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TEACHER COMPETENCY AND GREEN TECHNOLOGY ADOPTION FOR SUSTAINABLE EDUCATION OUTCOMES IN FEDERAL UNIVERSITIES IN SOUTH-SOUTH NIGERIA

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ABSTRACT

This study investigated teacher competency and green technology adoption for sustainable education outcomes in Federal Universities in South-South Nigeria. The growing emphasis on sustainability and digital transformation in higher education has increased expectations for the use of green technologies; however, their effectiveness largely depends on teachers' capacity to integrate them into instructional practices. Anchored on systems theory, the study adopted a descriptive survey research design. A sample of 312 academic staff was selected from Federal Universities in the region using stratified random sampling. Data were collected using a validated questionnaire, with a reliability coefficient of 0.84. Mean and standard deviation were used to answer research questions, while Pearson Product-Moment Correlation was employed to test hypotheses at the 0.05 level of significance. Findings revealed a moderate level of teacher competency in the use of green technologies, but a low extent of green technology adoption for achieving sustainable education outcomes. Although teacher competency showed a positive and statistically significant relationship with green technology adoption and sustainable education outcomes, the strength of these relationships was moderate. The study concludes that teacher competency is a necessary but insufficient condition for achieving sustainable education outcomes. It recommends policy-driven professional development, stronger institutional support, and integrated sustainability strategies to enhance the effectiveness of green technology initiatives in Nigerian universities.

KEYWORDS: Teacher competency, green technology adoption, sustainable education, higher education, South-South Nigeria.

INTRODUCTION

Higher education institutions are increasingly recognized as key drivers of sustainable development through their roles in knowledge production, human capital development, and social transformation. In recent years, the integration of green technology into university teaching and learning environments has gained prominence as a strategy for promoting environmentally responsible education and improving institutional efficiency. Green technologies, such as digital learning platforms, energy-efficient ICT infrastructure, virtual laboratories, and paperless instructional systems, are designed to reduce environmental impact while enhancing access, flexibility, and quality of education (OECD, 2023).

In Nigeria, Federal Universities in the South-South region operate within a context marked by environmental vulnerability, technological disparities, and growing demand for quality higher education. Despite policy emphasis on digitalization and sustainability, the effective utilization of green technologies in universities remains inconsistent. One of the major factors influencing this inconsistency is the competency of teachers who are expected to integrate these technologies into instructional practices.

Teacher competency encompasses pedagogical knowledge, technological proficiency, environmental awareness, and adaptive skills required for innovative teaching. Studies have shown that the mere provision of technology does not guarantee improved learning outcomes unless teachers possess the competence and confidence to use such technologies effectively (Lozano et al., 2021). In the context of sustainable education, teachers play a pivotal role in shaping students' attitudes toward environmental responsibility and sustainability-oriented problem solving.

Although several studies have examined green technology and sustainability in higher education, empirical research focusing on teacher competency as a determinant of green technology adoption in Federal Universities in South-South Nigeria remains limited. This gap necessitates an empirical investigation into how teacher competency influences the adoption of green technologies and the attainment of sustainable education outcomes in the region.

Statement of the Problem

Despite increasing investment in digital infrastructure and sustainability initiatives in Nigerian Federal Universities, the expected improvements in sustainable education outcomes have not been fully realized. In many institutions, green technologies such as learning

management systems, virtual classrooms, and energy-efficient ICT facilities are either underutilized or poorly integrated into teaching and learning processes. A major concern is that many lecturers lack adequate training in the pedagogical and environmental dimensions of green technology use. Limited digital literacy, resistance to change, and insufficient professional development opportunities have constrained teachers' ability to effectively adopt and sustain green technologies. Consequently, students are often exposed to traditional, resource-intensive teaching methods that undermine sustainability goals.

In Federal Universities in South-South Nigeria, where environmental challenges and infrastructural constraints coexist, the inability of teachers to effectively utilize green technologies poses a serious threat to sustainable education delivery. However, empirical evidence linking teacher competency to green technology adoption and sustainable education outcomes in this context is scarce. This study therefore seeks to empirically examine the influence of teacher competency on green technology adoption for sustainable education outcomes in Federal Universities in South-South Nigeria.

Purpose of the Study

The main purpose of this study was to examine teacher competency and green technology adoption for sustainable education outcomes in Federal Universities in South-South Nigeria.

Specifically, the study sought to:

1. Determine the level of teacher competency in the use of green technologies in Federal Universities in South-South Nigeria.
2. Examine the extent of green technology adoption for sustainable education outcomes in Federal Universities in South-South Nigeria.
3. Determine the relationship between teacher competency and green technology adoption for sustainable education outcomes.

Research Questions

The following research questions guided the study:

1. What is the level of teacher competency in the use of green technologies in Federal Universities in South-South Nigeria?
2. To what extent are green technologies adopted for sustainable education outcomes in Federal Universities in South-South Nigeria?
3. What is the relationship between teacher competency and green technology adoption for sustainable education outcomes?

