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Ethnomathematics and Ugandan basketry: an innovative pedagogical tool in teaching and learning school mathematics

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ABSTRACT

This study explores how indigenous Ugandan basketry can be integrated into lower secondary school mathematics instruction as a culturally responsive pedagogical resource. Using a qualitative multi-case ethnographic approach, data were collected from indigenous basket weavers, secondary school mathematics teachers, and mathematics teacher educators across four regions of Uganda through interviews, focus group discussions, observations, and document analysis. The analysis identified mathematical concepts embedded in basketry, including geometry, measurement, ratio and proportion, symmetry, and pattern. The findings indicate that basketry can serve as a meaningful context for teaching and learning mathematics by connecting abstract concepts to learners' cultural experiences. A prototype lesson plan is presented to illustrate how this approach may be implemented in classroom practice. Overall, the study suggests that integrating basketry into mathematics instruction offers a promising pathway for supporting culturally responsive pedagogy and enhancing conceptual understanding.

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Social Sciences; Education; Curriculum Studies; Mathematics; Social Sciences; Social Sciences; Education - Social Sciences; Teaching & Learning - Education; Social Sciences; Education; Classroom Practice

1. Introduction

Mathematics is a compulsory subject in Uganda from primary education (P.1–P.7) through ordinary secondary school (S.1–S.4) because of its broad applicability in everyday life (Kaya & Keşan, 2023) and its significant contribution to national development (Makramalla et al., 2025). However, at the advanced secondary school level (S.5–S.6), mathematics becomes optional, resulting in declining enrolment in mathematics-related subjects and relatively low participation in mathematics-based university programs (Maselli & Beblavý, 2014). This challenge is further compounded by persistent low performance in mathematics at the ordinary secondary school level (Muwonge et al., 2018). One contributing factor is the limited connection between school mathematics and learners' socio-cultural experiences and everyday realities (Benson-O'Connor, McDaniel, & Carr, 2019). In response, the Ministry of Education and Sports (MoES) introduced reforms such as the National Teacher Policy (MoES, 2019) and the competence-based curriculum (CBC) implemented in 2020. These reforms emphasize learner-centered pedagogy, problem-solving, and the use of real-life contexts in teaching and learning. They also encourage the integration of Indigenous Knowledge (IK) to enhance relevance and learner engagement. Despite these policy directions, mathematics instruction in many classrooms remains largely abstract and decontextualized

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(Ngware & Mutisya, 2022), partly because teachers often lack practical guidance on how to identify and align culturally relevant content with curriculum expectations (Batiibwe, 2024; 2025).

Within this context, ethnomathematics provides an important perspective for understanding mathematics as culturally situated and embedded in everyday practices (D'Ambrosio, 1985, 2001). Research from different contexts shows that cultural practices such as weaving and quilting (Presmeg, 1998), games (Brandt & Chernoff, 2015), and artistic designs (Eglash, 1999), can support mathematical understanding and learner engagement (Ali & Davis, 2018; Fouze & Amit, 2017; Gerdes, 2011; Jacob & Dike, 2023; Thompson, 2023), and culturally responsive mathematics teaching (Balabuch & Rasoarifetra, 2023; Yanti, 2025). Among these practices, basketry has been identified as particularly rich in mathematical ideas, including symmetry, measurement, patterning, spatial reasoning, and proportional thinking (Gerdes, 2011; Gunawan et al., 2022). However, although international studies have demonstrated the mathematical potential of basketry, few studies have examined how basketry can be systematically aligned with formal mathematics curricula in Uganda or translated into practical classroom pedagogy. This study addresses this gap by exploring basketry as a culturally grounded pedagogical resource for mathematics teaching in Uganda. Focusing on lower secondary school (S.1–S.2), where foundational mathematical understanding is developed, the study investigates how mathematical concepts embedded in basketry can support contextually relevant teaching and learning. The study was guided by the following objectives:

i. To establish how mathematics instruction can be contextualized through indigenous basketry practices.
ii. To identify and align mathematical concepts embedded in basketry with the S.1–S.2 mathematics curriculum.
iii. To develop a prototype lesson plan demonstrating how basketry can be integrated into mathematics instruction.

By drawing on basketry practices from the four regions of Uganda, the study contributes to ongoing efforts to develop culturally responsive, competence-based, and contextually meaningful mathematics pedagogy.

