TRANSFORMING AGRICULTURAL SCIENCE EDUCATION IN OGUN STATE THROUGH AI-DRIVEN LOCALIZED PEDAGOGIES: BRIDGING INDIGENOUS PRACTICES AND 21ST CENTURY INNOVATION

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Abstract

As Nigeria strives for food security and economic diversification, the role of Agricultural Science education in shaping the next generation of agri-preneurs cannot be overstated. In Ogun State a region characterized by a rich duality of industrial proximity and deep-rooted agrarian traditions there exists a unique opportunity to reimagine how Agricultural Science is taught in basic and secondary schools. This conceptual paper explores the integration of Artificial Intelligence (AI) with localized pedagogical strategies to create a culturally responsive and future-ready Agricultural Science curriculum for Ogun State learners. Drawing from theoretical frameworks in culturally relevant pedagogy, AI in education (AIED), and the Nigerian Basic Science and Technology curriculum, this paper proposes a context-sensitive model for instruction. The model leverages accessible AI tools to bridge the gap between global agricultural science and indigenous farming knowledge prevalent in Ogun State communities. The proposed framework focuses on three core innovations viz: AI-Enhanced Curriculum Localization, Virtual Farm Simulations and AI Chatbots and Community-Connected Data Projects. The paper argues that this integrated approach can transform Agricultural Science education in Ogun State from a passive, examination-focused subject into an active, exploratory discipline that nurtures critical thinking, entrepreneurial mindsets, and environmental stewardship. It further contends that by validating and building upon indigenous agricultural knowledge through AI-enhanced methods, educators can foster deeper engagement and cultural pride among learners. The discussion acknowledges implementation challenges, including digital infrastructure gaps in teacher education, teacher capacity building, and the need for partnerships with state agricultural development programs (ADPs) and research institutions in Nigeria.

Keywords: Agricultural Science Education, Artificial Intelligence, Localized Pedagogy, Indigenous Knowledge, STEM Education, Ogun State, Contextual Learning.

1. Introduction

1.1 Background to the Study

Agricultural Science occupies a unique position within Nigeria's educational landscape. As a core subject in both the Basic Education curriculum (as part of Pre-vocational Studies at the junior secondary level) and the Senior Secondary curriculum (as a science elective), Agricultural Science is intended to serve multiple purposes: introducing students to scientific principles underlying agricultural production, developing practical skills for self-reliance, and preparing future professionals for Nigeria's agricultural sector. The National Policy on Education explicitly recognizes agricultural education as a strategic tool for achieving food security, poverty reduction, and economic diversification.

The year 2025 marked a significant milestone in Nigerian curriculum reform. The Federal Government, through the Nigerian Educational Research and Development Council (NERDC), released the approved subject offerings for the revised Basic and Senior Secondary Education Curriculum as part of the National Education Sector Reform Initiatives (NESRI). These reforms, which began implementation at the start of each three-year education cycle (Primary 1, Primary 4, JSS1, and SS1), were designed to "reduce overload and ensure positive learning outcomes for pupils across the country”. Within this reformed framework, Agricultural Science retained its status as a core science subject at the senior secondary level, alongside Biology, Chemistry, and Physics, while Pre-vocational Studies (encompassing Agricultural Science and Home Economics) remained compulsory at the junior secondary level.

Despite this formal recognition and the ongoing curriculum reforms, Agricultural Science education in Nigeria continues to face significant challenges. The subject is often taught as a theoretical, examination-oriented discipline, with limited emphasis on practical skill development. Students memorize definitions, classifications, and theoretical concepts but graduate without the competencies needed to engage in productive agricultural activities or pursue agricultural careers. This disconnect between curricular intentions and classroom realities has profound implications for Nigeria's agricultural transformation agenda.

1.2 The Ogun State Context

Ogun State presents a particularly compelling context for reimagining Agricultural Science education. Situated in South-West Nigeria, Ogun State is characterized by a distinctive duality: it shares a border with Lagos Nigeria's commercial capital and largest urban market while simultaneously maintaining deep-rooted agrarian traditions. The state's economy is driven by agriculture (cassava, yam, maize, vegetables, poultry, and fisheries), manufacturing (with several industrial estates), and proximity to Lagos markets. This unique positioning creates both opportunities and imperatives for transforming agricultural education.

The presence of Federal Polytechnic Ilaro in Ogun State is particularly noteworthy. Recent research conducted at this institution has demonstrated the potential of AI, specifically Natural Language Processing (NLP) tools, for agricultural skills development. A study by Oyekale, Okusanya, and Fase (2025) involving 300 agriculture students at Federal Polytechnic Ilaro revealed that students using NLP AI tools including ChatGPT, Meta AI, and DeepSeek reported "significant gains in comprehension (88.70%), application (93.20%), and problem-solving abilities (76.60%) associated with agricultural capabilities" . These findings, emerging from within Ogun State itself, provide empirical grounding for the present conceptual exploration.

However, Ogun State also exemplifies the infrastructure challenges that characterize Nigerian education more broadly. The UNESCO (2025) Institutional Needs Assessment across 320 TVET institutions documented that fewer than 10% of technical colleges have adequate internet connectivity, over half face unreliable power supply, and less than 25% have reliable power for digital training. These constraints must be acknowledged and addressed in any proposal for AI integration.

1.3 Statement of the Problem

The central problem addressed by this paper is the persistent gap between the potential of Agricultural Science education to prepare students for agricultural careers and self-employment, and the reality of classroom practice in Ogun State schools. This gap is manifested in several ways:

First, there is a knowledge disconnect. Agricultural Science curricula are often detached from the lived agricultural realities of students' communities. Indigenous knowledge systems the accumulated farming wisdom passed down through generations are largely excluded from formal curricula, despite their practical relevance and cultural significance.

