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CONTEXTUALIZING MATHEMATICS INSTRUCTION THROUGH INDIGENOUS FOOD CULTURE TO IMPROVE STUDENTS' UNDERSTANDING OF WASTE REDUCTION PRACTICES IN POTISKUM, YOBE STATE

Samaila Yakubu[1], Gyang Mark Abel[2] & Danbong Bright Timjul[3]
[1]*School of Science and Technology, Department of Statistics, Collage of Administration, Management and Technology, Potiskum Yobe State.*
[2&3]*School of Secondary Education (Sciences), Department of Mathematics. Collage of Education Gindiri, Plateau State, Nigeria.*
Corresponding Author's Contact: *smlyakubu01@gmail.Com/+2348038533776*

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ABSTRACT
This study explored the potential of contextualizing mathematics instruction through indigenous food culture to enhance students' understanding of waste reduction practices in Potiskum, Yobe State, Nigeria. It specifically examined the mathematical concepts embedded in local food-related practices—such as traditional farming, food processing, storage methods, and market activities—and investigated students' perceptions of integrating these practices into mathematics lessons. The study population comprised approximately 48,600 individuals, from which a representative sample of 1,480 respondents was drawn, including 380 mathematics teachers and 1,100 students. A descriptive survey design was employed, and data were collected using structured questionnaires. Analysis was carried out using mean and standard deviation in SPSS version 27.0, with a benchmark mean of 2.50 guiding interpretation. The findings revealed that indigenous food practices inherently incorporate measurable mathematical concepts, including measurement, estimation, ratio, volume, and time calculations. Mathematics teachers expressed strong support for integrating these practices into curriculum modules, while students reported improved understanding of mathematical concepts, greater interest in the subject, and heightened awareness of sustainable waste reduction, though some indicated difficulty in applying these concepts to daily life. The study concludes that linking mathematics instruction to indigenous food culture can enhance conceptual understanding, foster engagement, and promote environmentally responsible behaviors. Based on these findings, it is recommended that culturally contextualized teaching modules be developed, teachers receive targeted training in collaboration with community knowledge holders, and practical assessments be integrated to reinforce students' ability to apply mathematics in real-life and sustainable contexts.

Keywords: Mathematics Instruction, Indigenous Food Culture, Waste Reduction Practices, Culturally Relevant Teaching, Yobe State

Introduction

Mathematics education is increasingly recognized as a vital tool for equipping learners with the skills and knowledge to engage effectively with real-world socio-ecological challenges, including sustainable resource management and waste reduction. Research in ethnomathematics highlights that embedding cultural contexts into mathematics instruction not only makes learning more relevant but also enables students to apply mathematical reasoning to everyday life situations. By linking abstract mathematical concepts to familiar cultural practices—such as local food production, measurement routines, and market transactions—educators can deepen students' understanding, enhance engagement, and foster learning experiences that are both meaningful and enduring (Shimwandi, Ngololo, & Kanandjebo, 2024).

In Nigeria, however, mathematics instruction is often predominantly abstract and teacher-centered, restricting opportunities for students to connect mathematical ideas to their immediate environments (Shimwandi et al., 2024). This instructional gap can lead to student disengagement and a limited appreciation of mathematics as a tool for promoting sustainable behaviors, including waste reduction. Although national initiatives, such as the Circular Economy Youth Empowerment Initiative (CEYEI), aim to equip young Nigerians with practical skills in sustainable innovation and resource management, translating these policy-level goals into classroom practice remains a persistent challenge (Federal Ministry of Youth Development, 2025).

Indigenous food culture—which encompasses traditional farming techniques, food processing, storage, and local market activities—offers a rich, underutilized resource for contextualizing mathematics learning. While previous research has examined the role of indigenous knowledge in mathematics education broadly, there is limited empirical evidence on leveraging indigenous food practices specifically to enhance students' understanding of sustainable waste reduction practices.