2. Theoretical perspective

This study is informed by an integrated theoretical framework drawing on constructivism, social constructivism, and ethnomathematics to explain how culturally embedded practices can support mathematics teaching and learning. Constructivist theory, associated with Piaget (2009), posits that learners actively construct knowledge through interaction with their environment. Within this study, basketry provides a familiar and concrete context through which learners can relate mathematical concepts to prior experiences and observable practices. Mathematical understanding is therefore viewed as emerging through active engagement with culturally meaningful activities. This perspective is complemented by Vygotsky's (1978) social constructivist theory, which emphasizes that learning is socially mediated through interaction, language, and cultural tools. Basketry, as a communal and culturally shared practice, creates opportunities for collaborative learning, observation, guided participation, and discussion. Through these interactions, learners can negotiate and construct mathematical meaning collectively. Ethnomathematics, introduced by D'Ambrosio (1985), provides the central analytical lens for the study by conceptualizing mathematics as culturally embedded rather than culture-free or purely abstract. From this perspective, mathematical ideas emerge from everyday activities and problem-solving practices within communities. In the context of this study, ethnomathematics guides the identification and interpretation of mathematical concepts embedded in basketry practices, including symmetry, patterning, proportional reasoning, measurement, and spatial organization.

Together, these perspectives position basketry as both a cultural and pedagogical resource for mathematics learning. The framework also informed the methodological orientation of the study by supporting qualitative and interpretive approaches aimed at understanding how mathematical knowledge is embedded within indigenous practices and how such knowledge can be translated into classroom instruction. As illustrated in Figure 1, the framework conceptualizes basketry as a mediating link between indigenous cultural practices, embedded mathematical concepts, and classroom pedagogy. The framework informed data collection and analysis by guiding the identification of mathematical ideas within basketry practices, their alignment with the S.1–S.2 curriculum, and their translation into teaching and learning activities. During analysis, the framework was refined through insights generated from interviews with basket weavers, focus group discussions with mathematics teachers (MTs) and mathematics teacher educators (MTEs), and observations of basket-making processes. The framework, therefore, functions both as a conceptual guide and as an analytical lens for interpreting the findings.

3. Literature review

Research increasingly recognizes mathematics as socially and culturally situated rather than entirely abstract and context-free. Scholars such as Appelbaum and Stathopoulou (2015) and Rosa and Orey (2011) argue that learners develop a deeper understanding when mathematical concepts are connected to their cultural and social experiences. Similarly, the National Council of Teachers of Mathematics (NCTM, 1991) emphasizes contextualized instruction as important for conceptual understanding. Context-based approaches have also been associated with enhanced experiential learning (Chahine, 2020), conceptual understanding (Atta, 2024), and learner engagement (Fouze & Amit, 2025). One approach to contextualized mathematics instruction involves integrating Indigenous Knowledge (IK) into formal education (Gula & Jojo, 2024). Indigenous Knowledge, also referred to as traditional or local knowledge (Odora-Hoppers, 2021), includes the skills, practices, philosophies, and values developed by communities through long-term interaction with their environments (Hiwasaki et al., 2014). Such knowledge is reflected in activities including storytelling, music, dances, farming, craftsmanship, and weaving practices (Tabuti & Van Damme, 2012). Scholars argue that integrating IK into education supports cognitive development, validates learners' lived experiences, and strengthens connections between formal education and cultural heritage (Mania & Alam, 2021; Mawere, 2015).

Ethnomathematics provides a framework for operationalizing the integration of Indigenous Knowledge into mathematics education. Pioneered by D'Ambrosio (1985), ethnomathematics conceptualizes mathematics as emerging from culturally situated problem-solving practices. Scholars such as Cimen (2014) and Rosa and Orey (2011) describe ethnomathematics as the relationship between formal mathematics and cultural knowledge, while D'Ambrosio (1985) emphasizes the mathematical practices of identifiable cultural groups. This perspective challenges dominant representations of mathematics as culture-neutral and instead positions it as meaningful and grounded in lived experience (Gerdes, 2011). In African contexts, where colonial education systems frequently marginalized indigenous forms of knowledge, ethnomathematics has been identified as a culturally responsive and inclusive approach to mathematics teaching (Gerdes, 1996; Bishop, 1988), which enables learners to perceive mathematics as a human activity that is relevant to their everyday lives while fostering equitable learning environments (Powell & Frankenstein, 1997). It also aligns with contemporary decolonial perspectives and Sustainable Development Goal 4, which advocates inclusive and contextually grounded education (Dhungana et al., 2024; Dias, 2025; Meeran, 2024; Owusu & Obuo Addo, 2023; Rawat & Nagaraju, 2024). Building on this foundation, integrating Indigenous Knowledge (IK) into mathematics education provides a meaningful pathway for connecting abstract concepts to learners' lived experiences (Gerdes, 1996; Vithal & Skovsmose, 1997). However, such integration requires careful selection and alignment of cultural practices with mathematical concepts to ensure pedagogical relevance (Fouze & Amit, 2025).

