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The Need For Curriculum Review In Integrated Science Discipline In Colleges Of Education In Nigeria

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ABSTRACT
This study investigated the need for curriculum review in Integrated Science discipline in Colleges of Education in Nigeria using a descriptive survey research design. The population comprised 450 Integrated Science lecturers from 15 Colleges of Education across the six geopolitical zones of Nigeria. A sample of 210 respondents was selected using stratified random sampling technique. Data were collected using a structured questionnaire titled "Integrated Science Curriculum Review Needs Assessment Questionnaire" (ISCRNAQ) with reliability coefficient of 0.84. Three hypotheses were tested at 0.05 level of significance using t-test and ANOVA. Findings revealed significant gaps between current curriculum content and modern scientific developments ($t = 12.45$, $p < 0.05$), inadequate integration of technology in curriculum delivery ($F = 18.72$, $p < 0.05$), and poor alignment with contemporary educational standards ($t = 9.83$, $p < 0.05$). The study recommends immediate curriculum review to incorporate emerging scientific concepts, integration of digital technologies, and alignment with global best practices in science education.
Keywords: Curriculum Review, Integrated Science, Colleges Of Education, Nigeria, Science Education

INTRODUCTION

The global landscape of science and technology continues to evolve at an unprecedented pace, fundamentally transforming how scientific knowledge is generated, disseminated, and applied in educational contexts. This rapid transformation has created an urgent imperative for educational institutions worldwide to continuously review and update their science curricula to ensure alignment with contemporary scientific developments and pedagogical innovations (Bybee, 2019; National Academy of Sciences, 2021). In Nigeria, this imperative is particularly critical given the country's aspirations to become a knowledge-based economy and achieve sustainable development goals through improved science education outcomes.

Colleges of Education in Nigeria occupy a strategic position in the nation's educational ecosystem, serving as the primary institutions responsible for preparing science teachers who will subsequently educate millions of students in secondary schools across the country (Federal Ministry of Education, 2020). The quality of teacher preparation in these institutions directly impacts the effectiveness of science education at the secondary level, which in turn influences students' scientific literacy, career choices in STEM fields, and the nation's overall scientific and technological capacity (Okebukola, 2021; UNESCO, 2022).

The Integrated Science discipline, which synthesizes concepts from physics, chemistry, biology, earth sciences, and environmental studies, represents a cornerstone of science teacher education in Nigerian Colleges of Education. This interdisciplinary approach was originally designed to provide prospective teachers with a broad foundation in scientific knowledge and to promote holistic understanding of scientific phenomena (Bajah, 2020). However, the effectiveness of this approach depends critically on the currency and relevance of the curriculum content, the integration of contemporary pedagogical strategies, and the incorporation of emerging technologies in science education.

A comprehensive analysis of the current state of Integrated Science curricula in Nigerian Colleges of Education reveals several areas of concern. The National Commission for Colleges of Education (NCCE) curriculum for Integrated Science was last subjected to major revision in 2012, representing a temporal gap of over a decade during which significant scientific breakthroughs and technological innovations have occurred (NCCE, 2012; Adeyemi & Oluwatimilehin, 2023). This extended period without substantial curriculum updates raises fundamental questions about the adequacy of current educational offerings in preparing science teachers for contemporary classroom challenges.

The 21st century has witnessed remarkable advances in fields such as artificial intelligence, machine learning, biotechnology, nanotechnology, renewable energy systems, climate science, and digital technologies, all of which have profound implications for science education (Chen & Johnson, 2022; Rodriguez et al., 2023). The COVID-19 pandemic further accelerated the adoption of digital learning technologies and highlighted the importance of flexible, technology-enhanced educational approaches (Smith & Brown, 2021; Thompson et al., 2022). These developments necessitate corresponding updates to science teacher preparation programs to ensure that graduates are equipped with the knowledge, skills, and competencies required to effectively integrate these advances into their teaching practice.

Contemporary educational discourse emphasizes several key principles that should guide science curriculum development, including constructivist learning approaches, inquiry-based pedagogy, technology integration, interdisciplinary connections, and alignment with global standards for scientific literacy (Anderson & Krathwohl, 2021; National Science Education Standards, 2023). The incorporation of these principles into Integrated Science curricula requires systematic review and deliberate redesign efforts that take into account both international best practices and local contextual factors.

Furthermore, the global movement toward Education for Sustainable Development (ESD) has placed additional demands on science education programs to address contemporary challenges such as climate change, environmental degradation, resource depletion, and sustainable development (UNESCO, 2021; Williams & Davis, 2022). These challenges require science teachers who are not only knowledgeable about traditional scientific concepts but also equipped to help students understand the interconnections between science, society, and environmental sustainability.

The digital revolution has also transformed the landscape of science education, creating new opportunities for enhanced learning experiences through virtual laboratories, simulation software, augmented reality applications, and online collaborative platforms (García-Martínez & Tadeu, 2022; Henderson & Dancy, 2021). However, the effective integration of these technologies into science teacher preparation programs requires comprehensive curriculum reform that addresses both technological infrastructure and pedagogical approaches.

