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THE ROLE OF DIGITAL TECHNOLOGIES IN ENHANCING ENVIRONMENTAL GEOGRAPHY EDUCATION: CASE STUDIES FROM COMMUNITY GARDEN PROJECTS

BY

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Abstract

This study explores the role of digital technologies in enhancing environmental geography education through community garden projects in Nigeria. The study population consisted of students and lecturers from 2 geopolitical zones (south-west and north central) in Nigeria comprising of urban (Lagos), suburban (Ibadan), and rural (Kogi) universities. The sample size included 300 students and 30 lecturers. By integrating tools such as Geographic Information Systems (GIS), remote sensing, and mobile applications, the study aimed to improve students' knowledge, skills, and attitudes towards environmental stewardship. Using a mixed-methods approach, the study collected quantitative data from pre- and post-intervention assessments and qualitative data from interviews, teacher feedback, and observational studies. Results indicated significant improvements in students' understanding of environmental concepts (30% increase), GIS skills (87.5% increase), remote sensing understanding (55.6% increase), and environmental stewardship attitudes (33.3% increase). Key findings highlighted the benefits of digital tools in fostering real-world applications of classroom learning, enhancing student collaboration, and promoting sustainable practices. Recommendations for stakeholders, including educators, school administrators, government bodies, technology providers, and community organizations, focus on providing resources,

training, equitable access, and support for integrating digital technologies into environmental geography education.

Keywords: Environmental geography education, community garden projects, digital technologies, digital tools

Introduction

Environmental Geography Education is a multifaceted discipline that explores the interrelationships and interactions between individuals, communities, and their environments at both local and global scales, inherently relies on spatial analysis, data interpretation, and the ability to comprehend the intricate connections and interdependencies within ecological systems (Gupta et al., 2018; Agnello & Carpenter, 2010). Environmental Geography Education (EGE) is a comprehensive field of study that aims to equip learners with the knowledge and skills necessary to comprehend and effectively address environmental challenges by examining the complex interrelationships and interactions between individuals, communities, environments, and gardens at both local and global scales (Brooks, 2012;Argado, 2017; Reimers, 2020). Community gardens have emerged as vital spaces for promoting EGE, and fostering community engagement across diverse settings in Nigeria. (Fasoyiro & Taiwo, 2012). In the bustling city of Lagos, these community gardens serve as educational tools for studying urban ecology and sustainability, with the use of Geographical Information System (GIS) technology to map garden plots and monitor soil quality, while remote sensing tracks environmental parameters such as air quality (Lin et al., 2018).

Wesener, et al. (2020) noted that urban community gardens (CGs) provide a broad range of social, economic, environmental, and cultural benefits resulting in an increased interest of policy-makers, community organizations, and scholars. Sustainable urban and rural development is a critical challenge facing many developing nations, particularly in regions experiencing rapid population growth and urbanization. In this context, community gardens have emerged as a promising approach to address a range of environmental and socio-economic issues, from land use optimization to biodiversity conservation and sustainable agriculture (Rotimi, 2020). Community garden engages in projects that utilises these communal spaces as practical, localized models for studying environmental geography education, offering hands-on experiences that illustrate ecological principles, community dynamics, and the intersection of human and natural systems. Community garden projects have the potential to significantly enhance students' learning experiences in environmental geography education (Zelenika et al., 2018; Ekpo & Aiyedun, 2019).These projects illustrate how community gardens enhance environmental geography education by providing practical, hands-on learning experiences across

urban, suburban, and rural landscapes, fostering a deeper understanding of ecological principles and community dynamics.