Research Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H_{o1}: There is no significant relationship between teacher competency and green technology adoption in Federal Universities in South-South Nigeria.

H_{o2}: There is no significant relationship between teacher competency and sustainable education outcomes in Federal Universities in South-South Nigeria.

Theoretical Framework

This study is anchored on Systems Theory propounded by Ludwig von Bertalanffy. Systems theory conceptualizes universities as open systems comprising interdependent components such as teachers, students, technology, administration, and policy environment. Teacher competency represents a critical subsystem that influences how technological inputs, including green technologies, are transformed into sustainable educational outputs.

When teachers lack the required competencies, the system experiences inefficiencies, resulting in underutilization of green technologies and weak sustainability outcomes. Conversely, competent teachers enhance system synergy by effectively integrating technology, pedagogy, and sustainability goals.

Methodology

Research Design

The study adopted a descriptive survey research design, which was considered appropriate for examining relationships among variables as they naturally occur without manipulation.

Area of the Study

The study was conducted in Federal Universities located in the South-South geopolitical zone of Nigeria, comprising Akwa Ibom, Bayelsa, Cross River, Delta, Edo, and Rivers States.

Population of the Study

The population consisted of all academic staff in Federal Universities in South-South Nigeria.

Sample and Sampling Technique

A sample of 312 lecturers was selected using stratified random sampling to ensure proportional representation across faculties and universities.

Instrument for Data Collection

Data were collected using a researcher-developed questionnaire titled *Teacher Competency and Green Technology Adoption Questionnaire* (TCGTAQ), structured on a 4-point Likert scale.

Validity and Reliability of the Instrument

The instrument was face- and content-validated by experts in educational technology and sustainability studies. Reliability was established using Cronbach's Alpha, yielding a coefficient of 0.84.

Method of Data Analysis

Mean and standard deviation were used to answer research questions, while Pearson Product Moment Correlation was used to test hypotheses at the 0.05 level of significance.

RESULTS

Table 1

Mean and Standard Deviation of Respondents on Teacher Competency in the Use of Green Technologies. ***(n = 312)***

S/N	Items	Mean ($\bar{x}$)	SD	Remark
1	Teachers possess basic digital skills for green technology use	2.55	0.72	Moderate
2	Teachers integrate green technologies into classroom instruction	2.47	0.74	Moderate
3	Teachers demonstrate awareness of sustainability principles	2.58	0.70	Moderate
4	Teachers are confident in using online learning platforms	2.46	0.76	Moderate
5	Teachers receive training on green and sustainable technologies	2.41	0.75	Moderate
	Aggregate Mean	**2.49**	**0.73**	**Moderate**

Decision Rule: Mean ≥ 2.50 = High; 2.00–2.49 = Moderate; < 2.00 = Low

Table 1 indicates that teacher competency in the use of green technologies in Federal Universities in South-South Nigeria is moderate. The aggregate mean score of 2.49 suggests that lecturers possess foundational digital and sustainability-related skills but lack advanced competencies required for innovative and sustained integration of green technologies into teaching.

Table 2

Mean and Standard Deviation of Respondents on Green Technology Adoption for Sustainable Education Outcomes.*(n = 312)*

S/N	Items	Mean ($\bar{x}$)	SD	Remark
1	Learning management systems reduce paper usage	2.28	0.76	Low
2	Virtual classrooms support sustainability-driven teaching	2.24	0.73	Low

3	Digital materials replace printed instructional resources	2.32	0.71	Low
4	Energy-efficient ICT facilities are used for teaching	2.10	0.79	Low
5	Green technologies improve sustainability learning outcomes	2.13	0.77	Low
	Aggregate Mean	**2.21**	**0.77**	**Low**

Table 2 reveals a low extent of green technology adoption for sustainable education outcomes. The aggregate mean score of 2.21 indicates that green technologies such as learning management systems, digital instructional materials, and energy-efficient ICT facilities are either underutilized or inconsistently applied.

Table 3

Pearson Product Moment Correlation between Teacher Competency and Green Technology Adoption.

Variables	**N**	**Mean**	**SD**	**r**	**p-value**	**Decision**
Teacher Competency	312	2.49	0.73			
Green Technology Adoption	312	2.21	0.77	**0.46**	0.000	Reject H_{01}

Table 3 shows a moderate, positive, and statistically significant relationship between teacher competency and green technology adoption ($r = 0.46$, $p < .05$). This indicates that increases in teacher competency are associated with improvements in green technology adoption.

Table 4

Pearson Product Moment Correlation between Teacher Competency and Sustainable Education Outcomes

Variables	**N**	**Mean**	**SD**	**R**	**p-value**	**Decision**
Teacher Competency	312	2.49	0.73			
Sustainable Education Outcomes	312	2.34	0.74	**0.39**	0.001	Reject H_{02}

Table 4 indicates a weak to moderate but statistically significant relationship between teacher competency and sustainable education outcomes ($r = 0.39$, $p < .05$). This implies that teacher competency contributes to sustainability-oriented learning outcomes, but its impact is constrained by the low level of green technology adoption and broader institutional challenges.