Within ethnomathematics research, basketry has emerged as a particularly rich cultural practice for mathematical exploration (Ali & Davis, 2018; Rao, 2021). Studies from different contexts demonstrate that basketry embodies mathematical concepts such as symmetry, spatial reasoning, geometric transformations, proportional thinking, measurement, and pattern formation. For example, Ali and Davis (2018) demonstrates how basketry in Ghana supports early number concepts, while Gould (2007) highlights its application in teaching geometry and spatial relationships across diverse cultural settings. Research in Nigeria (Omere & Ogedengbe, 2022; Ubana et al., 2017) further indicates that incorporating cultural artifacts into mathematics instruction can improve learners' understanding and achievement in geometry. Additional studies emphasize the pedagogical value of weaving and basketry in promoting hands-on

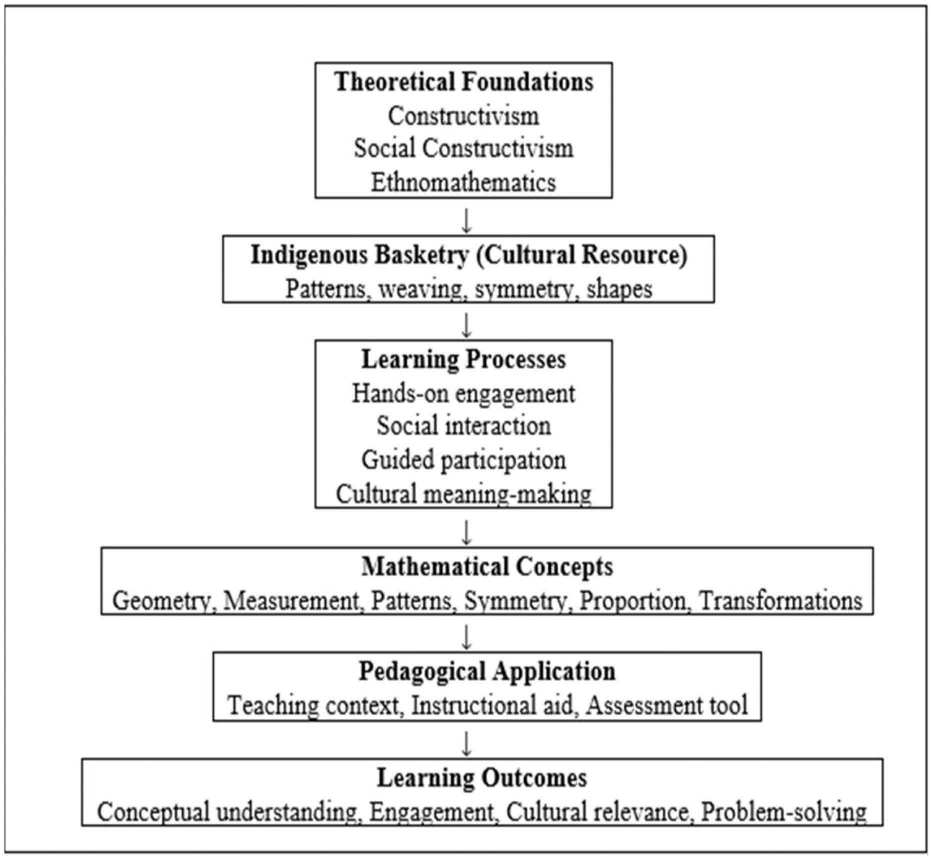


Figure 1. Conceptual framework illustrating the relationship between indigenous basketry practices, embedded mathematical concepts, curriculum alignment, and pedagogical applications in S.1–S.2 mathematics instruction.