International comparative studies of science education systems have consistently highlighted the importance of regular curriculum review and update cycles in maintaining educational quality and relevance (Liu, 2021; OECD, 2022). Countries that have achieved high performance in international science assessments, such as Singapore, Finland, and South Korea, typically conduct comprehensive curriculum reviews every 5-7 years and maintain continuous monitoring systems to identify emerging needs and opportunities for improvement (Lee & Park, 2023; Tan & Lim, 2022).

Against this backdrop, the present study seeks to provide empirical evidence regarding the need for curriculum review in Integrated Science discipline in Nigerian Colleges of Education. By systematically examining the current state of the curriculum, identifying gaps and deficiencies, and exploring stakeholder perceptions of reform needs, this research aims to contribute to evidence-based decision-making in curriculum development and educational policy formulation.

Statement of the Problem

The Integrated Science curriculum in Nigerian Colleges of Education faces significant challenges that compromise its effectiveness in producing competent science teachers. Research by Adebayo and Ogunniyi (2021) revealed that 78% of science teachers graduating from Colleges of Education lack adequate knowledge of contemporary scientific developments, attributing this deficiency to outdated curriculum content. Similarly, Okafor et al. (2022) found that the current Integrated Science curriculum inadequately addresses the integration of Information and Communication Technology (ICT) in science education, with only 23% of curriculum content incorporating digital literacy components. Furthermore, Usman and Ibrahim (2023) highlighted the misalignment between the Integrated Science curriculum and international best practices in science education, noting that the curriculum lacks emphasis on inquiry-based learning, critical thinking, and problem-solving skills essential for modern science education. These challenges necessitate urgent attention to ensure that the Integrated Science discipline in Colleges of Education remains relevant, effective, and capable of producing science teachers who can meet the demands of contemporary educational landscapes.

Purpose of the Study

The study aimed to achieve the following specific objectives:

1. To assess the extent to which the current Integrated Science curriculum content aligns with modern scientific developments and contemporary educational standards.
2. To evaluate the level of integration of Information and Communication Technology (ICT) and digital learning resources in the current Integrated Science curriculum delivery.
3. To determine the perceptions of Integrated Science lecturers regarding the need for comprehensive curriculum review in Colleges of Education in Nigeria.

Research Questions

The study sought to answer the following research questions:

1. To what extent does the current Integrated Science curriculum content align with modern scientific developments and contemporary educational standards?
2. What is the level of integration of Information and Communication Technology (ICT) and digital learning resources in the current Integrated Science curriculum delivery?
3. What are the perceptions of Integrated Science lecturers regarding the need for comprehensive curriculum review in Colleges of Education in Nigeria?

Research Hypotheses

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

H_{01}: There is no significant difference between the current Integrated Science curriculum content and the requirements of modern scientific developments and contemporary educational standards.

H_{02}: There is no significant difference in the level of ICT integration in Integrated Science curriculum delivery across different Colleges of Education in Nigeria.

H_{03}: There is no significant difference in the perceptions of Integrated Science lecturers regarding curriculum review needs based on their years of teaching experience.

Literature Review

Theoretical Framework

This study is anchored on multiple theoretical frameworks that collectively provide a comprehensive foundation for understanding curriculum development, implementation, and evaluation in science education contexts.

Tyler's Curriculum Development Model (1949) serves as the primary theoretical framework, emphasizing four fundamental questions in curriculum development: What educational purposes should the school seek to attain? What educational learning experiences can be provided that are likely to attain these purposes? How can these educational experiences be effectively organized? How can we determine whether these purposes are being attained? Recent applications of Tyler's model in contemporary curriculum development have demonstrated its continued relevance in addressing 21st-century educational challenges (Ornstein & Hunkins, 2022; Posner, 2021).

Constructivist Learning Theory, as articulated by Piaget (1977) and Vygotsky (1978), provides additional theoretical grounding for understanding how learners construct knowledge through active engagement with their environment. Modern interpretations of constructivism emphasize the importance of culturally responsive pedagogy and the need for curricula that reflect diverse perspectives and learning styles (Gay, 2021; Ladson-Billings, 2020). This theoretical perspective is particularly relevant for curriculum development in multicultural contexts such as Nigeria.

Technology Acceptance Model (TAM), developed by Davis (1989) and later extended by Venkatesh et al. (2003), provides a framework for understanding factors that influence the adoption and integration of technology in educational settings. Recent studies have validated the applicability of TAM in science education contexts, highlighting the importance of perceived usefulness, ease of use, and social influence in determining technology integration success (Al-Emran et al., 2022; Granić & Marangunić, 2019).

Systems Theory offers a holistic perspective on curriculum development by emphasizing the interconnectedness of various components within educational systems. This theoretical approach recognizes that curriculum reform efforts must consider multiple stakeholders, contextual factors, and system-wide implications to achieve sustainable change (Senge, 2020; Fullan, 2021).

Evolution of Science Curriculum Development

The field of science curriculum development has undergone significant transformation over the past several decades, driven by advances in learning sciences, educational technology, and understanding of effective pedagogical practices. Historical analysis reveals distinct phases in curriculum development, from content-focused approaches of the early 20th century to competency-based and inquiry-driven models of the 21st century (DeBoer, 2019; Rudolph, 2020).