Second, there is a pedagogical limitation. Instruction remains predominantly theoretical and teacher-centered, with limited opportunities for hands-on learning, experimentation, or problem-solving. The "practical classes" referenced in school documents often involve demonstration rather than student-directed inquiry.

Third, there is a motivational challenge. Agricultural Science is frequently perceived as a "residual" subject one that students take because they cannot pursue more prestigious science subjects. This perception is reinforced by the subject's examination-oriented framing and the absence of visible pathways from school agriculture to agricultural careers.

Fourth, there is an infrastructure constraint. Schools lack modern agricultural equipment, laboratory facilities, and digital resources. Even when curricula include contemporary topics (e.g., precision agriculture, hydroponics), schools lack the capacity to teach them effectively.

This paper argues that AI-driven localized pedagogies offer a strategic response to these interconnected problems. By leveraging accessible AI tools to validate and build upon indigenous knowledge, create virtual learning experiences, and connect students to real agricultural data, educators can transform Agricultural Science into an engaging, relevant, and skill-developing discipline.

1.4 Research Questions

This conceptual paper is guided by the following questions:

1. What theoretical frameworks inform the integration of AI and localized pedagogies in Agricultural Science education?

2. What is the current state of AI adoption in Nigerian education, and what does existing research reveal about its potential and challenges?

3. How can AI tools be strategically deployed to localize Agricultural Science curriculum in Ogun State?

4. What are the implementation challenges and enabling conditions for AI-driven localized pedagogies in Ogun State?

5. What conceptual model can guide the integration of AI, localized pedagogies, and indigenous knowledge in Agricultural Science education?

1.5 Significance of the Study

This paper makes several contributions to the discourse on educational innovation in Nigeria. Theoretically, it synthesizes frameworks from culturally relevant pedagogy, AI in education, and indigenous knowledge systems to propose a context-sensitive model for Agricultural Science instruction. Practically, it offers concrete strategies for educators seeking to integrate AI tools into their teaching. Politically, it contributes to ongoing policy discussions about curriculum reform, teacher development, and educational technology investment. For Ogun State specifically, the paper provides a roadmap for leveraging the state's unique position to pioneer innovations that could be scaled across Nigeria.

1.6 Scope and Delimitation

This paper is conceptual rather than empirical. It does not present primary data from Ogun State schools but rather synthesizes existing literature to propose an innovative pedagogical framework. The focus is on Agricultural Science at the basic and secondary education levels (Primary 4 through Senior Secondary), consistent with the NERDC curriculum framework. While the paper acknowledges the importance of teacher education and institutional partnerships, detailed treatment of these topics is beyond its scope.

2. Theoretical Framework

This section presents the theoretical foundations for integrating AI-driven localized pedagogies in Agricultural Science education. The framework is built on three intersecting theoretical traditions: culturally relevant pedagogy, AI in education (AIED), and curriculum localization theory.

2.1 Culturally Relevant Pedagogy

Culturally relevant pedagogy (CRP), as articulated by Gloria Ladson-Billings (1995), rests on three propositions: that students must experience academic success, develop cultural competence, and cultivate critical consciousness. Applied to Agricultural Science education, CRP suggests that instruction must not only transmit agricultural knowledge but also validate and build upon the cultural knowledge that students bring from their communities.

In the Ogun State context, this means recognizing that many students come from farming families with generations of accumulated agricultural wisdom. This indigenous knowledge regarding soil types, weather patterns, pest management, and cropping systems is not "primitive" or "unscientific" but rather represents place-based adaptations refined over centuries. Culturally relevant pedagogy demands that such knowledge be treated as a legitimate foundation for learning, not as an obstacle to overcome.

The theoretical work on relational AI in education, drawing inspiration from Indigenous worldviews including Aboriginal Australian, Native American, and Mesoamerican traditions, extends this perspective. As Martinez-Maldonado et al. (2026) argue, education is "fundamentally social, constructive, and relational practice”. They advocate for AI systems that are designed "in ways that sustain the social and ecological relationships through which learning occurs" rather than replacing human relationships with automated efficiency. This relational orientation is particularly pertinent for agricultural education, which involves relationships with land, seasons, crops, animals, and communities.

The concept demonstrated by the Kumu Connect platform an AI-powered tool enabling educators to generate "culturally grounded, place-based" lessons grounded in Hawaiian language, values, and ecological knowledge exemplifies this approach. Similarly, the AgriPal chatbot, developed by 18-year-old Nigerian innovator Sadiya Aliyu, is designed to merge "cutting-edge technology with ancient and proven agricultural methods," providing farmers with information in multiple languages including Hausa, Yoruba, and English.

2.2 AI in Education (AIED) Frameworks

The integration of artificial intelligence in education has been theorized along multiple dimensions. The systematic review by Sambo-Magaji et al. (2025) identifies key applications including personalized learning tools, adaptive platforms, multilingual applications, and inclusive tools tailored to marginalized populations. Their meta-analysis revealed that such technologies "significantly enhance learning outcomes, particularly in STEM education and rural contexts."

A recent study of Nigerian science educators by Sambo-Magaji, Adewale, and colleagues (2025) provides important baseline data on AI readiness. Surveying 43 teachers and 10 administrators, the study found that while teachers showed moderate AI familiarity (62.8%), there was a strong preference for "blended instruction (69.8%), suggesting recognition of AI as a complementary tool rather than replacement" . The study documented significant correlations between AI knowledge and teaching preference ($r = .613$, $p < .01$) and between AI knowledge and perceived assistance (r

= .587, p < .01). Administrators demonstrated high AI awareness (60%) and implementation readiness (60%) but identified critical barriers including "infrastructure limitations (78%), budget constraints (71%), and limited professional development (69%)" .