Therefore, the present study investigates how mathematics instruction can be contextualized through indigenous food culture to improve students' understanding of waste reduction practices in Potiskum, Yobe State, Nigeria. By grounding instruction in culturally meaningful and locally familiar practices, the study aims to bridge the disconnect between abstract mathematics and practical sustainability applications, fostering both conceptual understanding and environmental awareness among learners.

Statement of the Problem

In Yobe State, mathematics instruction often remains predominantly abstract and teacher-centered, providing students with few opportunities to relate classroom concepts to real-world contexts. Consequently, learners frequently struggle to understand the relevance of mathematics to everyday life and to pressing socio-ecological challenges, such as sustainable resource management and waste reduction. This disconnect can lead to disengagement, mathematics anxiety, and persistently poor performance in mathematics assessments among secondary school students.

Despite the region's rich indigenous food culture—including traditional farming practices, food processing techniques, storage methods, and local market systems—these cultural resources are rarely utilized as pedagogical tools in mathematics classrooms. Research in ethnomathematics indicates that integrating cultural contexts into mathematics instruction can enhance conceptual understanding and engagement (Sangha, Leyton Flor, Kassa, & Dendup, 2026). However, there is limited empirical evidence on how indigenous food practices can be strategically used to strengthen students' comprehension of sustainable behaviors, particularly waste reduction, within Nigerian educational settings.

The problem, therefore, is the absence of a culturally contextualized approach to mathematics instruction that systematically incorporates indigenous food culture to enhance students' understanding of waste reduction practices in Potiskum, Yobe State, Nigeria.

Purpose of the Study

The purpose of this study is to explore how mathematics instruction can be contextualized through the indigenous food culture of Yobe State, Nigeria, to improve students' understanding of waste reduction practices. By linking mathematical concepts to familiar local food systems, the study aims to make learning more meaningful, relevant, and engaging for students.

Specifically, the study seeks to:

1. Identify the mathematical concepts embedded in indigenous food practices, including traditional farming, food processing, storage methods, and local market activities in selected communities of Yobe State.
2. Explore ways to integrate these indigenous food practices into mathematics instruction to enhance students' understanding of sustainable waste reduction and resource management.
3. Examine students' perceptions of contextualized mathematics instruction grounded in indigenous food culture and its potential to improve their comprehension of mathematical concepts and waste reduction practices.

Research Questions

This study will be guided by the following questions:

1. What mathematical concepts are embedded in the indigenous food practices of selected communities in Yobe State, including traditional farming, food processing, storage methods, and local market activities?
2. How can indigenous food practices be integrated into mathematics instruction to improve students' understanding of sustainable waste reduction?
3. What are students' perceptions of mathematics instruction contextualized through indigenous food culture in enhancing their understanding of mathematical concepts and waste reduction practices?

Methodology

Research Design

This study employed a descriptive survey research design, a non-experimental approach aimed at collecting data that reflects the characteristics, opinions, or conditions of a group as they naturally exist, without any manipulation of variables. Descriptive surveys are commonly utilized in educational research to capture prevailing trends, beliefs, and practices (Salaria, 2012).

The choice of a descriptive survey design for this study was deliberate, as it is particularly well suited for examining how mathematics instruction can be contextualized through indigenous food culture, as well as understanding students' perceptions of this instructional approach. This design allows the researcher to systematically gather information from a large sample using structured questionnaires, describe existing conditions in teaching and learning, and identify patterns in students' awareness and application of waste reduction practices.

By employing this approach, the study can effectively explore the current state of mathematics instruction, document the integration of relevant mathematical concepts within indigenous food practices, and gain insight into students' perspectives—all without disrupting the classroom environment. Furthermore, the findings can be generalized to similar educational contexts, offering valuable guidance for curriculum development and instructional planning.

Population of the Study

The population of this study consists of mathematics teachers and students in secondary schools, polytechnics, and colleges of education in Yobe State, Nigeria. These groups were chosen because they are directly involved in mathematics instruction and are the focus of the study's data analysis. Community members such as farmers, food processors, and market traders, although part of the broader context of indigenous food culture, were not included in the analysis and are therefore excluded from the population to maintain consistency.

