

## Enhancing quality Education in Gambian School's through Digitalization of using Sustainable Technology

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### Abstract

The integration of information and communication technology (ICT) in The Gambia's education system has historically been limited, although recent developments have begun to transform teaching and learning practices. Effective use of ICT is essential for promoting innovative educational approaches that support Sustainable Development Goals (SDGs). This study aims to review and systematize research on innovative strategies that integrate ICT in online learning to promote sustainability in education. The study employs a mixed approach using questionnaire data as the primary source and a comprehensive literature review as the secondary source. The analysis is guided by research questions that examine theoretical and practical perspectives on the relationship between ICT-based educational innovation and sustainable development. The findings highlight key factors influencing the effective use of ICT in educational practice to support the SDGs. The study concludes that digital education plays a significant role in advancing sustainable and innovative learning systems.

**Keywords:** Sustainable Development Goals (SDGs); Digital Education;

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### INTRODUCTION

Education is widely recognized as a key driver of social and economic development and plays a crucial role in achieving the United Nations Sustainable Development Goal 4 (SDG 4), which emphasizes inclusive and equitable quality education for all. In many developing countries, improving the quality of education remains a major challenge due to limited resources, unequal access to learning opportunities, and inadequate infrastructure. These challenges are particularly evident in low-income countries where education systems struggle to adapt to rapid technological changes while maintaining sustainable development objectives (Anwar, 2025; Hungwe & Khan, 2025; Maqbool et al., 2025; Vindigni, 2024).

In The Gambia, the education sector has undergone several reforms aimed at expanding access and improving learning outcomes. Institutional restructuring led to the establishment of the Ministry of Basic and Secondary Education (MoBSE) and the Ministry of Higher Education, Research, Science and Technology (MoHERST), which are responsible for managing different levels of the education system. Despite these efforts, significant barriers still affect the delivery of quality education. Rural-urban disparities, limited access to educational technologies, large

student–teacher ratios, and persistent poverty continue to constrain effective learning environments. These factors often limit students’ access to learning resources and reduce the capacity of teachers to implement innovative instructional strategies (Adeniyi et al., n.d.; Blimpo et al., 2015; Chand, 2024; Pilozo et al., 2025).

The rapid advancement of digital technologies has transformed education systems globally by enabling new forms of teaching, learning, and knowledge sharing. The integration of information and communication technologies (ICT) into education has been shown to enhance instructional quality, expand access to educational resources, and support more interactive and student-centered learning environments. However, the successful adoption of digital technologies in developing countries requires careful consideration of sustainability, affordability, and infrastructure availability. Sustainable technology solutions, such as solar-powered ICT systems and energy-efficient digital devices, have been identified as effective approaches for addressing technological limitations while supporting environmentally responsible educational development (Ivanova et al., 2025; Omar & Abdullahi, 2024; Sibagariang et al., 2023).

Previous research highlights the positive role of digital technologies in improving educational accessibility and teacher capacity, particularly in resource-constrained contexts. Digital learning tools can support teacher training, increase access to up-to-date educational materials, and facilitate flexible learning opportunities for students. Nevertheless, existing studies often focus primarily on the technological aspects of digitalization, with limited attention to how sustainable technologies can be integrated into national education systems to simultaneously improve learning quality and support sustainable development goals (Makinde et al., 2024; Zaw & Hlaing, 2024).

Given these challenges, there remains a need for research that examines practical and sustainable approaches to digitalizing education in developing contexts such as The Gambia. Understanding how sustainable digital technologies can enhance educational quality is essential for designing policies and strategies that support long-term development in the education sector.

Therefore, this study investigates how digitalization through sustainable technologies can improve the quality of education in Gambian schools. The study focuses on identifying key challenges in the current education system, exploring strategies for integrating sustainable digital technologies into teaching and learning practices, and analyzing their potential contributions to achieving inclusive and quality education in line with SDG 4.

## **METHODS**

This study uses a qualitative exploratory research design to examine how digitalization through sustainable technologies can improve the quality of education in The Gambia. The research was conducted in public schools located in the West Coast Region (WCR), one of the most populated regions in the country. A random selection technique was used to select ten public schools that have implemented ICT initiatives in their teaching and learning processes.

Data were collected from multiple sources to ensure reliability and depth of information. Semi-structured interviews were conducted with twenty-five teachers and ten education officials to explore their experiences, perceptions, and challenges related to the integration of ICT in education. In addition, policy documents and reports from the Ministry of Basic and Secondary Education (MoBSE) and UNESCO were reviewed to understand the policy context of digital education and sustainable technology in The Gambia.

The collected data were analyzed using thematic analysis. Interview transcripts and documents were coded to identify recurring themes related to digital integration, sustainability, and educational outcomes. This approach enabled the study to examine how ICT initiatives and sustainable technologies can support improvements in the quality of education.