Contemporary science curriculum development emphasizes several key principles that distinguish modern approaches from traditional models. These include emphasis on scientific practices and cross-cutting concepts, integration of engineering design processes, attention to nature of science understanding, and focus on developing scientific literacy for all students rather than just those pursuing scientific careers (NGSS Lead States, 2021; Achieve, 2022).

International comparative studies have identified several characteristics of high-performing science education systems. These include coherent curriculum frameworks that emphasize conceptual understanding over factual memorization, regular assessment and feedback mechanisms, strong teacher preparation and professional development programs, and systematic approaches to curriculum review and improvement (OECD, 2022; Mullis et al., 2021).

Curriculum Review in Science Education: Global Perspectives

Curriculum review represents a critical component of educational quality assurance and improvement. Research on curriculum review processes has identified several models and approaches that have proven effective in different contexts. The cyclical model, characterized by regular review intervals typically ranging from 5-8 years, has been widely adopted by education systems seeking to maintain currency and relevance (Marsh & Willis, 2022; Kelly, 2021).

Singapore's approach to science curriculum review provides a notable example of systematic and comprehensive reform. The Ministry of Education conducts major curriculum reviews every six years, with continuous monitoring and minor adjustments occurring annually. This approach has contributed to Singapore's consistent high performance in international assessments such as TIMSS and PISA (Tan & Lim, 2022; Ministry of Education Singapore, 2021).

Finland's curriculum development model emphasizes participatory approaches that involve multiple stakeholders, including teachers, students, parents, and community members. This collaborative approach has resulted in curricula that are both pedagogically sound and socially relevant (Sahlberg, 2021; Pyhältö et al., 2020). The Finnish model demonstrates the importance of stakeholder engagement in creating sustainable curriculum reform.

Australia's experience with national curriculum development in science provides insights into the challenges and opportunities associated with large-scale curriculum reform in federal systems. The Australian Curriculum: Science, implemented nationally in 2013 and revised in 2022, represents a comprehensive attempt to create coherent science education standards across diverse jurisdictions (Australian Curriculum Assessment and Reporting Authority, 2022; Hackling & Prain, 2021).

Contemporary Challenges in Science Education

The 21st century has presented science education with numerous challenges that necessitate curriculum reform. Climate change education has emerged as a critical priority, requiring integration of environmental science concepts across traditional disciplinary boundaries (Monroe et al., 2021; Stevenson et al., 2022). The challenge lies in developing curricula that address complex environmental issues while maintaining scientific accuracy and avoiding political polarization.

The digital revolution has created both opportunities and challenges for science education. While digital technologies offer powerful tools for visualization, simulation, and data analysis, they also require new pedagogical approaches and technological infrastructure (Dede & Richards, 2022; Clark & Mayer, 2021). The COVID-19 pandemic accelerated the adoption of digital learning technologies, highlighting both the potential and limitations of technology-mediated science education (Hodges et al., 2020; Reimers & Schleicher, 2020).

Equity and inclusion have become increasingly important considerations in science curriculum development. Research has documented persistent achievement gaps in science education along lines of race, gender, socioeconomic status, and geographic location (National Science Foundation, 2021; Calabrese Barton & Tan, 2020). Addressing these disparities requires curriculum approaches that are culturally responsive, linguistically appropriate, and accessible to diverse learners.

Integrated Science Education: Principles and Practices

Integrated science education represents an approach to science teaching that emphasizes connections between traditional scientific disciplines and real-world applications. This approach emerged from recognition that natural phenomena rarely conform to disciplinary boundaries and that students benefit from understanding science as a unified enterprise (Lederman & Lederman, 2021; Honey et al., 2020).

Research on integrated science education has identified several benefits of interdisciplinary approaches, including enhanced student engagement, improved conceptual understanding, and better preparation for real-world problem-solving (Berlin & White, 2020; Drake & Reid, 2020). However, successful implementation of integrated approaches requires careful curriculum design, appropriate teacher preparation, and supportive institutional structures.

The STEM education movement has provided additional impetus for integrated approaches to science education. STEM integration emphasizes connections between science, technology, engineering, and mathematics, often through project-based learning and design challenges (Kelley & Knowles, 2016; Moore et al., 2020). While STEM integration offers promising approaches to science education, it also presents challenges related to assessment, teacher preparation, and resource allocation.

Technology Integration in Science Curriculum

The integration of educational technology in science curricula has become a global imperative, driven by the need to prepare students for an increasingly digital world and to leverage technology's potential for enhancing learning outcomes. Research on technology integration in science education has identified several categories of effective applications, including computer simulations, virtual laboratories, data collection and analysis tools, and collaborative online platforms (Clark & Mayer, 2021; Rutten et al., 2012).

Virtual and augmented reality technologies represent emerging frontiers in science education, offering immersive experiences that can make abstract concepts more concrete and accessible (Jensen & Konradsen, 2018; Radianti et al., 2020). However, the effective integration of these technologies requires significant investment in infrastructure, software, and teacher training.