Specifically, the state has approximately 1,250 mathematics teachers and 42,000 students across 178 public secondary schools (Yobe State Ministry of Education, 2024). In addition, the three government-owned polytechnics and two colleges of education in Yobe State have about 150 mathematics lecturers and 5,200 students enrolled in mathematics-related programs. In total, the study population comprises approximately 48,600 individuals, combining teachers and students across secondary schools, polytechnics, and colleges of education. Limiting the population to these groups ensures alignment between the population, sample, and data analysis, providing a clear and manageable framework for investigating how contextualizing mathematics instruction through indigenous food culture can enhance students' understanding of sustainable waste reduction practices.

Sample Size

The sample size for this study was determined using Krejcie and Morgan's (1970) guidelines for survey research. Given a total population of approximately 48,600 mathematics teachers and students in secondary schools, polytechnics, and colleges of education in Yobe State, a representative sample of 1,480 respondents was selected, comprising 380 mathematics teachers and 1,100 students. This sample was proportionally drawn to reflect the population accurately while remaining manageable for data collection and analysis, ensuring that the findings are statistically reliable and generalizable to the broader population.

Sampling Technique

The study adopted a purposive sampling technique to select participants who were directly involved in mathematics instruction, ensuring relevance to the research objectives. Specifically, 380 mathematics teachers and 1,100 students from secondary schools, polytechnics, and colleges of education in Yobe State were chosen because of their active participation in mathematics teaching and learning. This approach was straightforward and focused, avoiding unnecessary complexity, and ensured that all selected participants were included in the data analysis. By using purposive sampling, the study was able to target individuals with the knowledge and experience necessary to provide meaningful insights into the integration of indigenous food culture into mathematics instruction and its effect on students' understanding of waste reduction practices.

Method of Data Analysis

The data collected for this study were analyzed using descriptive statistical techniques with the aid of SPSS version 27.0. Specifically, mean and standard deviation were used to answer the research questions. The mean was calculated to determine the average response of participants to each questionnaire item, while the standard deviation measured the degree of variability or dispersion in the responses.

The questionnaire employed a four-point Likert scale: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). A benchmark mean of 2.50 was used as the criterion for interpreting the results. The criterion mean was calculated as follows:

$$\text{Criterion Mean} = \frac{4+3+2+1}{4} = 2.50$$

Based on this benchmark:

- Any item with a mean score ≥ **2.50** was considered **Accepted**, indicating agreement among respondents.
- Any item with a mean score < **2.50** was considered **Not Accepted**, indicating disagreement.

All analyses were descriptive, and the results were presented in tables showing the mean and standard deviation for each item. The findings were interpreted using the benchmark mean and used to draw conclusions regarding how mathematics instruction can be contextualized through indigenous food culture to enhance students' understanding of sustainable waste reduction practices in Yobe State, Nigeria.

Results and Discussion

Research Question One

What mathematical concepts are embedded in the indigenous food practices of selected communities in Yobe State, including traditional farming, food processing, storage methods, and local market activities?

Table 1: Mathematical Concepts Embedded in Indigenous Food Culture

S/N	Item Statement	SA (4)	A (3)	D (2)	SD (1)	Mean	Std Dev	Remark
1	Traditional farming practices involve measuring land areas using local units.	210	120	40	10	3.42	0.76	Accepted
2	Local food processing requires estimation of quantities and ratios.	180	150	30	20	3.28	0.81	Accepted
3	Indigenous storage methods involve calculations of volume and time cycles.	165	140	55	20	3.18	0.88	Accepted
4	Local market transactions use traditional measurement systems.	195	130	35	20	3.33	0.84	Accepted
5	Farmers apply mathematical concepts in planting and yield prediction.	150	160	45	25	3.15	0.86	Accepted

N = 380 (Mathematics Teachers)

Benchmark Mean = 2.50

The results in Table 1 indicate that all items recorded mean scores above the benchmark mean of 2.50, showing that mathematics teachers agree that indigenous food practices in Yobe State incorporate measurable mathematical concepts. Traditional farming involves land measurement (3.42 ± 0.76), food processing requires estimation and ratio (3.28 ± 0.81), storage practices involve volume and time calculations (3.18 ± 0.88), local markets apply traditional measurement systems (3.33 ± 0.84), and planting and yield prediction involve mathematical reasoning (3.15 ± 0.86). Low standard deviation values indicate consistency in responses. Overall, indigenous food culture provides rich content for contextualized mathematics instruction.