and experiential learning. Thompson (2023) and Bunn et al. (2022), working in the United States and the United Kingdom, respectively, show that weaving activities support spatial reasoning and stimulate mathematical discussion. Similarly, Balabuch and Rasoarifetra (2023), drawing on examples from Canada, Ghana, and Madagascar, demonstrate that weaving can integrate mathematics with science, cultural heritage, and personal development while supporting both cognitive and affective learning outcomes. Research also demonstrates that basketry practices embody sophisticated mathematical reasoning. Gerdes (2011) identifies concepts such as symmetry, proportional reasoning, geometric transformation, and patterning within African basketry traditions. Similarly, De Las Peñas, Garciano, and Verzosa (2021) and Arribay (2025) demonstrate how weaving practices in the Philippines involve geometric reasoning and transformations. Studies by Madusise (2022) and Sunzuma and Maharaj (2020) further show that Zimbabwean basketry reflects geometric and algebraic thinking, while Gunawan et al. (2022) and Subba et al. (2022) highlight how basketry in Indonesia and Bhutan can support the teaching of measurement, number patterns, and spatial structures.

Collectively, these studies suggest that basketry: provides concrete and culturally meaningful contexts for abstract mathematical ideas; supports experiential and hands-on learning; enhances learner motivation and engagement; and strengthens the connection between mathematics and everyday life. However, several gaps remain within the literature. First, much of the existing research is conducted outside East Africa, limiting contextual applicability to Ugandan classrooms. Second, many studies remain largely descriptive, focusing on identifying mathematical concepts in cultural artifacts without demonstrating how these can be systematically integrated into curriculum-aligned classroom pedagogy. Third, limited attention has been given to how ethnomathematical practices can support competence-based curricula such as Uganda's CBC. This study addresses these gaps by examining mathematical concepts embedded in Ugandan basketry, aligning them with the S.1–S.2 mathematics curriculum, and developing a prototype lesson plan for classroom implementation. In doing so, the study extends existing ethnomathematics research beyond descriptive analysis toward practical pedagogical application within a Ugandan competence-based curriculum context.

4. Methodology

4.1. Study approach

This study utilized a qualitative research approach (Lim, 2025) to gain an in-depth understanding of how basketry can be integrated into mathematics teaching and learning. A qualitative orientation was fitting because it allowed the researchers to explore the cultural, pedagogical, and experiential nuances embedded in basketry traditions, as well as the interpretations and practices of secondary school mathematics teachers, mathematics teacher educators, and weavers regarding its application in classroom instruction. This approach provided rich descriptions of local knowledge systems, mathematical processes inherent in basketry, and the secondary school mathematics and mathematics teacher educators' perspectives on culturally responsive pedagogy.

4.2. Study design

This study adopted an ethnographic research design (Reeves et al., 2013) as the overarching methodological framework guiding the exploration of indigenous basket-weaving practices within their natural socio-cultural settings. Ethnography was considered appropriate because the study sought to document, interpret, and understand the cultural meanings, practices, symbols, and mathematical ideas embedded in everyday basketry activities among different Ugandan communities. The ethnographic orientation enabled prolonged engagement with participants and close observation of weaving practices, interactions, tools, patterns, and locally situated mathematical reasoning. Within this broader ethnographic framework, the study employed a multiple-case study design (Adams et al., 2022) to facilitate in-depth examination and comparison of basketry practices across culturally diverse regions of Uganda. Each selected case represented a distinct cultural community with unique basket-weaving traditions, materials, designs, and indigenous knowledge systems. The multiple-case structure enabled the study to identify both shared mathematical ideas across communities and context-specific mathematical practices embedded within particular cultural settings.

In addition, a phenomenological lens (Reeves et al., 2013) was incorporated to deepen understanding of participants' lived experiences and interpretations of basketry-related mathematics. This interpretive component focused on how indigenous basket weavers, secondary school mathematics teachers, and mathematics teacher educators perceived, experienced, and attached meaning to the mathematical concepts embedded in basket weaving and their potential integration into school mathematics. The study, therefore, operated at three interconnected methodological levels. Ethnography served as the primary research orientation by situating the inquiry within participants' natural cultural environments. The multiple-case study design provided the organizational structure for examining different cultural contexts comparatively, while phenomenology complemented the analysis by foregrounding participants' subjective experiences and meanings.