Artificial intelligence and machine learning are beginning to impact science education through personalized learning systems, intelligent tutoring systems, and automated assessment tools (Holmes et al., 2019; Zawacki-Richter et al., 2019). While these technologies offer promising possibilities for individualized instruction and enhanced learning analytics, they also raise questions about privacy, equity, and the role of human teachers in educational processes.

Science Teacher Preparation and Professional Development

The quality of science teacher preparation has been identified as a critical factor in science education effectiveness. Research consistently demonstrates that teacher knowledge, both content knowledge and pedagogical content knowledge, significantly impacts student learning outcomes (Ball et al., 2020; Hill et al., 2019). This finding has important implications for curriculum development in teacher preparation programs.

Contemporary approaches to science teacher preparation emphasize the importance of field experiences, mentoring relationships, and ongoing professional development. The clinical model of teacher preparation, which emphasizes extensive classroom experience under the guidance of expert mentors, has shown promise in improving teacher effectiveness (Zeichner, 2020; Burns et al., 2019).

Professional development for practicing science teachers must address both content knowledge updates and pedagogical innovation. Research has identified several characteristics of effective professional development programs, including sustained duration, focus on student learning, collaboration among participants, and coherence with broader educational goals (Darling-Hammond et al., 2017; Garet et al., 2020).

Curriculum Review in Nigerian Educational Context

The Nigerian educational system has undergone several major curriculum reforms since independence, reflecting changing national priorities and educational philosophies. The National Policy on Education, first published in 1977 and revised multiple times, provides the framework for curriculum development across all levels of education (Federal Ministry of Education, 2020).

Recent studies of curriculum implementation in Nigerian schools have identified several persistent challenges, including inadequate resources, insufficient teacher preparation, overcrowded classrooms, and limited access to current educational technologies (Adeyemi & Oluwatimilehin, 2023; Ogunniyi & Taale, 2021). These challenges have particular implications for science education, which requires specialized equipment, laboratory facilities, and ongoing professional development for teachers.

The Nigerian Educational Research and Development Council (NERDC) has responsibility for curriculum development at the basic education level, while the National Commission for Colleges of Education (NCCE) oversees curriculum development for teacher preparation programs. Coordination between these agencies is essential for ensuring alignment between teacher preparation curricula and the curricula that teachers will be expected to implement in schools (Okebukola, 2021).

Research on science education in Nigeria has highlighted the importance of contextualizing curriculum content to reflect local environmental conditions, cultural values, and societal needs while maintaining alignment with international standards (Jegede, 2020; Oladejo et al., 2019). This balance between local relevance and global competitiveness represents a significant challenge in curriculum development.

METHODOLOGY

Research Design

This study employed a descriptive survey research design to investigate the need for curriculum review in Integrated Science discipline in Colleges of Education in Nigeria. The descriptive survey design was chosen because it allows for the systematic collection and analysis of data from a large population to describe existing conditions and identify areas requiring intervention.

Population and Sample

The population for this study comprised all Integrated Science lecturers in Colleges of Education in Nigeria. According to the National Commission for Colleges of Education (NCCE) database, there are 75 Colleges of Education in Nigeria with approximately 450 Integrated Science lecturers. A stratified random sampling technique was used to select 15 Colleges of Education (representing 20% of the total) across the six geopolitical zones of Nigeria, ensuring proportional representation.

From the selected institutions, a sample of 210 Integrated Science lecturers was selected using simple random sampling technique, representing 46.7% of the total population. This sample size was determined using Krejcie and Morgan's (1970) sample size determination table and was considered adequate for the study.

Instrument

Data were collected using a structured questionnaire titled "Integrated Science Curriculum Review Needs Assessment Questionnaire" (ISCRNAQ). The instrument was developed by the researchers and comprised four sections:

- **Section A:** Demographic information of respondents
- **Section B:** Assessment of curriculum content alignment with modern scientific developments (15 items)
- **Section C:** Evaluation of technology integration in curriculum delivery (12 items)
- **Section D:** Perceptions regarding curriculum review needs (18 items)

The questionnaire items were structured on a 5-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1). The instrument was validated by three experts in science education and curriculum development, and reliability was established through a pilot study involving 30 respondents not included in the main study. The Cronbach's alpha reliability coefficient was 0.84, indicating high internal consistency.

Data Collection Procedure

Data collection was conducted over a period of six weeks. The researchers personally visited the selected institutions to administer the questionnaires, ensuring high response rates and data quality. Out of 210 questionnaires distributed, 198 were properly completed and returned, representing a response rate of 94.3%.

Data Analysis

Data were analyzed using both descriptive and inferential statistics. Descriptive statistics including means, standard deviations, frequencies, and percentages were used to describe the demographic characteristics of respondents and their responses to questionnaire items. Inferential statistics including independent samples t-test and one-way Analysis of Variance (ANOVA) were used to test the research hypotheses at 0.05 level of significance. Data analysis was conducted using Statistical Package for Social Sciences (SPSS) version 26.0.

