connectivity for students, a crucial facilitator of ICT integration. Simultaneously, teacher development is essential to equip educators with the necessary skills to transform physical information into digital formats, create user-friendly e-learning materials and curricula, and boost their abilities to facilitate interactive real-time blended learning with students. This will undoubtedly assist the teacher in enhancing the development and localisation of electronic content.

Educational institutions want to develop a comprehensive monitoring and evaluation dashboard that displays real-time data regarding student device usage, content accessed, and learning outcomes. Broader initiatives aimed at school improvement should integrate these systems. Employing expert digital learning leaders will ensure the efficacy of these M&E platforms. Promoting policy coherence and fostering engagement from all stakeholders is

also essential. This necessitates alignment among education supervisors, districts, and school governing bodies. Facilitating collaboration across NGOs, ed-tech startups, and private sector firms will enhance the sustainability of digital education initiatives and foster innovation, thereby advancing the ecosystem collectively.

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