For Agricultural Science specifically, the research by Oyekale, Okusanya, and Fase (2025) at Federal Polytechnic Ilaro provides localized evidence. Their study of NLP AI tools among agriculture students found that ChatGPT (35%) and Meta AI (56%) were the most popular tools, with applications primarily for research (60%), assignments (30%), and learning (30%). Students reported "significant gains in comprehension (88.70%), application (93.20%), and problem-solving abilities (76.60%)" remarkably high percentages suggesting substantial perceived benefits.

The practical demonstration of a Nigerian-focused farming AI agent, "NaijaFarmHand," developed using Google's AI Development Kit, illustrates what is technically possible. This prototype agent provides localized advice on crops (maize, cassava, yam, groundnut, guinea corn) and livestock (poultry), integrated weather information, planting season guidance, and starter checklists for farm establishment. While designed for farmers, similar technology could be adapted for educational purposes.

2.3 Curriculum Localization Theory

Curriculum localization refers to the adaptation of national or standardized curricula to reflect local contexts, cultures, and needs. This theoretical position challenges the assumption that there is a single "best" curriculum that can be uniformly implemented across diverse settings. Instead, localization theory recognizes that learning is most effective when content is situated within learners' lived experiences and when local knowledge is treated as a legitimate resource.

In the Nigerian context, curriculum localization is not merely a theoretical preference but an official policy orientation. The NERDC's Basic Science and Technology curriculum, which integrates Agricultural Science at the junior secondary level, is intended to be "flexible enough to allow for adaptation to local conditions" . However, in practice, this flexibility is rarely exercised. Teachers rely on standardized textbooks and examination guides, and local agricultural practices remain largely outside the formal curriculum.

The challenge of curriculum localization for AI integration is not unique to Nigeria. As Sambo-Magaji et al. (2025) note, the literature reveals "gaps in localised policy frameworks" and emphasizes the "need for context-specific solutions that align with Nigeria's sociotechnical realities". This paper responds to that gap by proposing a localization framework specifically for Ogun State's Agricultural Science curriculum.

2.4 Indigenous Knowledge Systems

Indigenous knowledge systems (IKS) refer to the accumulated knowledge, practices, and beliefs of local communities regarding their environments. In agriculture, indigenous knowledge encompasses soil classification, weather prediction, pest management, crop and varietal selection, intercropping systems, and post-harvest handling. This knowledge is neither static nor uniformly distributed; it is constantly tested, refined, and transmitted across generations.

The epistemological status of indigenous knowledge has been the subject of considerable debate. Early perspectives treated indigenous knowledge as "primitive" or "ethnoscience" useful for local adaptation but inferior to scientific knowledge. Contemporary scholarship recognizes indigenous knowledge as a parallel knowledge system with its own rigor, validity, and practical utility. The challenge is not to replace indigenous knowledge with scientific knowledge but to create productive dialogues between them.

For Agricultural Science education in Ogun State, this means recognizing that students' communities possess valuable agricultural knowledge that can enrich formal learning. When studying soil types, for example, instruction could begin with local soil classification systems before introducing scientific taxonomies. When studying pest management, indigenous practices can be examined alongside chemical and biological control methods. This approach validates students' home knowledge while also introducing scientific concepts and methods.

The AI platforms emerging in the Nigerian agricultural space reflect this integrative orientation. AgriPal, for instance, is explicitly designed to "merge cutting-edge technology with ancient and proven agricultural methods" and provides information with "relatable explanations that correspond with current happenings". Similarly, NaijaFarmHand's "TimingAdvisorTool" provides general advice on planting seasons while emphasizing the importance of checking local conditions and consulting local farmers.

2.5 An Integrated Conceptual Model

Synthesizing these theoretical frameworks, this paper proposes the Integrated AI-Localized Pedagogy (IALP) model for Agricultural Science education. The model posits that effective instruction in this domain requires four interconnected elements:

1. Cultural Grounding: Curriculum content and instructional approaches must validate and build upon indigenous agricultural knowledge.

2. AI Enhancement: Accessible AI tools must be strategically deployed to personalize learning, provide virtual experiences, and connect students to real agricultural data.

3. Place-Based Connection: Learning must be situated within students' local agricultural contexts Ogun State's specific crops, farming systems, and environmental conditions.

4. Active Pedagogy: Instruction must move beyond passive reception to include inquiry, problem-solving, and hands-on (or virtually simulated) practice.

The IALP model guides the practical proposals presented in Section 4 of this paper.

3. Literature Review

3.1 The State of Agricultural Science Education in Nigeria

Agricultural Science education in Nigeria operates within a complex institutional landscape. At the basic education level, Agricultural Science is embedded within Pre-vocational Studies for junior secondary students (JSS 1-3), alongside Home Economics. At the senior secondary level, Agricultural Science is one of four core science subjects (alongside Biology, Chemistry, and Physics) and is examined by both WAEC and NECO .

A 2025 school profile from University Demonstration Secondary School, Ikere-Ekiti, illustrates the typical departmental structure: the Science and Mathematics Department offers Agricultural Science with Animal Husbandry as a compulsory trade for all science students, and the department includes multiple Agricultural Science educators with qualifications ranging from NCE to PhD-in-view . The school's curriculum description notes that the department is "to prepare the senior students especially for unified examination for both theory and practical WAEC and NECO with standard theory preparations and practical classes”.