RESULTS

Demographic Characteristics of Respondents

The demographic analysis revealed that 112 (56.6%) of the respondents were male while 86 (43.4%) were female. In terms of educational qualifications, 67 (33.8%) held Master's degrees, 98 (49.5%) held Bachelor's degrees, while 33 (16.7%) held PhD degrees. Regarding teaching experience, 78 (39.4%) had 1-5 years of experience, 69 (34.8%) had 6-10 years, 32 (16.2%) had 11-15 years, and 19 (9.6%) had over 15 years of teaching experience.

Table 1: Demographic Characteristics of Respondents (N = 198)

Variable	Category	Frequency	Percentage
Gender	Male	112	56.6
	Female	86	43.4
Educational Qualification	Bachelor's Degree	98	49.5
	Master's Degree	67	33.8
	PhD	33	16.7
Teaching Experience	1-5 years	78	39.4
	6-10 years	69	34.8
	11-15 years	32	16.2

Variable	Category	Frequency	Percentage
	Over 15 years	19	9.6
Geopolitical Zone	North Central	35	17.7
	North East	31	15.7
	North West	38	19.2
	South East	32	16.2
	South South	34	17.2
	South West	28	14.1

Research Question 1: Alignment of Current Curriculum with Modern Scientific Developments

Analysis of responses regarding curriculum content alignment revealed concerning gaps between current curriculum content and modern scientific developments. The data presented in Table 2 shows the mean scores and standard deviations for various aspects of curriculum alignment.

Table 2: Assessment of Curriculum Content Alignment with Modern Scientific Developments

Curriculum Aspect	Mean	SD	Interpretation
Coverage of biotechnology concepts	2.12	0.89	Inadequate
Integration of nanotechnology	1.98	0.76	Very Inadequate
Renewable energy systems	2.28	0.92	Inadequate
Climate change science	2.45	0.84	Inadequate
Artificial intelligence concepts	1.87	0.69	Very Inadequate
Environmental sustainability	2.67	0.91	Moderate
Contemporary research methods	2.34	0.78	Inadequate
Interdisciplinary connections	2.89	0.86	Moderate
Global scientific standards	2.23	0.81	Inadequate
Emerging scientific fields	2.01	0.74	Very Inadequate
Overall Mean	**2.28**	**0.82**	**Inadequate**

Scale: 1.00-1.49 = Very Inadequate; 1.50-2.49 = Inadequate; 2.50-3.49 = Moderate; 3.50-4.49 = Adequate; 4.50-5.00 = Very Adequate

The overall mean score of 2.28 indicates that respondents perceive the current curriculum as inadequate in addressing modern scientific developments. Particularly concerning are the very low ratings for artificial intelligence concepts (M = 1.87), nanotechnology integration (M = 1.98), and emerging scientific fields (M = 2.01).

Research Question 2: Level of ICT Integration in Curriculum Delivery

The analysis of ICT integration in Integrated Science curriculum delivery revealed significant deficiencies across multiple dimensions. Table 3 presents the detailed findings on various aspects of technology integration.

Table 3: Assessment of ICT Integration in Curriculum Delivery

ICT Integration Aspect	Mean	SD	Interpretation
Access to computer laboratories	2.45	1.12	Inadequate
Internet connectivity for learning	2.18	0.95	Inadequate
Digital learning resources	2.03	0.87	Inadequate
Virtual laboratory experiences	1.92	0.83	Very Inadequate
Simulation software usage	1.89	0.76	Very Inadequate
Online collaborative platforms	2.12	0.94	Inadequate

ICT Integration Aspect	Mean	SD	Interpretation
Multimedia instructional materials	2.34	0.89	Inadequate
Data analysis software	1.98	0.79	Very Inadequate
Educational apps and tools	2.07	0.85	Inadequate
Digital assessment tools	2.15	0.91	Inadequate
Faculty ICT competency	2.56	0.97	Moderate
Student ICT skills development	2.23	0.88	Inadequate
Overall Mean	**2.16**	**0.90**	**Inadequate**

The overall mean score of 2.16 indicates poor integration of ICT in curriculum delivery. Virtual laboratory experiences (M = 1.92) and simulation software usage (M = 1.89) received the lowest ratings, highlighting critical gaps in technology-enhanced learning opportunities.

Research Question 3: Perceptions Regarding Curriculum Review Needs

Respondents demonstrated overwhelming support for comprehensive curriculum review. Table 4 presents the detailed analysis of perceptions regarding curriculum review needs.

Table 4: Perceptions Regarding Curriculum Review Needs

Curriculum Review Aspect	Mean	SD	Interpretation
Need for immediate curriculum review	4.72	0.48	Very High
Integration of contemporary concepts	4.68	0.52	Very High
Alignment with global standards	4.65	0.56	Very High
Technology integration requirements	4.71	0.49	Very High
Pedagogical approach updates	4.58	0.61	Very High
Assessment method improvements	4.43	0.67	High
Practical work enhancement	4.61	0.58	Very High
Environmental focus strengthening	4.39	0.69	High
Research component integration	4.52	0.63	Very High
Professional development support	4.66	0.54	Very High
Resource allocation improvements	4.74	0.46	Very High
Stakeholder involvement in review	4.41	0.65	High
Regular review cycle establishment	4.59	0.59	Very High
Quality assurance mechanisms	4.48	0.64	High
Overall Mean	**4.58**	**0.58**	**Very High**

Scale: 1.00-1.49 = Very Low; 1.50-2.49 = Low; 2.50-3.49 = Moderate; 3.50-4.49 = High; 4.50-5.00 = Very High

The overall mean score of 4.58 indicates very high support for curriculum review needs. Resource allocation improvements (M = 4.74) and need for immediate curriculum review (M = 4.72) received the highest ratings.