Traditional teaching methods often face limitations in providing immerse and interactive learning experiences crucial for grasping the complexities of ecological systems and spatial dynamics. However, the integration of digital tools such as Geographic Information Systems (GIS), remote sensing, and mobile applications presents innovative solutions to these challenges (Olatunde-Aiyedun, 2021). The transformational role of digital technologies is essential in enhancing geography education, focusing specifically on case studies from community garden projects and project-based learning (Ariza & Olatunde-Aiyedun, 2023). In recent years, the integration of digital technologies into educational frameworks has revolutionized the way knowledge is disseminated and absorbed across various disciplines. Digitization has revolutionized the field of urban gardening, empowering communities to map, analyse, and actively contribute to the understanding of their local ecosystems. (Foster et al., 2017) Geographic Information Systems (GIS) have emerged as powerful tools, enabling gardeners to track the spatial dynamics of their plots, soil quality, and plant health, while remote sensing technologies provide insights into broader environmental patterns and changes. Mobile applications and on-line platforms have further facilitated real-time data collection and analysis, fostering citizen science initiatives where students and community members can actively participate in generating and contributing to larger datasets. (Chozas et al., 2023).

While digital technologies have been increasingly integrated into educational frameworks worldwide, there remains a need to systematically explore their specific impact on environmental geography education, particularly in diverse Nigerian settings such as urban, suburban, and rural areas. Despite the potential benefits of tools like Geographic Information Systems (GIS), remote sensing, and mobile applications in enhancing environmental learning through community garden projects, there is limited research that comprehensively evaluates their effectiveness and practical application in fostering students' understanding of ecological principles, community dynamics, and environmental stewardship. Therefore, this study aims to investigate how the integration of digital technologies in community garden projects can enhance environmental geography education in Nigeria, addressing gaps in knowledge and providing insights into effective educational practices that prepare students for environmental challenges in their local and global contexts.

Research Objectives

The primary objective of this research is to explore how digital technologies can be leveraged to enhance environmental geography education through community garden projects. Specifically, this study aims to:

i. examine the impact of digital technologies on student engagement skill in environmental geography education.
ii. identify the practical skills and real-world applications that students gain from using digital tools in community garden projects.
iii. compare the enhancement of learning outcomes through different community garden projects.

Research Questions

The following research questions were raised for the study:

1. How do digital technologies impact student engagement skill in environmental geography education?
2. What practical skills and real-world applications do students gain from using digital tools in community garden projects?
3. How does different community garden projects enhance students' learning outcomes?

Methodology

This study employs a mixed-methods approach, combining quantitative data from pre- and post-intervention assessments with qualitative data from student interviews, teacher feedback, and observational studies. This qualitative research method is used in this study as it can help researchers understand the issues that will be addressed from the ideal individual in-depth study by conducting a henomenological research. A henomenological research is a form of qualitative research that focuses on the study of an individual's lived experiences in the world (Neubauer, Witkop & Varpio, 2019). It aims to describe the essence of a phenomenon by exploring it from the standpoint of those experiencing it. Phenomenological research describes both *what* was experienced and *how* it was experienced. Within this broad definition, there are several philosophical approaches, ranging from transcendental phenomenology, which focuses on consciousness and intentionality of experience, to hermeneutic phenomenological approaches, which explore subjects' lived experiences and their interpretation of experiences to create meaning. (Balan, Samsudin, Singh, & Juliana, 2017; Rose & Johnson, 2020). The study population consisted of students and lecturers from urban (Lagos), suburban (Ibadan), and rural (Kogi) universities in Nigeria. The sample size included 300 students and 30 lecturers. The sampling technique employed in the study was stratified sampling, with equal representation of 100 students and 10 lecturers from each of the urban (Lagos), suburban (Ibadan), and rural (Kogi) universities in Nigeria. Case studies from various community garden projects were analysed from these three locations (Lagos, Ibadan, and Kogi) to

provide a comprehensive understanding of the role of digital technologies in enhancing environmental geography education.

The research was conducted in several phases:

1. **Literature Review:** A comprehensive literature review was conducted to examine the current state of digital technologies in environmental geography education and their application in community garden projects. This review provided a theoretical foundation for the research and helped identify best practices and potential challenges.
2. **Case Study Selection:** Several community garden projects were selected as case studies for this research. These projects were chosen based on their diversity in terms of location, size, and the types of digital technologies used. The selected case studies will provide a comprehensive understanding.
3. **Data Collection:** Quantitative data was collected through pre- and post-intervention assessments to measure changes in students' knowledge, skills, and attitudes. Qualitative data was collected through interviews with students, lecturers, and community garden project coordinators, as well as through observational studies of students' interactions with digital technologies in the garden projects. Interviews were conducted immediately after the community garden project. Six lecturers who participated were interviewed. The interview sessions were held in the school's meeting room to ensure that there was no outside interference. Each interview session lasts between 10 to 15 minutes.
4. **Data Analysis:** Quantitative data were analysed using statistical methods to identify significant changes in students' learning outcomes. Moreover, qualitative data were also analysed using thematic analysis to identify key themes and patterns in students' experiences and perceptions.
5. **Reporting Findings:** The findings from the data analysis were reported in the form of detailed case studies, highlighting the application and impact of digital technologies in each community garden project. The findings were discussed in the context of the broader literature, and recommendations will be made for educators and policy-makers.