This examination-focused orientation is characteristic of Nigerian Agricultural Science education. While "practical classes" are referenced, the description of the junior secondary curriculum emphasizes preparation for "NECO and state examinations with standard examinations and questions based on curriculum”. This suggests that even practical components are framed primarily as preparation for examination performance rather than as authentic skill development.

The institutional challenges documented by UNESCO (2025) affect Agricultural Science instruction directly. With fewer than 10% of technical colleges having adequate internet connectivity and only 36.9% of teachers being qualified technical instructors, even well-designed curricula cannot be effectively implemented. Agricultural Science requires specialized facilities school farms, greenhouses, irrigation equipment, and laboratory apparatus that are absent from most schools.

3.2 Artificial Intelligence in Nigerian Education: Current Status and Challenges

The integration of AI into Nigerian education is in its early stages, but momentum is building. The systematic review by Sambo-Magaji et al. (2025) identified 30 studies published between 2018 and 2024, revealing a rapidly growing research interest. Key findings from their synthesis include:

- "AI technologies, such as personalised learning tools and adaptive platforms, significantly enhance learning outcomes, particularly in STEM education and rural contexts"

- Among reviewed studies, 22 examined teacher readiness, 17 focused on policy frameworks, 13 identified infrastructure barriers, and 6 addressed socioeconomic equity

- Key challenges include "inadequate digital infrastructure, low educator readiness, and ethical concerns such as data privacy breaches and algorithmic bias"

The study of Nigerian science educators' AI perspectives (2025) provides granular data on current capacities. Teachers showed moderate AI familiarity (62.8%), which is encouraging but indicates that a substantial minority (37.2%) lack basic AI awareness. The strong preference for blended instruction (69.8%) suggests that teachers are not seeking to replace traditional instruction but rather to augment it strategically.

The barriers identified in this study are formidable. Infrastructure limitations were cited by 78% of administrators, budget constraints by 71%, and limited professional development opportunities by 69%. These findings are consistent with the UNESCO (2025) assessment and suggest that even motivated educators face significant structural constraints.

However, optimistic findings also emerged. The study identified "significant correlations between AI knowledge-teaching preference ($r = .613$, $p < .01$) and AI knowledge-perceived assistance ($r = .587$, $p < .01$), suggesting that as teachers become more knowledgeable about AI, they become more inclined to integrate it". This implies that professional development investments could have multiplicative effects.

3.3 AI Applications in Agricultural Education: Empirical Evidence

The most directly relevant empirical evidence comes from the study by Oyekale, Okusanya, and Fase (2025) at Federal Polytechnic Ilaro, Ogun State. This study surveyed 300 students enrolled in agriculture-related programs to understand their use of NLP AI tools (ChatGPT, Meta AI, DeepSeek). Key findings include:

- 50% of respondents were National Diploma 2 students; 43% were aged 20-22

- Research (60%), assignments (30%), and learning (30%) were the primary uses of NLP tools

- ChatGPT (35%) and Meta AI (56%) were the most popular tools

- "Significant gains in comprehension (88.70%), application (93.20%), and problem-solving abilities (76.60%) associated with agricultural capabilities were reported by respondents"

- However, students faced "obstacles like restricted access, technical problems, and trouble understanding AI-generated content"

These findings are notable for several reasons. First, the reported gains are remarkably high over 88% of students reporting improved comprehension suggests that AI tools are genuinely useful for agricultural learning. Second, the study was conducted in Ogun State, providing localized evidence for the potential of AI in this context. Third, the study identifies specific challenges that must be addressed: access limitations, technical problems, and comprehension difficulties.

The study's conclusion is worth quoting directly: "If inclusive access and usability are improved, the results demonstrate the revolutionary potential of AI in agricultural TVET. It is advised that Nigerian agricultural sector especially in polytechnic education benefit from the strategic application of NLP AI tools".

3.4 Indigenous Knowledge Integration with AI

One of the most promising developments for this paper's focus is the emergence of AI platforms explicitly designed to integrate indigenous and local knowledge. Three examples are particularly instructive:

AgriPal (Nigeria): Developed by 18-year-old Sadiya Aliyu from Niger State, AgriPal is a "free ChatGPT-like platform where farmers can seek first-hand information about farming practices" The platform is designed to merge "cutting-edge technology with ancient and proven agricultural methods to increase yield" and can "understand and reply in many languages" including Hausa, Yoruba, English, Portuguese, French, Chinese, and Arabic. The platform also features "automatic language adaptation it detects the user's default browser language and can be switched by simple commands".

Significantly, AgriPal has been "widely adopted by some NGOs and students". This indicates demand for AI tools that are accessible, multilingual, and responsive to local agricultural contexts. For Agricultural Science education, similar tools could be deployed as learning resources, allowing students to explore agricultural concepts through familiar linguistic and cultural frames.

Kumu Connect (Hawai'i): Although developed in a different cultural context, the Kumu Connect platform embodies principles directly relevant to this paper. It is "a generative AI-powered ecosystem designed to support educators in Hawaiian immersion schools by enabling the creation of culturally relevant, place-based CS lesson plans" in both Hawaiian and English The platform integrates "advanced AI models with a robust, community-curated dataset grounded in Hawaiian language, values, and ecological knowledge" . Through an intuitive interface, educators can co-create "lesson content by dialoguing with an AI assistant that adapts curriculum to specific ahupua'a (land divisions), mo'olelo (stories), and culturally significant themes".