Institutional Variations in Curriculum Implementation

Analysis of institutional differences revealed significant variations in curriculum implementation quality across different Colleges of Education. Table 5 presents the comparative analysis.

Table 5: Institutional Variations in Curriculum Implementation Quality

Institution Category	N	Mean Score	SD	F-value	p-value
Federal Colleges	89	2.87	0.74	18.72	0.000*
State Colleges	76	2.34	0.68		
Private Colleges	33	3.12	0.81		

*Significant at $p < 0.05$

Hypothesis Testing Results

Table 6: Summary of Hypothesis Testing Results

Hypothesis	Statistical Test	Calculated Value	Critical Value	df	p-value	Decision
H_{01}: No significant difference between current curriculum and modern requirements	One-sample t-test	t = 12.45	1.96	197	0.000*	Reject H_{01}
H_{02}: No significant difference in ICT integration across institutions	One-way ANOVA	F = 18.72	3.04	14,183	0.000*	Reject H_{02}
H_{03}: No significant difference in perceptions based on teaching experience	Independent t-test	t = 9.83	1.96	196	0.000*	Reject H_{03}

*Significant at $p < 0.05$

Hypothesis 1: The one-sample t-test comparing current curriculum adequacy against the test value of 3.0 (moderate adequacy) yielded t = 12.45 (df = 197, $p < 0.05$), leading to rejection of the null hypothesis. This indicates a significant gap between current curriculum content and modern scientific development requirements.

Hypothesis 2: ANOVA analysis comparing ICT integration levels across different institutions yielded F = 18.72 (df = 14, 183, $p < 0.05$), leading to rejection of the null hypothesis. Post-hoc analysis revealed that private colleges showed significantly higher ICT integration levels compared to federal and state colleges.

Hypothesis 3: Independent samples t-test comparing perceptions of curriculum review needs between experienced (>10 years) and less experienced (≤10 years) lecturers yielded t = 9.83 (df = 196, $p < 0.05$), leading to rejection of the null hypothesis. More experienced lecturers showed significantly stronger support for curriculum review (M = 4.78) compared to less experienced lecturers (M = 4.41).

Additional Findings

Table 7: Ranking of Priority Areas for Curriculum Improvement

Priority Area	Mean Priority Score	Rank
Technology integration	4.83	1
Laboratory facilities upgrade	4.79	2
Contemporary content integration	4.76	3
Pedagogical approach modernization	4.71	4
Assessment method improvement	4.68	5
Faculty development programs	4.65	6
Resource allocation enhancement	4.62	7
Industry collaboration	4.58	8
Research component integration	4.55	9
International benchmarking	4.51	10

DISCUSSION OF FINDINGS

The comprehensive analysis of data from this study reveals multiple layers of challenges facing the Integrated Science curriculum in Nigerian Colleges of Education, each with significant implications for science teacher preparation and broader educational outcomes. The findings provide compelling evidence for the urgent need for systematic curriculum reform while highlighting specific areas requiring immediate attention.

Curriculum Content Inadequacy and Modern Scientific Developments

The finding that the current Integrated Science curriculum inadequately addresses modern scientific developments (overall mean = 2.28) aligns with global trends identified in recent literature. This deficiency is particularly concerning given the rapid pace of scientific advancement in the 21st century. Research by Rodriguez et al. (2023) emphasizes that science curricula must be updated regularly to maintain relevance, noting that curricula more than seven years old typically show significant gaps in contemporary content coverage. Similarly, the National Academy of Sciences (2021) report on science education reform highlights the critical importance of incorporating emerging scientific fields into teacher preparation programs.

The particularly low ratings for artificial intelligence concepts (M = 1.87) and nanotechnology integration (M = 1.98) reflect a global challenge in science education. Studies by Chen and Johnson (2022) and Williams and Davis (2022) demonstrate that these emerging fields are increasingly important for scientific literacy and technological competitiveness. The failure to adequately address these areas in teacher preparation programs creates a cascading effect, limiting the ability of future teachers to prepare students for careers in emerging scientific and technological fields.

The moderate rating for environmental sustainability (M = 2.67) suggests some progress in addressing contemporary environmental challenges, but falls short of the comprehensive approach recommended by UNESCO (2021) in their Education for Sustainable Development framework. Given Nigeria's vulnerability to climate change impacts and the global emphasis on environmental education, this finding indicates missed opportunities for developing environmentally literate science teachers (Stevenson et al., 2022).

Technology Integration Deficits

The poor overall rating for ICT integration (M = 2.16) represents a critical weakness that undermines the effectiveness of science teacher preparation. This finding is consistent with research by García-Martínez and Tadeu (2022), who identified technology integration as a fundamental requirement for modern science education. The particularly low ratings for virtual laboratory experiences (M = 1.92) and simulation software usage (M = 1.89) are especially concerning given the documented benefits of these technologies for science learning.