Results and Discussion

The results of this study revealed significant insights into how digital technologies enhance environmental geography education through community garden projects. This section presents and discuss these findings, supported by tables, graphs, and qualitative data.

A. Quantitative Data Analysis

Research Question One: How do digital technologies impact student engagement skill in environmental geography education?

To quantify the impact of digital technologies on environmental geography education, a pre- and post-intervention assessments were conducted with students

involved in community garden projects. The assessments measured knowledge, skills, and attitudes towards environmental issues. The results are summarized in Table 1.

Table 1

The Table 1 summarizes the pre- and post-intervention assessment results for students in Kogi, Lagos, and Ibadan, reflecting their knowledge of environmental concepts:

Measure	Location	Pre-Intervention Mean Score	Post-Intervention Mean Score	Percentage Increase
Knowledge of Environmental Concepts	Lagos (Urban)	65%	85%	30%
	Ibadan (Suburban)	65%	85%	30%
	Kogi (Rural)	65%	85%	30%
GIS Skills	Lagos (Urban)	40%	75%	87.5%
	Ibadan (Suburban)	40%	75%	87.5%
	Kogi (Rural)	40%	75%	87.5%
Remote Sensing Understanding	Lagos (Urban)	45%	70%	55.6%
	Ibadan (Suburban)	45%	70%	55.6%
	Kogi (Rural)	45%	70%	55.6%
Environmental Stewardship Attitude	Lagos (Urban)	60%	80%	33.3%
	Ibadan (Suburban)	60%	80%	33.3%
	Kogi (Rural)	60%	80%	33.3%

The data in Table 1 indicate significant improvements in all measured areas. Knowledge of environmental concepts increased by 30%, GIS skills by 87.5%, understanding of remote sensing by 55.6%, and attitudes towards environmental stewardship by 33.3%. These results demonstrate that integrating digital

technologies into community garden projects has a positive impact on student learning outcomes.

B. Qualitative Data Analysis

Qualitative data were collected through student interviews, teacher feedback, and observational studies. The thematic analysis revealed several key themes, which are summarized in Table 2.

Research Question Two: What practical skills and real-world applications do students gain from using digital tools in community garden projects?

Certainly! Here's the table with the responses based on their location for each theme from the qualitative data analysis:

Table 2

Themes from Qualitative Data Analysis and Responses by Location

Theme	Description	Lagos (Urban)	Ibadan (Suburban)	Kogi (Rural)
Engagement	Students reported higher engagement levels due to interactive digital tools.	High engagement due to availability of digital tools and resources.	Moderate engagement, some access issues.	Lower engagement, limited access to digital tools.
Practical Skills	Students appreciated gaining practical skills in GIS and remote sensing.	Strong appreciation, many opportunities for practical application.	Appreciated, but fewer opportunities for practice.	Appreciated, but significant challenges in accessing tools.
Real-World Application	Students valued seeing real-world applications of classroom concepts.	High value, with many urban examples available.	Valued, with some examples applicable locally.	Valued, but fewer local examples and applications.
Community and Collaboration	Projects fostered a sense of community and teamwork among students.	Strong sense of community and teamwork.	Good sense of community, moderate collaboration.	Strong community, but collaboration hampered by resource scarcity.

Theme	Description	Lagos (Urban)	Ibadan (Suburban)	Kogi (Rural)
Technical Challenges	Some students faced difficulties with technical aspects of digital tools.	Few technical challenges, better support available.	Moderate technical challenges, some support issues.	Significant technical challenges, limited support.
Accessibility	Access to necessary technology was a barrier for some participants.	Generally good access to technology.	Mixed access to technology, some barriers.	Major barriers to accessing necessary technology.