4.3. Study sites

The research was conducted in four districts representing Uganda's major geographical and cultural regions: Mayuge District (Eastern Region), Wakiso District (Central Region), Mbarara District (Western Region), and Gulu District (Northern Region) (Audet & d'Amboise, 2001). Including sites from all four regions ensured the study captured a wide range of cultural practices, allowing learners from various backgrounds to see their cultural experiences reflected in mathematics instruction. This diverse representation enhanced the study's goal of promoting inclusivity and contextual relevance in mathematics teaching.

4.4. Sample size and participants

The study involved 16 participants: four indigenous basket weavers (one from each region), eight secondary school mathematics teachers (two from each region: one teaching S.1 and one teaching S.2), and four mathematics teacher educators (MTEs) (one from each region) (Dahal et al., 2024). Participants were carefully selected to ensure the inclusion of individuals with relevant expertise and experience aligned with the study objectives. Indigenous basket weavers were selected based on the following criteria: (i) demonstrated expertise in traditional basket weaving within their community, (ii) a minimum of five years' experience in basket production, and (iii) active engagement in culturally recognized basketry practices. These criteria ensured that participants possessed deep, practice-based knowledge of indigenous weaving techniques. Secondary school mathematics teachers were selected based on: (i) current teaching responsibility at the S.1 or S.2 level, (ii) at least three years of teaching experience, and (iii) familiarity with or willingness to engage in culturally responsive teaching approaches. Selecting one teacher per grade level per region ensured representation across lower secondary mathematics instruction. Mathematics teacher educators (MTEs) were selected based on: (i) involvement in pre-service teacher education, (ii) a minimum of three years' experience in teacher training, and (iii) demonstrated engagement with mathematics pedagogy or curriculum development. Their inclusion provided a broader pedagogical and curriculum perspective. The selected sample size was considered adequate for in-depth qualitative inquiry, allowing for rich, contextually grounded insights while enabling cross-case comparisons across regions. Additionally, it was intended to generate in-depth, contextually grounded insights rather than support statistical generalization.

4.5. Sampling procedure

While the study sites were purposively selected to reflect the diversity of basketry practices across Uganda, participant selection followed a combination of purposive and snowball sampling techniques (Gentles et al., 2015). Local council chairpersons initially assisted in identifying skilled basket weavers, after which snowball sampling was used to recruit additional participants with relevant expertise. Final selection of weavers was based on clearly defined criteria, including demonstrated expertise, fluency in describing the basket-making process, and depth of experience in traditional basketry, ensuring the credibility and richness of the data generated. Secondary school mathematics teachers and mathematics teacher educators were purposively selected based on their experience teaching S.1 to S.2 mathematics, familiarity with cultural practices or prior use of indigenous examples in instruction, and years of service within their local communities. These criteria ensured that participants could meaningfully engage with both the cultural and pedagogical dimensions of the study. The purposive sampling approach is consistent with the ethnographic design of the study, which emphasizes the selection of information-rich participants capable of providing deep cultural and pedagogical insights into the phenomenon under investigation. Overall, the combined sampling approach enabled the inclusion of information-rich participants whose experiences supported in-depth exploration of the integration of indigenous knowledge into mathematics teaching, while also strengthening the trustworthiness of the study.

4.6. Data collection tools and procedure

Data were collected between 27 June 2023, and 19 June 2024, using multiple qualitative methods to enable triangulation and enhance the credibility and trustworthiness of the findings (Chand, 2025). The study employed four main data collection tools: interviews, observations with video documentation, focus group discussions, and document analysis. Open-ended interviews were conducted with basket weavers to document the processes involved in basket production, including material selection, pattern construction, and weaving techniques. These interviews generated detailed accounts of the procedural and cultural dimensions of basketry, which were subsequently analyzed to identify implicit mathematical reasoning embedded in the practices. Structured observations of basket-making sessions were conducted to capture real-time weaving processes. These observations were supported by video recordings to ensure accuracy and allow for repeated viewing during analysis. The video data enabled systematic examination of specific stages of basket production, facilitating the identification and verification of mathematical concepts such as patterns, symmetry, and spatial relationships across different weaving processes. Focus group discussions (FGDs) were conducted with secondary school mathematics teachers and mathematics teacher educators. During these sessions, selected excerpts from the video recordings and interview transcripts were used as analytical prompts to guide discussion. Participants collaboratively examined the basketry practices, identified relevant mathematical concepts, and discussed their alignment with S.1 and S.2 curriculum content. These discussions also informed the development of a prototype lesson plan by generating pedagogical strategies for integrating basketry into classroom instruction.