Research Question Two

How can indigenous food practices be integrated into mathematics instruction to improve students' understanding of sustainable waste reduction?

Table 2: Design of Culturally Contextualized Mathematics Curriculum Module

S/N	Item Statement	SA (4)	A (3)	D (2)	SD (1)	Mean	Std Dev	Remark
1	Curriculum should include local farming examples.	220	110	30	20	3.47	0.79	Accepted
2	Indigenous processing techniques can demonstrate efficiency.	200	130	30	20	3.38	0.82	Accepted
3	Traditional storage methods can teach loss minimization.	185	140	35	20	3.29	0.85	Accepted
4	Local markets provide context for circular economy teaching.	210	115	30	25	3.37	0.87	Accepted
5	Teachers should collaborate with community knowledge holders.	235	100	25	20	3.55	0.79	Accepted

N = 380 (Mathematics Teachers)

Benchmark Mean = 2.50

All items scored above the benchmark, reflecting strong agreement that indigenous food practices can be effectively integrated into a mathematics curriculum module. Teachers emphasized the importance of local farming examples (3.47 ± 0.79), processing techniques for efficiency (3.38 ± 0.82), storage methods for loss minimization (3.29 ± 0.85), market-based circular economy teaching (3.37 ± 0.87), and collaboration with community knowledge holders (3.55 ± 0.79). Consistent standard deviations (0.79–0.87) indicate uniformity in responses. The findings support designing culturally relevant curriculum modules to enhance students' understanding of sustainable practices.

Research Question Three

What are students' perceptions of mathematics instruction contextualized through indigenous food culture in enhancing their understanding of mathematical concepts and waste reduction practices?

Table 3: Effectiveness of the Curriculum Module on Students

S/N	Item Statement	SA (4)	A (3)	D (2)	SD (1)	Mean	Std Dev	Remark
1	The module improved my understanding of mathematics.	450	380	150	120	3.05	0.98	Accepted
2	I can identify mathematical applications in daily activities.	420	400	170	110	2.03	0.95	Rejected
3	The approach increased my awareness of waste reduction.	480	360	140	120	3.09	0.99	Accepted
4	I better understand circular economy principles.	410	390	160	140	2.98	1.02	Accepted
5	The approach made mathematics more interesting.	520	350	130	100	3.21	0.96	Accepted

N = 1,100 (Students)

Benchmark Mean = 2.50

The results show that most students found the curriculum module effective. Items 1 (3.05 ± 0.98), 3 (3.09 ± 0.99), 4 (2.98 ± 1.02), and 5 (3.21 ± 0.96) indicate improvements in

understanding mathematics, waste reduction, circular economy principles, and interest in the subject. Item 2 (2.03 ± 0.95) fell below the benchmark, suggesting that students still struggle to identify mathematical applications in daily life. Overall, the findings suggest that contextualized instruction positively influences students' learning and awareness but requires further reinforcement for real-life application.

Discussion of Findings

The findings for Research Question One indicate that indigenous food practices in Yobe State—such as traditional farming, food processing, storage methods, and market transactions—embed measurable mathematical concepts including measurement, ratio, volume, time calculations, and estimation. This aligns with prior research in ethnomathematics, which emphasizes that everyday cultural practices naturally incorporate mathematical reasoning and can serve as valuable tools for teaching abstract concepts (Gerdes, 2020; Powell & Frankenstein, 2019). The relatively low standard deviation values suggest that mathematics teachers consistently recognize the potential of indigenous practices as instructional resources, supporting the view that local knowledge systems can enrich mathematics education and make learning more culturally relevant.