## FINDING AND DISCUSSIONS

### 1. Accessibility and Infrastructure

The results show that many Gambian schools, especially those in rural areas, continue to face significant obstacles to digital education due to a lack of dependable electricity and internet connectivity. Due to erratic power supplies and spotty network coverage, a number of schools reported having trouble sustaining reliable access to digital learning platforms. On the other hand, pilot projects introducing solar-powered ICT labs have shown encouraging outcomes. These programs made it possible for schools in off-grid communities to use renewable energy sources to run computers, digital projectors, and internet devices. Students now have access to previously unattainable online resources and digital learning materials. This implies that in settings with limited resources, renewable energy solutions—especially solar-powered systems—can be extremely important for promoting sustainable digital education.

### 2. Teacher Training and Capacity Building

Another important thing that came out of the interviews is that teachers don't know much about technology. A lot of teachers said that even though some schools have digital devices, they often don't have the skills or confidence to use them effectively in the classroom. Teachers stressed the importance of ongoing professional development programs that teach how to use online learning platforms, digital pedagogy, and how to integrate ICT into the classroom. Without proper training, we can't fully take advantage of the benefits of digital technologies. Prior research underscores that teacher preparedness and digital literacy are critical determinants of effective technology integration within educational systems. To make sure that digital technologies are used effectively in teaching and learning, it is important to invest in teacher ICT training and certification programs on a regular basis.

### 3. Pedagogical Innovation

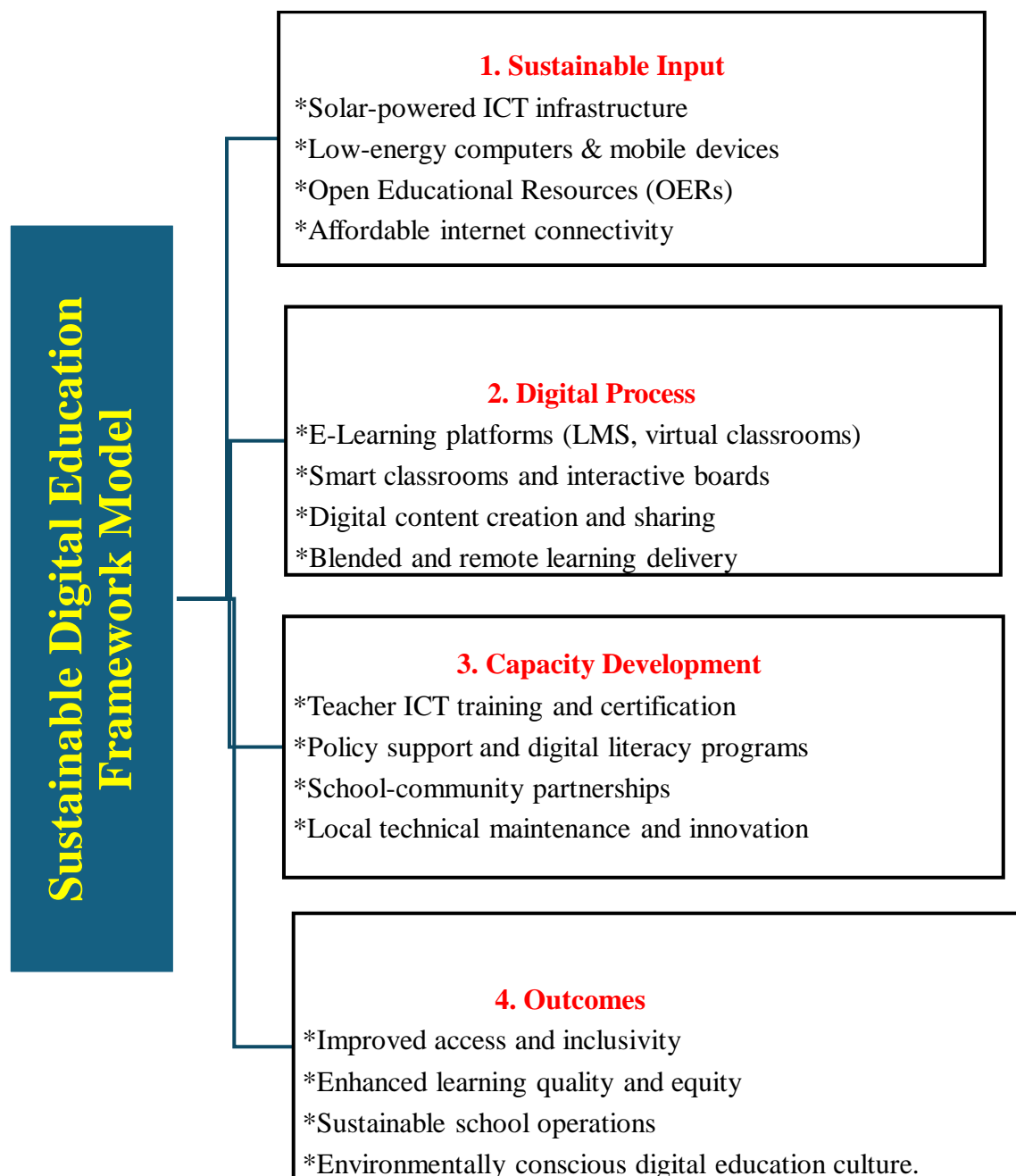
Digital technologies have also changed the way teachers teach and students learn. Schools that used digital tools like interactive whiteboards, mobile learning apps, and virtual classroom platforms said that their classrooms were more interactive and encouraged students to take part in the learning process. Teachers said that digital tools let them teach lessons with videos, animations, and interactive quizzes, which help students understand difficult subjects better. Students at these schools also said they were more motivated and interested in what was going on in class. Combining traditional face-to-face teaching with digital learning platforms in a blended learning approach was especially helpful for flexible, student-centered learning.