Discussion of Findings

Teacher Competency in the Use of Green Technologies

The findings of this study revealed that teacher competency in the use of green technologies in Federal Universities in South-South Nigeria is moderate. Although lecturers demonstrated

basic digital skills and a general awareness of sustainability principles, their capacity to confidently and innovatively integrate green technologies into teaching remained limited. The moderate aggregate mean score suggests that teachers are neither entirely unprepared nor fully competent to drive sustainability-oriented instructional practices.

This finding reflects the realities of Nigerian public universities, where professional development opportunities related to sustainability and green technology are often irregular and inadequately institutionalized. Similar studies have reported that lecturers may possess foundational ICT skills but lack exposure to specialized training on environmentally sustainable technologies and pedagogy (Lozano et al., 2021; Olatoye et al., 2022). Consequently, teachers tend to use digital tools in conventional ways rather than as instruments for advancing sustainability goals.

Extent of Green Technology Adoption for Sustainable Education Outcomes

The study further revealed a low extent of green technology adoption for sustainable education outcomes. Despite the presence of learning management systems, digital instructional materials, and virtual platforms in some institutions, their utilization for sustainability-driven teaching was minimal. The low aggregate mean score indicates that green technologies are largely underutilized and have not been fully mainstreamed into instructional practices. This finding suggests that infrastructural availability alone does not guarantee adoption. Factors such as unreliable power supply, inadequate maintenance, limited institutional incentives, and insufficient technical support may constrain the effective use of green technologies in Federal Universities. This aligns with earlier research indicating that sustainability initiatives in higher education often remain at the policy or infrastructural level without deep integration into teaching and learning processes (Tilbury, 2020; UNESCO, 2022).

Relationship between Teacher Competency and Green Technology Adoption

The correlation analysis revealed a moderate, positive, and statistically significant relationship between teacher competency and green technology adoption ($r = 0.46$, $p < .05$). This finding implies that improvements in teacher competency are associated with increased adoption of green technologies, even though the overall level of adoption remains low. The moderate strength of the relationship suggests that teacher competency is a necessary but insufficient condition for widespread green technology adoption. While competent teachers are more inclined to experiment with and utilize green technologies, systemic challenges such as funding constraints and weak institutional frameworks may limit the extent to which these

competencies translate into practice. This supports systems theory, which posits that weaknesses in one subsystem can constrain the performance of the entire system.

Relationship between Teacher Competency and Sustainable Education Outcomes

The study also found a weak to moderate but statistically significant relationship between teacher competency and sustainable education outcomes ($r = 0.39$, $p < .05$). This result indicates that teacher competency contributes to sustainability-oriented learning outcomes, but its impact is diluted by the low level of green technology adoption and other contextual limitations. This finding underscores the complexity of achieving sustainable education outcomes in higher education. While competent teachers play a critical role, sustainability outcomes are also shaped by institutional culture, curriculum design, infrastructure, and policy support. Without adequate integration of green technologies, teacher efforts alone may not yield substantial sustainability gains.

Implications for Policy and Practice

1. **Teacher Professional Development:**
   The moderate level of teacher competency highlights the need for continuous, structured professional development programmes focused on green technology integration and sustainability pedagogy.
2. **Institutional Commitment:**
   Universities must move beyond symbolic sustainability initiatives and embed green technology use into curriculum delivery, assessment, and quality assurance mechanisms.
3. **Policy Alignment:**
   National and institutional policies should explicitly link sustainability goals with teacher capacity development, funding priorities, and performance evaluation.
4. **Support Systems:**
   Technical support units, reliable power supply, and maintenance structures are essential to enable teachers to translate competency into practice.

CONCLUSION

This study provides empirical evidence that teacher competency in the use of green technologies in Federal Universities in South-South Nigeria is moderate, while the extent of green technology adoption for sustainable education outcomes remains low. Although teacher competency demonstrates a statistically significant relationship with both green technology

adoption and sustainable education outcomes, the strength of these relationships indicates that teacher capacity alone cannot drive sustainability transformation in higher education.

From a policy perspective, the findings suggest that current investments in digital infrastructure and sustainability initiatives are not yielding optimal returns due to insufficient alignment with teacher capacity development. Sustainable education cannot be achieved through technology provision alone; it requires deliberate policy frameworks that prioritize continuous professional development, institutional accountability, and supportive implementation structures.

Therefore, achieving sustainable education outcomes in Federal Universities in South-South Nigeria demands a coordinated policy response that integrates teacher competency development with green technology planning, funding mechanisms, and institutional governance. Without such alignment, green technology initiatives are likely to remain underutilized, limiting their contribution to sustainability goals and educational quality.

RECOMMENDATIONS

Based on the findings, the study recommends that:

1. Universities should institutionalize continuous professional development programmes focused on green technology and sustainability pedagogy.
2. Government and university management should align sustainability policies with teacher training initiatives.
3. Incentives should be provided to encourage innovative and sustainable teaching practices.
4. Universities should establish monitoring mechanisms to ensure effective utilization of green technologies.

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