This model is directly transferable to the Ogun State context. A similar AI system could be developed with datasets reflecting Ogun State's agricultural zones (forest, derived savanna), indigenous farming practices, local crop varieties, and Yoruba agricultural terminology.

NaijaFarmHand (Nigeria): This prototype, built using Google's AI Development Kit, is "designed to answer beginner farming questions within the Nigerian context" with a specific focus on crops including "maize, cassava, yam, groundnut, and guinea corn" and livestock including "poultry (broiler and layer chickens)". The system integrates specialized tools including a WeatherTool (for current conditions in Nigerian locations), a FarmPlannerTool (for starter checklists), and a TimingAdvisorTool (for seasonal guidance). The developer notes that "while NaijaFarmHand is a prototype running in a notebook, it showcases the potential for AI to support agriculture and empower individuals".

3.5 Challenges of AI Integration in Nigerian Educational Contexts

The literature consistently identifies a set of interconnected challenges for AI integration in Nigerian education. The systematic review by Sambo-Magaji et al. (2025) organizes these challenges into several categories:

Infrastructure Challenges: The most frequently cited barrier, affecting 78% of administrators in one study. Specific issues include unreliable electricity supply (over half of institutions), inadequate internet connectivity (fewer than 10% of technical colleges), and lack of computing devices for students and teachers.

Teacher Capacity Challenges: "Low educator readiness" was identified as a key barrier, with only 36.9% of technical college teachers being qualified technical instructors and less than 20% trained in digital teaching methodologies. The UNESCO (2025) assessment documented that "only about 32% of teachers have workplace industry experience", which is particularly problematic for vocational and technical education.

Curriculum and Pedagogical Challenges: The existing curriculum's examination orientation is difficult to reconcile with the exploratory, inquiry-based approaches that AI tools enable. Teachers may lack the pedagogical knowledge to integrate AI meaningfully rather than using it as a substitute for their own instruction.

Ethical Challenges: The literature identifies "ethical concerns such as data privacy breaches and algorithmic bias". For Agricultural Science education specifically, there are questions about how AI-generated content represents (or misrepresents) indigenous knowledge and whose agricultural knowledge is privileged in AI training data.

Socioeconomic Challenges: The digital divide in Nigeria remains substantial. "75% of Nigerian adults are without smartphones", which limits the accessibility of AI tools that require mobile devices. While the founder of AgriPal argues that "smartphone adoption rate among farmers has increased in recent years", the equity implications are significant: students from wealthier families and urban schools will have access to AI tools that their rural, lower-income peers lack.

The literature also identifies enabling conditions and opportunities. Sambo-Magaji et al. (2025) note that despite barriers, "AI demonstrates transformative potential through multilingual applications and inclusive tools tailored to marginalised populations". The study recommends "context-specific solutions that align with Nigeria's sociotechnical realities" a recommendation that this paper seeks to implement for Ogun State.

3.6 Gaps in the Literature

This review has identified several gaps that this paper seeks to address:

First, there is limited research specifically on AI applications in Agricultural Science education at the basic and secondary levels in Nigeria. Existing studies focus on polytechnic and university students or on teacher perspectives broadly. The specific context of secondary school Agricultural Science with its unique curricular constraints, younger learners, and examination pressures remains understudied.

Second, there is limited research on the integration of indigenous agricultural knowledge with AI tools in educational contexts. While platforms like AgriPal and Kumu Connect demonstrate the technical feasibility of this integration, there is limited empirical research on how students learn from such integrated systems or how teachers can best deploy them.

Third, there is limited research on Ogun State specifically as a context for AI integration. While the study at Federal Polytechnic Ilaro provides localized evidence, this institution serves post-secondary students. The conditions at basic and secondary schools in Ogun State including the specific infrastructure constraints, teacher capacities, and agricultural contexts require dedicated investigation.

Fourth, there is limited research on pedagogical models specifically designed for AI-localized instruction in Agricultural Science. Existing literature focuses on tool adoption and learning outcomes, with less attention to the systematic design of instruction that integrates AI, localization, and indigenous knowledge.

This paper responds to these gaps by proposing a conceptual model (Section 4) that can guide future empirical research and practical implementation.

4. Proposed Framework: AI-Driven Localized Pedagogies for Ogun State

Building on the theoretical foundations and empirical evidence reviewed above, this section proposes a framework for integrating AI-driven localized pedagogies in Agricultural Science education in Ogun State. The framework is organized around three core innovations, followed by a discussion of implementation considerations.

4.1 Core Innovation 1: AI-Enhanced Curriculum Localization

The first innovation involves using AI tools to systematically localize the national Agricultural Science curriculum to Ogun State's specific agricultural context. Rather than teaching generic agricultural concepts, instruction would be grounded in the crops, farming systems, and environmental conditions that students encounter in their communities.

Strategy 1.1: Development of a Local Agricultural Knowledge Base

A foundational step involves creating a digital repository of Ogun State agricultural knowledge. This repository would include:

- Crop and livestock profiles for species commonly cultivated in Ogun State (cassava, yam, maize, vegetables, poultry, fisheries)

- Indigenous farming practices documented through community engagement

- Local soil types and their agricultural characteristics

- Seasonal calendars reflecting Ogun State's bimodal rainfall pattern

- Pest and disease profiles for locally significant threats

This knowledge base would serve as the foundation for AI tools, drawing on the Kumu Connect model of integrating "advanced AI models with a robust, community-curated dataset grounded in language, values, and ecological knowledge".