### 4. Sustainability and Maintenance

The study also found that sustainability is very important for the long-term success of digital education programs. Setting up ICT infrastructure is a big first step, but many projects run into problems with keeping the equipment running, getting help with technical issues, and upgrading the system. When digital equipment breaks down, schools often don't have trained technicians who can fix or maintain it. So, for digital education to last, there needs to be a strong culture of maintenance, local technical knowledge, and community involvement. Working with local solar technology companies, tech providers, and non-governmental organizations (NGOs) can give you the technical help you need and make sure that your digital infrastructure stays up and running over time (GAMBIA/UNECA, 2007). Community involvement can also make people feel more responsible for taking care of school technology resources.

### 5. Proposed Framework: Sustainable Digital Education Model

Below is a conceptual model illustrating how digitalization and sustainable technology interact to enhance education quality:



**Figure 1:** Sustainable Digital Education Model Framework Components (Guo et al., 2019)

The Sustainable Digital Education Framework Model illustrates a comprehensive approach for integrating digital technologies into education systems while ensuring long-term sustainability. The model consists of four interconnected components: sustainable inputs, digital processes, capacity development, and educational outcomes. These components collectively support the effective implementation of digital education while addressing challenges related to infrastructure, human capacity, and environmental sustainability.

The first component, sustainable inputs, refers to the foundational resources required to support the implementation of digital education in a sustainable manner. These resources include renewable energy solutions such as solar-powered ICT infrastructure, which are

particularly important in regions with limited or unstable electricity supply. In addition, the use of low-energy computers and mobile devices helps reduce operational costs and energy consumption, making digital education more accessible in resource-constrained environments. The framework also emphasizes the use of Open Educational Resources (OERs), which provide freely accessible teaching and learning materials that can expand educational access and reduce dependency on costly textbooks. Affordable and reliable internet connectivity further supports access to digital learning platforms and global knowledge resources (Aarthi et al., 2025; Cotfas & Cotfas, 2023; Karatayeva et al., 2023).

The second component, digital processes, represents the integration of digital technologies into the teaching and learning environment. This stage involves the use of e-learning platforms such as Learning Management Systems (LMS), virtual classrooms, and other digital tools that facilitate communication, collaboration, and content delivery. Smart classroom technologies, including interactive boards and multimedia tools, can enhance student engagement and support interactive learning experiences. Furthermore, digital platforms allow educators to create, adapt, and share educational content more efficiently. The adoption of blended learning and remote learning models also enables flexible learning opportunities, particularly in situations where physical classroom attendance may be limited (Karatayeva et al., 2023; Kasymaliev et al., 2023).

The third component, capacity development, focuses on strengthening the human and institutional capabilities required for successful digital transformation in education. Teachers play a critical role in the effective use of technology in classrooms; therefore, professional development programs and ICT training are essential for improving teachers' digital competencies. In addition, policy support from educational authorities and digital literacy initiatives for students and communities contribute to a more supportive learning environment. Collaboration between schools, local communities, and technical support providers also ensures the maintenance of digital infrastructure and encourages local innovation in educational technology (Fatimah et al., 2024; Sakirman, 2025; Yadav, 2024).

The final component, outcomes, represents the expected benefits of implementing sustainable digital education practices. These outcomes include improved access to education, particularly for underserved and remote communities, as well as enhanced learning quality using interactive and diverse digital resources. The framework also promotes greater inclusivity by enabling more flexible learning opportunities for students with different needs and backgrounds. Furthermore, the integration of sustainable technologies contributes to environmentally responsible school operations by reducing energy consumption and promoting environmentally conscious digital education practices (Chen et al., 2020).

## CONCLUSION

This study shows that digitalization supported by sustainable technologies can improve the quality and accessibility of education in The Gambia. The use of renewable energy-based ICT infrastructure, digital learning platforms, and open educational resources can help overcome challenges such as limited electricity, inadequate learning materials, and restricted access to information. However, successful implementation requires adequate infrastructure, teacher digital competencies, and supportive education policies. When these elements are integrated effectively, sustainable digitalization can support inclusive and quality education and contribute to achieving SDG 4. To support sustainable digital education, several actions are recommended. First, the government should expand solar-powered ICT infrastructure, particularly in rural schools. Second, continuous ICT training programs should be provided to strengthen teachers' digital competencies. Third, collaboration with private sectors, NGOs, and international partners should be encouraged to support resources and innovation. Finally, clear monitoring and evaluation systems are needed to assess the effectiveness of digital education initiatives. This study highlights the importance of integrating sustainable technology into education policies and

practices to improve learning quality and access. The findings also provide a foundation for future research on the long-term impact of digital education and sustainable technologies in developing countries.

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