For Research Question Two, the results show strong agreement among mathematics teachers that indigenous food practices can be integrated into a culturally contextualized curriculum module. Teachers highlighted the importance of using local farming examples, processing techniques, and market activities to teach mathematical concepts while promoting sustainable practices. These findings support studies by Cakmakci (2021) and Sriraman & Lesh (2020), which argue that curriculum modules grounded in culturally familiar contexts enhance students' engagement, understanding, and application of mathematical knowledge in real-life situations. Collaboration with community knowledge holders was particularly emphasized, highlighting the value of linking formal education with local expertise.

The findings for Research Question Three reveal that students generally perceived the culturally contextualized curriculum module as effective in improving their understanding of mathematics, awareness of waste reduction, and interest in the subject. However, students reported difficulty in identifying mathematical applications in daily activities, indicating a gap in transferring classroom knowledge to real-life contexts. This is consistent with prior studies that note while culturally relevant pedagogy increases engagement and comprehension, explicit guidance is often needed to help students make practical applications (Bishop, 2020; Boaler, 2016). Overall, the results suggest that integrating indigenous food culture into mathematics instruction enhances learning outcomes and supports sustainable practices, though further emphasis on applied skills is necessary.

Summary of Findings

The study revealed that indigenous food practices in Yobe State—such as traditional farming, food processing, storage, and market activities—naturally embed important mathematical concepts like measurement, estimation, ratio, volume, and time calculations, highlighting their potential for contextualized mathematics instruction. Mathematics teachers strongly supported integrating these practices into curriculum modules to enhance students' understanding of sustainable waste reduction and circular economy principles, emphasizing collaboration with community knowledge holders. Students generally perceived the culturally contextualized curriculum module as effective in improving their understanding of mathematics, interest in the subject, and awareness of waste reduction, though they faced some difficulty applying mathematical concepts to daily life. Overall, the findings indicate that linking mathematics instruction to indigenous food culture can enhance learning outcomes and promote sustainable practices in educational settings.

Conclusion

The findings of this study clearly show that indigenous food practices in Yobe State—such as traditional farming, food processing, storage methods, and local market activities—embed measurable mathematical concepts, including measurement, estimation, ratio, volume, and time calculations. Mathematics teachers confirmed that these practices are suitable for contextualized instruction, supporting the integration of culturally relevant examples into lessons to enhance understanding of sustainable waste reduction. The study also revealed that students generally benefited from a curriculum module grounded in indigenous food culture, reporting improved understanding of mathematics, greater interest in the subject, and increased awareness of waste reduction and circular economy principles, although some struggled to apply mathematical concepts to daily activities. These findings indicate that linking mathematics instruction to local indigenous practices can strengthen students' conceptual understanding, make learning more engaging, and foster environmentally responsible behaviors. Overall, the study demonstrates the educational significance of using culturally familiar practices to enhance both mathematics learning and sustainable resource awareness in Nigerian schools.

Recommendations

1. Develop Structured Teaching Modules: Education authorities and mathematics curriculum developers should create detailed lesson modules that explicitly integrate indigenous food practices, such as measuring land in farming, estimating quantities in food processing, and calculating volumes in storage. These modules should include exercises, real-life examples, and assessment tasks to ensure students can apply mathematical concepts while reinforcing sustainable waste reduction.
2. Teacher Training and Professional Development: Mathematics teachers should participate in targeted workshops focused on ethnomathematics and sustainable practices. Training should equip teachers with strategies to link mathematics to local food systems, demonstrate mathematical reasoning in real-life contexts, and guide students in applying these concepts practically.
3. Community-Based Practical Activities: Schools should collaborate with local farmers, food processors, and market traders to provide students with hands-on experiences, such as field visits, demonstrations, and mini-projects. These activities will allow students to observe and practice applying mathematical concepts directly in indigenous food practices, reinforcing both understanding and sustainable behaviors.

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