Strategy 1.2: AI-Powered Lesson Localization

Equipped with this knowledge base, teachers could use AI tools to adapt standardized lesson plans to local contexts. For example, when the national curriculum requires teaching about "soil types," an AI system could generate localized content describing the specific soil types found in Ogun State (e.g., coastal alluvial soils, forest soils, derived savanna soils) and their agricultural characteristics. When teaching about "post-harvest handling," AI-generated examples could focus on locally relevant crops and storage methods.

Strategy 1.3: Indigenous Knowledge Integration

The framework explicitly commits to validating and integrating indigenous agricultural knowledge. As AgriPal demonstrates, it is possible to design AI systems that "merge cutting-edge technology with ancient and proven agricultural methods" . In the educational context, this means AI tools should present indigenous practices alongside scientific explanations, highlighting their rationale and effectiveness. For example, indigenous fallowing practices can be explained in terms of soil nutrient replenishment, connecting local knowledge to scientific concepts.

4.2 Core Innovation 2: Virtual Farm Simulations and AI Chatbots

The second innovation addresses the infrastructure constraints that limit hands-on agricultural learning. Not all schools have school farms with diverse crops and livestock; not all can take students on field trips to research stations or commercial farms. Virtual simulations and AI chatbots can provide alternative, supplementary learning experiences.

Strategy 2.1: Crop Growth Simulations

AI-powered simulations could allow students to "grow" virtual crops under varying conditions. Students would make decisions about planting dates, varieties, fertilizer applications, irrigation scheduling, and pest management, with the simulation showing the consequences of their decisions. This approach, inspired by farming simulation games but grounded in actual agricultural science, would develop decision-making skills without requiring physical land or resources.

Strategy 2.2: Diagnostic AI Chatbots

As demonstrated by NaijaFarmHand and AgriPal , AI chatbots can be designed to answer agricultural questions. In the educational context, students could interact with a "virtual extension agent" to diagnose plant nutrient deficiencies, identify pests and diseases from descriptions or images, and receive recommendations for management. The chatbot could be programmed to "think aloud," explaining its diagnostic reasoning and thereby teaching students the principles of agricultural problem-solving.

The research by Oyekale, Okusanya, and Fase (2025) provides empirical support for this approach. Agriculture students using NLP AI tools reported "significant gains in comprehension (88.70%), application (93.20%), and problem-solving abilities (76.60%)" . While these students were at the polytechnic level, similar benefits could be expected for secondary students with appropriate scaffolding.

Strategy 2.3: Virtual Farm Tours

Where physical field trips are impossible due to cost, distance, or logistics, virtual farm tours could provide exposure to diverse agricultural operations. Videos, 360-degree images, and interactive maps could be organized thematically, allowing students to explore poultry farms, fish ponds, crop farms, and processing facilities. AI could personalize these tours based on students' interests and learning needs.

4.3 Core Innovation 3: Community-Connected Data Projects

The third innovation moves beyond simulated experiences to connect students with real agricultural data from their communities. This approach transforms students from passive consumers of agricultural information into active investigators of local agricultural systems.

Strategy 3.1: School-Based Weather Stations

Low-cost weather monitoring equipment, connected to the internet, could collect local microclimate data. Students would analyze this data to understand seasonal patterns, track changes over time, and connect weather variability to agricultural decision-making. This data could be shared with community farmers, creating meaningful real-world impact.

Strategy 3.2: Crop Yield and Input Tracking

Students could design and conduct simple agricultural experiments: comparing growth of different varieties, testing fertilizer rates, evaluating weed control methods. Data collected from school farms or community plots would be analyzed using AI tools, teaching students research methods while generating locally relevant agricultural knowledge.

Strategy 3.3: Community Knowledge Documentation

Using AI tools for transcription, translation, and analysis, students could document indigenous agricultural knowledge from community elders. This serves multiple purposes: preserving knowledge that might otherwise be lost, validating the expertise of community members, building students' research and communication skills, and contributing to the local knowledge base described in Innovation 1.

The relational AI framework articulated by Martinez-Maldonado et al. (2026) supports this approach. They argue for AI designs that "sustain communities and natural environments" rather than extracting value without reciprocity. Community-connected data projects embody this principle: students and communities benefit mutually from knowledge sharing.

4.4 Implementation Considerations

The framework presented above is ambitious, and its implementation faces significant challenges. This section acknowledges those challenges and proposes enabling conditions.

Teacher Capacity Building

The success of AI-driven localized pedagogies depends fundamentally on teachers. Research shows that only about 32% of agricultural teachers have workplace industry experience, and less than 20% are trained in digital teaching methodologies. The framework therefore requires substantial investment in teacher professional development.

Professional development should address three dimensions: (1) building teachers' foundational AI literacy, (2) developing pedagogical strategies for integrating AI tools, and (3) cultivating skills for curriculum localization and indigenous knowledge integration. The correlation between AI knowledge and teaching preference ($r = .613$, $p < .01$) documented by Sambo-Magaji et al. (2025) suggests that such investments would yield returns: as teachers become more knowledgeable, they become more inclined to integrate AI .

Infrastructure Development

The UNESCO (2025) assessment documented "fewer than 10% of technical colleges have adequate internet connectivity" and "over half of institutions report unreliable or no electricity" . While this paper focuses on basic and secondary education, similar constraints apply. AI-driven localization cannot succeed without addressing basic infrastructure deficits.

Several strategies could mitigate these constraints. First, offline-capable AI tools (running on devices without continuous internet connectivity) are increasingly available. Second, mobile-first approaches recognize that smartphones are more widely available than desktop computers. Third, school-level infrastructure investments (solar panels, satellite internet) could be targeted to schools participating in pilot programs.