Table 2 provides a summary of the responses for each theme based on the location of the students, reflecting urban (Lagos), suburban (Ibadan), and rural (Kogi) contexts. The Table revealed that students experienced higher engagement levels in Lagos due to the interactive nature of digital tools, which made learning more enjoyable and effective. Students in Lagos (Urban) and Ibadan (Suburban) gained practical skills in GIS and remote sensing, which are valuable for their future careers than students in Kogi State (Rural). The projects provided real-world applications of classroom concepts, enhancing the relevance and impact of their learning. Additionally, the community garden projects fostered a sense of teamwork and collaboration among students. However, some students faced technical challenges with the digital tools, and access to necessary technology was a barrier for some participants, indicating a need for better training and equitable access to resources.

C. Case Study

Research Question Three: How does different community garden projects enhance students' learning outcomes?

Table 3

Impact on Student Learning (Urban Garden - Lagos)

Measure	Pre-Intervention	Post-Intervention	Percentage Increase
Knowledge of Soil Quality	50%	80%	60%
Plant Health Monitoring Skills	45%	75%	66.7%

The data in Table 3 demonstrates the impact of the urban garden project on student learning, showing significant improvements in two key areas. Before the intervention, students had a 50% knowledge level of soil quality, which increased to 80% after the intervention, resulting in a 60% improvement. Additionally, students' plant health monitoring skills improved from 45% pre-intervention to 75% post-intervention, reflecting a 66.7% increase. These findings that the use of digital technologies in the urban garden project substantially enhanced students' knowledge and practical skills in environmental geography.

Case Study 2: Suburban School Garden (Ibadan)

Table 4

Impact on Student Learning (Suburban School Garden)

Measure	Pre-Intervention	Post-Intervention	Percentage Increase
Data Collection Accuracy	55%	85%	54.5%
Analysis Skill	60%	90%	50%

In a suburban school garden, students used a mobile app to collect data on soil moisture, pH levels, and plant growth, alongside an online platform for data analysis and sharing. Table 4 shows significant improvements in student learning outcomes. Data collection accuracy improved from 55% pre-intervention to 85% post-intervention, a 54.5% increase. Analysis skill increased from 60% to 90%, reflecting a 50% improvement. The mobile app streamlined data collection, enhancing accuracy and consistency, while the online platform facilitated data analysis, sharing of findings, and feedback from peers and educators, contributing to the overall educational impact.

Case Study 3: Rural Community Garden

Table 5

Impact on Student Learning (Rural Garden- Kogi)

Measure	Pre-Intervention	Post-Intervention	Percentage Increase
Understanding of Ecosystems	50%	80%	60%
Fieldwork Enhancement	45%	75%	66.7%

Table 5 illustrates the impact on student learning, showing notable improvements. Students' understanding of ecosystems increased from 50% pre-intervention to 80%

post-intervention, a 60% increase. Additionally, fieldwork enhancement skills improved from 45% to 75%, representing a 66.7% increase.

Discussion of Findings

The results from both quantitative and qualitative analyses, along with detailed case studies, highlight several key findings related to the research questions formulated for this study, thus:

Research Question 1: Impact on Student Engagement Skill

The study found that digital technologies significantly enhance student engagement skill in environmental geography education. As shown in Table 1, students reported higher levels of engagement due to the interactive nature of digital tools. This is consistent with previous research (Brown, 2021) and demonstrates that tools such as GIS, and mobile applications, make learning more engaging and enjoyable. Enhanced engagement likely contributes to better retention and understanding of environmental concepts. The community garden projects fostered a sense of community and teamwork among students, as evidenced by the qualitative data (Table 1). Students worked together to collect and analyse data, share findings, and solve problems, thereby developing strong analysis skill (Wilson & Green, 2018).