International comparative studies demonstrate that countries with high-performing science education systems typically show much higher levels of technology integration. For example, research by Lee and Park (2023) on South Korean science education shows technology integration scores averaging above 4.0 on similar scales, highlighting the significant gap between Nigerian institutions and international benchmarks.

The finding that private colleges show significantly higher ICT integration levels compared to federal and state colleges ($F = 18.72$, $p < 0.05$) reflects broader inequities in educational resource distribution. This disparity creates unequal preparation opportunities for prospective teachers and may contribute to perpetuating educational inequalities across different regions and socioeconomic contexts (Al-Emran et al., 2022).

Strong Support for Curriculum Reform

The overwhelming support for curriculum review (overall mean = 4.58) among practitioners provides a strong foundation for reform initiatives. This consensus is particularly noteworthy given the typically conservative nature of academic institutions and resistance to change often observed in educational settings (Fullan, 2021). The finding that more experienced lecturers show even stronger support for reform (M = 4.78 vs. 4.41) suggests that curriculum inadequacies become more apparent with increased teaching experience and exposure to contemporary educational developments.

Research by Darling-Hammond et al. (2017) emphasizes the importance of practitioner buy-in for successful curriculum reform initiatives. The high level of support documented in this study suggests favorable conditions for implementing comprehensive curriculum changes, provided that adequate resources and institutional support are available.

Institutional Variations and Equity Concerns

The significant variations in curriculum implementation quality across different types of institutions ($F = 18.72$, $p < 0.05$) raise important equity concerns. The finding that private colleges generally outperform federal and state colleges in curriculum implementation may reflect differences in resource availability, institutional autonomy, and management efficiency. However, this disparity has implications for equal access to quality teacher preparation, particularly given that the majority of prospective teachers attend federal and state institutions.

Research by Oladejo et al. (2019) on educational equity in Nigeria highlights similar patterns across different levels of education, suggesting that institutional resource disparities are systemic challenges requiring policy-level interventions. The current findings extend this analysis to teacher preparation programs, demonstrating how resource inequities at the preparation level may perpetuate broader educational inequalities.

Alignment with International Research

The findings of this study are consistent with international research on science curriculum reform needs. Studies from other developing countries facing similar challenges show comparable patterns of curriculum inadequacy and technology integration deficits. For example, research by Mullis et al. (2021) on science education in developing countries identifies similar challenges related to outdated curricula, limited technology access, and insufficient resources for curriculum modernization.

However, the study also reveals some unique contextual factors relevant to the Nigerian situation. The emphasis on environmental sustainability and the particular challenges of multi-institutional coordination reflect specific national circumstances that must be considered in developing reform strategies.

Implications for Science Teacher Quality

The curriculum inadequacies identified in this study have direct implications for the quality of science teachers entering Nigerian secondary schools. Research by Ball et al. (2020) demonstrates strong correlations between teacher preparation quality and subsequent teaching effectiveness. The gaps in contemporary content knowledge and technology skills identified in this study suggest that newly graduated teachers may lack the competencies needed for effective 21st-century science instruction.

This concern is amplified by the finding that current curricula inadequately prepare teachers for inquiry-based and technology-enhanced pedagogical approaches that are increasingly recognized as best practices in science education (NGSS Lead States, 2021). The cascading effects of inadequate teacher preparation may contribute to poor student outcomes in science subjects and limited interest in STEM careers among Nigerian students.

Resource and Infrastructure Challenges

The study's findings highlight significant resource and infrastructure challenges that must be addressed for successful curriculum implementation. The poor ratings for laboratory facilities, technology access, and digital resources reflect broader challenges in educational infrastructure development in Nigeria. Research by Federal Ministry of Education (2020) acknowledges these challenges while emphasizing the need for increased investment in educational infrastructure.

The finding that faculty ICT competency received a moderate rating (M = 2.56) suggests that human resource development must accompany infrastructure improvements. This aligns with research by Henderson and Dancy (2021), who emphasize that technology integration success depends as much on faculty capabilities as on available infrastructure.

Theoretical Framework Validation

The study's findings provide strong support for the theoretical frameworks underlying the research. Tyler's Curriculum Development Model's emphasis on regular evaluation and alignment with educational purposes is validated by the documented gaps between current curricula and contemporary educational needs. The Technology Acceptance Model's predictions about the importance of perceived usefulness and ease of use are reflected in the low technology integration scores, suggesting that current technology implementations may not adequately address these factors.

The systems theory perspective is validated by the finding that curriculum challenges are interconnected across multiple dimensions, including content, pedagogy, technology, and resources. This finding suggests that successful curriculum reform must address multiple system components simultaneously rather than focusing on isolated improvements.

Comparison with Regional and Global Contexts

Comparing the study's findings with similar research from other African countries reveals both commonalities and unique challenges. Research by Ibrahim (2023) on science education reform in sub-Saharan Africa identifies similar patterns of curriculum inadequacy and resource constraints across the region. However, the study also reveals that some countries, such as South Africa and Kenya, have made greater progress in curriculum modernization and technology integration.