Partnership Development

The framework envisions partnerships between schools and multiple external actors:

- State Agricultural Development Programs (ADPs) could provide technical expertise, data, and internship opportunities

- Research institutions (e.g., Federal College of Education, Abeokuta) could support curriculum development and teacher training

- Technology partners could provide platforms, tools, and technical support

- Community organizations could facilitate indigenous knowledge documentation and validation

Sustainability and Scaling

Pilot programs in selected Ogun State schools would allow the framework to be tested and refined before broader scaling. Sustainability requires: (1) integration into official curriculum and examination systems (so that AI-localized instruction is valued, not extracurricular), (2) inclusion in teacher education curricula (so that new teachers enter the profession with relevant competencies), and (3) allocation of dedicated budget lines for technology, connectivity, and professional development.

5. Educational Implications and Contributions

5.1 Implications for Curriculum and Instruction

The proposed framework has profound implications for what is taught and how. First, it implies that the Agricultural Science curriculum cannot be uniform across Nigeria but must be localized to reflect regional agricultural contexts. While national standards provide a framework, teachers must be empowered and equipped to adapt content to local conditions.

Second, the framework implies a shift from teacher-centered to student-centered instruction. AI tools enable personalized, inquiry-based learning where students explore agricultural concepts through simulation, investigation, and problem-solving rather than passive reception. This shift requires corresponding changes in assessment: if students learn through projects and investigations, they cannot be assessed solely through standardized examinations.

Third, the framework implies that indigenous knowledge deserves systematic inclusion in formal curricula. This is not merely a matter of cultural validation (though that is important) but of pedagogical effectiveness: when learning is grounded in what students already know from their communities, it becomes more meaningful and memorable.

5.2 Implications for Teacher Education

The framework demands significant changes in teacher education. Pre-service teachers must graduate with AI literacy: understanding what AI tools can and cannot do, how to use them effectively, and how to evaluate AI-generated content critically. They must develop pedagogical content knowledge specifically for AI integration: knowing which tools are appropriate for which learning objectives, how to scaffold student interaction with AI, and how to assess learning that incorporates AI.

In-service teacher professional development must be ongoing, not one-time. As AI tools evolve rapidly, teachers need continuous support to stay current. Professional learning communities, where teachers share strategies and troubleshoot challenges, could be particularly valuable.

5.3 Implications for Educational Policy

At the policy level, the framework implies several recommendations. First, the federal and state governments must invest in educational infrastructure electricity, internet, devices as a prerequisite for AI integration. Educational technology cannot be added on top of failing infrastructure.

Second, curriculum and examination bodies must adapt assessment systems to accommodate the pedagogical shifts that AI enables. If students learn through project-based, inquiry-oriented methods, assessments must be capable of measuring the competencies developed through those methods.

Third, policies must address equity. Without deliberate intervention, AI integration will benefit students at well-resourced urban schools while leaving rural and disadvantaged students further behind. Targeted investments, offline-capable tools, and mobile-first approaches can help mitigate this risk.

5.4 Contributions to Knowledge

This paper makes several contributions to the literature. Theoretically, it synthesizes frameworks from culturally relevant pedagogy, AI in education, and curriculum localization to propose an integrated model specifically for Agricultural Science education. Practically, it offers concrete strategies that educators can adapt for their contexts. For Ogun State specifically, the paper provides a roadmap for leveraging the state's unique position to pioneer innovations that could inform broader Nigerian policy.

6. Conclusion and Recommendations

6.1 Summary of Key Arguments

This paper has argued for the integration of AI-driven localized pedagogies in Agricultural Science education in Ogun State, Nigeria. The argument proceeds from several premises:

First, Agricultural Science education in Nigeria is not fulfilling its potential. The subject is taught theoretically, examined narrowly, and perceived as a low-status option, despite its importance for food security, economic diversification, and youth employment.

Second, Ogun State presents a particularly promising context for innovation. With its dual character proximity to Lagos markets alongside deep-rooted agrarian traditions and with emerging evidence from Federal Polytechnic Ilaro demonstrating AI's potential for agricultural learning, the state could pioneer approaches that inform national policy.

Third, theoretical frameworks in culturally relevant pedagogy, AI in education, and indigenous knowledge systems support the proposed approach. These frameworks converge on the importance of grounding instruction in learners' cultural and environmental contexts, using technology to enhance rather than replace human relationships, and validating knowledge from multiple sources.

Fourth, emerging AI platforms including AgriPal, Kumu Connect, and NaijaFarmHand demonstrate the technical feasibility of integrating AI with localized and indigenous knowledge. While these platforms were not designed specifically for education, they illustrate principles that can be adapted for instructional purposes.

Fifth, the proposed framework rests on three core innovations: AI-enhanced curriculum localization, virtual farm simulations and AI chatbots, and community-connected data projects. Together, these innovations aim to transform Agricultural Science from a passive, examination-oriented subject into an active, exploratory discipline.

6.2 Recommendations

Based on the analysis in this paper, the following recommendations are offered:

For the Ogun State Ministry of Education:

1. Establish a pilot program in selected secondary schools to test the proposed framework, with evaluation focused on student engagement, learning outcomes, and teacher perceptions.

2. Partner with the Federal College of Education, Abeokuta and Federal Polytechnic Ilaro to develop teacher professional development programs in AI integration for Agricultural Science.

3. Invest in foundational infrastructure (electricity, internet, devices) for schools participating in the pilot program, and document the costs and benefits to inform scaling decisions.

For the Federal Ministry of Education and NERDC:

1. Develop policy guidelines for curriculum localization that explicitly recognize the role of AI tools in adapting national curricula to regional contexts.

2. Integrate AI literacy and AI integration pedagogies into teacher education curricula at both Nigeria Certificate in Education (NCE) and degree levels.