In addition, document analysis was carried out on the S.1 and S.2 mathematics syllabi developed by the National Curriculum Development Centre (NCDC). This analysis focused on identifying curriculum content areas that could be aligned with mathematical concepts derived from basketry practices. The document analysis provided a basis for mapping culturally embedded mathematical ideas onto formal curriculum requirements. The use of multiple data sources and methods enabled triangulation by allowing the cross-verification of findings across interviews, observations, FGDs, and curriculum documents. This approach strengthened the analytical rigor of the study by ensuring that identified mathematical concepts and pedagogical applications were consistently supported by multiple forms of evidence.

4.7. Data analysis

Data analysis was conducted using a systematic and iterative qualitative approach based on thematic analysis (Lochmiller, 2021), which served as the primary method of analysis. This process consisted of eight steps as follows: (1) Data preparation and familiarization: In this initial step, all interview transcripts, field notes, and video recordings were transcribed, organized, and repeatedly reviewed to immerse the researchers in the data. (2) Initial coding (open coding): The second step involved inductively coding the data to identify meaningful units related to basket-weaving practices and the embedded mathematical ideas. Codes were generated across all data sources. (3) Domain and taxonomic structuring: Guided by the Spradley ethnographic analysis model (Spradley, 2016), initial codes were grouped into cultural domains such as materials, techniques, and patterns. These domains were further refined through taxonomic analysis to establish internal relationships and hierarchies among the categories. (4) Componential analysis: In this step, variations in practices and their associated mathematical features were distinguished by identifying attributes and contrasts within each domain. (5) Theme development: The fifth step involved synthesizing the codes and categories into overarching themes that captured key mathematical concepts such as patterns, symmetry, and proportionality. (6) Video analysis: Utilizing the APOS (*Action, Process, Object, and Schema*) learning theory lens (Kusnandi, 2020), the sixth step analyzed video data to trace the development of mathematical understanding in practice. Observed actions were examined as *Actions*, organized into sequences as *Processes*, interpreted as stable structures as *Objects*, and integrated into broader conceptual understandings as *Schemas*. This step complemented the thematic findings by elucidating how mathematical ideas emerge through practice. (7) Content mapping to the curriculum: A directed content analysis (Bengtsson, 2016) was performed in the seventh step to align the identified mathematical processes with concepts in the S.1–S.2 mathematics curriculum, ensuring pedagogical relevance. (8) Triangulation and validation: The final step involved comparing findings from interviews, observations, and video analysis to ensure consistency and enhance credibility. This structured approach provided a comprehensive framework for analyzing qualitative data related to basket-weaving practices and the mathematical concepts intertwined within them.

4.8. Ethics

Ethical considerations, as emphasized by Israel and Hay (2006), formed the cornerstone of this study, reflecting a strong commitment to integrity, respect, and responsible research practice. Ethical approval was obtained, and permission to conduct the study was granted by the relevant educational and community authorities in the selected regions before data collection. All participants willingly provided written informed consent after being fully informed about the purpose of the study, the nature of their participation, and their rights as participants. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any stage without any negative consequences. Consent was also obtained for audio and video recording, where applicable. To ensure confidentiality and anonymity, participants' identities were protected through the use of pseudonyms, and all identifying information was removed from interview transcripts, field notes, and reports. Data were securely stored and accessible only to the research team. These measures ensured the privacy and protection of all participants throughout the research process. Cultural sensitivity protocols were central to the conduct of the study, guiding respectful engagement with participants and the handling of basketry artifacts and Indigenous Knowledge. Particular care was taken to ensure that local practices, values, and knowledge systems were acknowledged and respected. This included recognizing the intellectual ownership of participants' knowledge and ensuring that their contributions were represented accurately and respectfully. These procedures reflect a commitment to honoring cultural heritage while maintaining ethical research standards.