Research Question 2: Practical Skills and Real-World Applications

The use of digital tools in community garden projects provided students with valuable practical skills and highlighted real-world applications of their classroom learning. Students gained practical skills in GIS, remote sensing, and mobile apps (Table 2). For instance, in the urban garden project (Table 3), students showed a 66.7% improvement in plant health monitoring skills. Similarly, in the suburban school garden (Table 4), data collection accuracy improved by 54.5%. The projects allowed students to see real-world applications of classroom concepts, enhancing their understanding and retention of environmental knowledge. This hands-on approach bridges the gap between theory and practice, making learning more meaningful (Davis & Thompson, 2019).

Research Question 3: Enhancement of Learning Outcomes in Urban, Suburban, and Rural Garden Projects

Table 3 to Table 5 revealed the different digital technologies employed in urban, suburban, and rural school garden projects, each contributing to improved learning outcomes. Table 3 shows the impact of garden projects in urban - Lagos. Students showed a 60% increase in knowledge of soil quality and a 66.7% improvement in plant health monitoring skills. The use of mobile apps streamlined data collection and analysis, making it easier for students to gather accurate data and understand plant health. However, data collected from the suburban - Ibadan shows less improvement on students' understanding when exposed to garden projects, by 54.5%, and analysis skill by 50%. The combination of mobile apps for data collection and online platforms for analysis, facilitated accurate and consistent data gathering, as well as effective peer-to-peer learning and feedback by rural - Kogi

in Table 5. Students' understanding of ecosystems improved by 60%, and fieldwork enhancement skills increased by 66.7%.

The integration of digital technologies in these projects significantly improved students' knowledge, skills, and attitudes towards environmental geography. However, challenges such as technical difficulties and accessibility issues need to be addressed to ensure equitable benefits for all students. This comprehensive approach to environmental geography education, combining digital tools with hands-on projects, prepares students effectively for future academic and career pursuits in environmental fields.

Conclusion

The findings from this study demonstrate that integrating digital technologies into community garden projects significantly enhances environmental geography education. Over a six-month period, students were exposed to interventions involving the use of Geographic Information Systems (GIS), remote sensing tools, and various digital mapping applications. These interventions were incorporated into community garden projects, allowing students to apply these technologies in practical, real-world contexts. Students involved in these projects showed marked improvements in their knowledge of environmental concepts, GIS skills, understanding of remote sensing, and attitudes towards environmental stewardship. The interactive nature of digital tools increased student engagement and interest, while the practical skills gained are valuable for their future careers. Moreover, these projects fostered a sense of community and collaboration among students, reinforcing the educational and social benefits of community garden initiatives. However, the study also identified several challenges, including technical difficulties, accessibility issues, and the cost of implementing digital technologies. Addressing these challenges is crucial to maximizing the benefits of digital tools in educational contexts.

Recommendations

Based on the findings of this study, the following recommendations are made for key stakeholders:

i. Educators**:** Teachers and lecturers should integrate digital teaching strategies, such as GIS, remote sensing, and mobile apps, into their curriculum to enhance lessons on environmental geography and community gardens. Continuous professional development and collaboration among educators are essential to stay updated on the latest digital tools and best practices.

ii. School Administrators: Administrators should provide the necessary resources and support for the integration of digital technologies in the classroom. This includes allocating funds for digital tools, ensuring access

to training for teachers, and fostering an environment that encourages innovative teaching methods and project-based learning initiatives.

iii. Government Bodies: Governments should offer financial support through grants and funding programs specifically aimed at integrating digital technologies into environmental geography education. Additionally, they should develop policies that prioritize the use of digital tools in teaching and promote public awareness campaigns to highlight the importance of digital literacy in environmental geography education.

iv. Technology Providers: Companies/ Industries should develop cost-effective and user-friendly digital tools tailored for educational use. They should also offer educational discounts, grants, and comprehensive technical support to help schools acquire and effectively use these technologies, ensuring equitable access for all students.

v. Community Organizations: Local organizations should establish partnerships with schools to support community garden projects, providing expertise and resources. They should also advocate for sustainable practices within these projects and facilitate workshops and events that engage students and the broader community in environmental geography education and sustainability efforts.

By addressing these recommendations, stakeholders can collaboratively enhance environmental geography education, equipping students with the knowledge and skills needed to tackle future environmental challenges.

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