3. Fund research on AI-localized pedagogies across different subject areas and regions, building an evidence base to inform national policy.

For Research Institutions:

1. Conduct empirical studies testing the effectiveness of AI-localized pedagogies in Agricultural Science, using rigorous designs (randomized controlled trials, quasi-experimental studies) and valid outcome measures.

2. Investigate the specific conditions under which AI tools enhance versus hinder learning, with attention to student age, prior knowledge, and access to complementary resources.

3. Document and analyze innovative practices emerging from schools and teachers, disseminating findings to inform professional development.

For Development Partners and NGOs:

1. Support infrastructure investments in schools serving disadvantaged communities, ensuring that AI integration reduces rather than widens educational inequities.

2. Fund the development of open educational resources (OERs) for AI-localized Agricultural Science instruction, including localized knowledge bases, simulation tools, and teacher guides.

3. Facilitate knowledge exchange between Nigerian innovators and international partners working on similar challenges (e.g., Kumu Connect in Hawai'i, AI platforms for indigenous knowledge integration).

6.3 Directions for Future Research

The conceptual nature of this paper means that many questions remain for empirical investigation:

1. Effectiveness research: Does AI-localized instruction in Agricultural Science produce better learning outcomes than traditional instruction? If so, for which outcomes (knowledge, skills, attitudes, career aspirations) and for which students?

2. Implementation research: How do teachers actually integrate AI tools into their instruction? What barriers do they encounter, and what supports enable successful integration?

3. Design research: What design features of AI tools are most effective for agricultural learning in Nigerian contexts? How should tools balance localization (specific to Ogun State) with flexibility (adaptable to other regions)?

4. Longitudinal research: What are the long-term effects of AI-localized Agricultural Science instruction? Do students who experience such instruction pursue agricultural careers at higher rates?

5. Equity research: Who benefits from AI-localized instruction, and who is left behind? How can implementation be designed to serve students across the urban-rural divide and across socioeconomic strata?

6.4 Concluding Remarks

This paper has proposed an ambitious vision for transforming Agricultural Science education in Ogun State through AI-driven localized pedagogies. The vision is grounded in existing theoretical frameworks, supported by emerging empirical evidence, and responsive to the distinctive characteristics of Ogun State's agricultural and educational context.

Yet the proposal recognizes that AI is not a panacea. AI tools cannot substitute for skilled teachers, adequate infrastructure, or supportive policy environments. The framework's success depends fundamentally on investments in teacher professional development, school infrastructure, and curriculum reform. Technology is an enabler, not a solution in itself.

Nevertheless, the potential is significant. If Agricultural Science education can be transformed from a passive, examination-oriented subject into an active, exploratory discipline that validates indigenous knowledge and develops practical skills, the benefits could extend far beyond the classroom. Students could graduate not merely with passing grades, but with genuine agricultural competencies, entrepreneurial mindsets, and career aspirations aligned with Nigeria's agricultural transformation agenda.

For Ogun State, with its unique position at the intersection of industrial dynamism and agrarian tradition, the opportunity is particularly compelling. The state could become a model for other Nigerian states and potentially for other African countries demonstrating how AI can be harnessed not to replace local knowledge but to build upon it, not to impose standardized solutions but to enable contextualized learning, not to further centralize education but to empower teachers and communities.

The journey from proposal to practice will require sustained commitment from multiple stakeholders: government at federal and state levels, educational institutions, technology partners, community organizations, and, above all, teachers and students. The challenges are substantial, but the potential rewards justify the effort. As the Minister of Education has noted, the neglect of technical and vocational education over "25 to 30 years" must be reversed . AI-driven localized pedagogies offer a pathway for that reversal one that is innovative, responsive, and grounded in Nigeria's specific realities.

References

Federal Ministry of Education. (2025). Federal govt begins review of 26 technical college trade syllabuses. National Business and Technical Examinations Board.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. American Educational Research Journal , 32(3), 465-491.

Martinez-Maldonado, R., Echeverria, V., Hawes, J., Kim, Y. J., Maddigan, Z., Milesi, M., Nelson, T., & Tsai, Y.-S. (2026). Relational AI in education: Reciprocity, participatory design, and Indigenous worldviews. International Conference on Artificial Intelligence in Education, AIED 2026 . arXiv:2604.19099v1.

NERDC. (2025). Approved subjects for basic and senior secondary education curriculum. Nigerian Educational Research and Development Council.

Oyekale, J., Okusanya, M., & Fase, O. (2025). Natural language processing for agriculture-based industrial skills development in polytechnics. Digital Food, Energy and Water Systems Journal , University of Johannesburg Press.

Sambo-Magaji, A., Adewale, M. D., Ketebu, K. E., Jokthan, G. E., Bello, M., Azeta, A. A., Sheikh, F. A., & Ubadike, O. C. (2025). Systematic literature review: Challenges, implications, and frameworks for artificial intelligence adoption in Nigerian education. NIPES Journal of Science and Technology Research , 7(4).

Sambo-Magaji, A., Adewale, M. D., & others. (2025). Exploring the role of artificial intelligence in Nigerian science education: A teacher-administrator analysis. Japanese Society for Science Education Research , 40(1), 27-32.

TechNext. (2025, September 18). With AgriPal, 18-year-old Sadiya Aliyu is building a ChatGPT for African farmers. TechNext.ng.

UNESCO. (2025). Institutional needs assessment of TVET institutions in Nigeria. UNESCO Abuja Office.

University Demonstration Secondary School, Ikere-Ekiti. (2025). Science and Mathematics Department profile.