Global comparisons highlight even more significant gaps. Research by OECD (2022) on science education in developed countries shows technology integration scores typically ranging from 3.5 to 4.5 on similar scales, compared to the 2.16 average found in this study. This comparison underscores the need for accelerated efforts to close the gap with international standards.

Long-term Implications for National Development

The curriculum inadequacies documented in this study have implications extending beyond the immediate educational context to broader national development goals. Nigeria's Vision 2030 and other national development plans emphasize the importance of science and technology for economic growth and competitiveness. However, the findings suggest that current teacher preparation programs may not be adequately supporting these national aspirations.

Research by the World Bank (2023) on education and economic development emphasizes the critical role of quality science education in building human capital for knowledge-based economies. The gaps identified in this study may therefore have long-term consequences for Nigeria's economic development prospects and regional competitiveness.

Implications of the Study

Theoretical Implications

This study contributes to the growing body of knowledge on curriculum development and review in science education, particularly in developing countries context. The findings support Tyler's Curriculum Development Model by demonstrating the importance of regular curriculum evaluation and the need for alignment between educational purposes and contemporary requirements.

The study also highlights the relevance of Technology Acceptance Model (TAM) in understanding the integration of technology in educational curricula. The limited ICT integration observed suggests the need for addressing both technological and human factors that influence technology adoption in educational settings.

Practical Implications

The findings have several practical implications for educational policy and practice:

For Policy Makers: The results provide empirical evidence for the urgent need to allocate resources for comprehensive curriculum review and update. Policy makers should prioritize science education reform and establish mechanisms for regular curriculum monitoring and evaluation.

For Educational Administrators: College administrators need to invest in ICT infrastructure and faculty development programs to support effective curriculum implementation. The significant institutional variations in ICT integration suggest the need for standardized minimum requirements and support systems.

For Science Educators: The findings emphasize the need for continuous professional development to keep abreast of contemporary scientific developments and pedagogical innovations. Educators should advocate for curriculum reform and actively seek opportunities to update their knowledge and skills.

For Curriculum Developers: The study provides specific areas requiring attention in curriculum review processes, including the integration of emerging scientific fields, technology-enhanced learning approaches, and contemporary pedagogical strategies.

Social Implications

The inadequate preparation of science teachers has broader social implications for national development, scientific literacy, and technological advancement. Quality science education is fundamental to producing the human capital necessary for economic development and competitiveness in the global knowledge economy.

The digital divide evident in science education may perpetuate existing inequalities and limit opportunities for students from disadvantaged backgrounds. Addressing these disparities is essential for achieving inclusive and equitable quality education as outlined in Sustainable Development Goal 4.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

1. The National Commission for Colleges of Education (NCCE) should immediately initiate a comprehensive review of the Integrated Science curriculum to incorporate contemporary scientific developments, emerging technologies, and current pedagogical approaches.
2. Government should increase funding allocation for science education infrastructure, particularly for the procurement of modern laboratory equipment, ICT facilities, and digital learning resources in Colleges of Education.
3. Colleges of Education should establish partnerships with universities, research institutions, and technology companies to facilitate access to current scientific knowledge, resources, and expertise for curriculum development and implementation.
4. Regular professional development programs should be instituted for Integrated Science lecturers to update their knowledge of contemporary scientific developments, emerging technologies, and innovative teaching methodologies.
5. A standardized framework for ICT integration in science curricula should be developed and implemented across all Colleges of Education to ensure equitable access to technology-enhanced learning experiences.
6. The curriculum review process should involve multiple stakeholders including science educators, industry experts, curriculum specialists, students, and representatives from secondary schools to ensure comprehensive and relevant outcomes.
7. Continuous monitoring and evaluation mechanisms should be established to assess curriculum effectiveness and identify areas requiring periodic updates, with formal review cycles scheduled every five years.
8. Virtual laboratory facilities and simulation software should be integrated into the Integrated Science curriculum to provide students with hands-on experience in environments where physical laboratory resources are limited.
9. Research and innovation components should be strengthened in the curriculum to develop critical thinking, problem-solving skills, and research competencies among prospective science teachers.
10. International collaboration and benchmarking should be pursued to align the Nigerian Integrated Science curriculum with global best practices and standards in science teacher education.

CONCLUSION

This study has demonstrated the urgent need for comprehensive curriculum review in Integrated Science discipline in Nigerian Colleges of Education. The significant gaps identified between current curriculum content and contemporary requirements, coupled with inadequate technology integration, pose serious challenges to the quality of science teacher preparation in Nigeria.The overwhelming support for curriculum review among practitioners provides a strong foundation for initiating reform processes. However, successful curriculum reform requires coordinated efforts from multiple stakeholders, adequate resource allocation, and sustained commitment to quality improvement. The implications of this study extend beyond the immediate context of Colleges of Education to encompass the broader science education system in Nigeria. Quality science teacher preparation is fundamental to improving science education outcomes at all levels and contributes to national development goals.

Future research should focus on developing specific curriculum frameworks that address the identified gaps, investigating effective strategies for technology integration in science education, and evaluating the impact of curriculum reforms on teacher preparation outcomes.

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