5. Findings

This section presents the major findings of the study, organized according to the three research objectives. The results are based on interviews with basket weavers, observations of weaving processes, focus group discussions with secondary school mathematics teachers and teacher educators, as well as an analysis of the S.1–S.2 mathematics syllabi. During data collection, we collected four baskets from the Central region, three from the Northern region, and one each from the Eastern and Western regions. Figure 2 showcases some of these baskets, which include: a basket from Eastern Uganda (Figure 2(a)) used for holding fish for sale; a basket from Central Uganda (Figure 2(b)), traditionally used to wrap, prepare, and serve green bananas (*matooke*), the region's staple food; a basket from Northern Uganda (Figure 2(c)) used for storing food items such as dried cassava strips; and a basket from Western Uganda (Figure 2(d)), used for serving ready-to-eat millet paste, the staple food in that region. Figure 3 illustrates sections of some of the basket designs analyzed in this study.

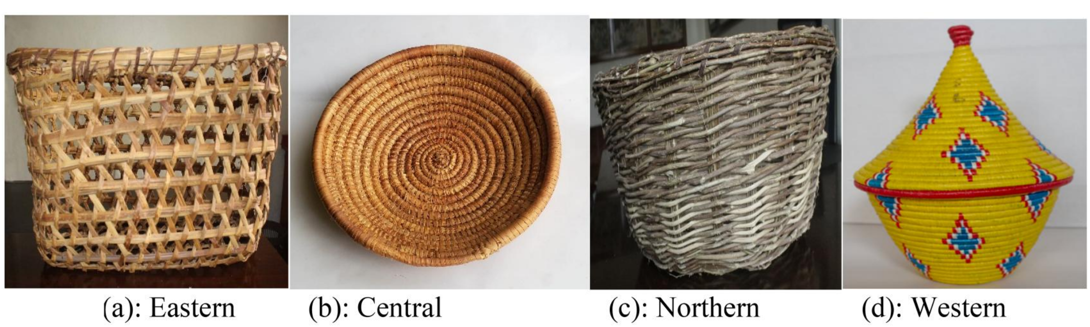


Figure 2. Examples of indigenous baskets from four different regions of Uganda. (a): Eastern, (b): Central, (c): Northern, and (d): Western.

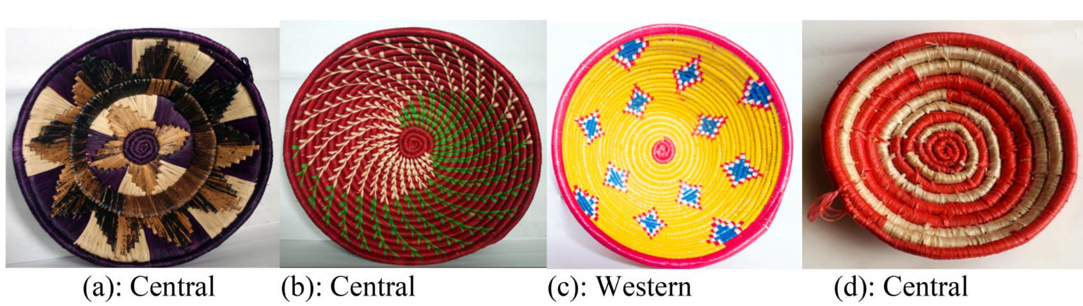


Figure 3. Sections of basket designs from Uganda. (a): Central, (b): Central, (c): Western, and (d): Central.

5.1. Contextualizing mathematics instruction through indigenous basketry practices

The first objective of this study was to establish how basketry can be used by mathematics teachers as an innovative pedagogical tool in S.1–S.2 classrooms. Analysis of interview data, classroom-oriented discussions, and observed basketry practices revealed three interrelated pedagogical uses of basketry: as a pedagogical context, an instructional aid, and an assessment tool. These themes emerged consistently across participants' accounts and were grounded in how secondary school mathematics teachers and mathematics teacher educators interpreted specific basket forms (Figures 2 and 3) and weaving processes. The following sections present these themes, supported by participant narratives and linked directly to observed basketry features and curriculum-relevant concepts.

5.1.1. Basketry as a pedagogical context

Mathematics teachers (MTs) and mathematics teacher educators (MTEs) described basketry as a pedagogical context that enables learners to engage with mathematical ideas through familiar cultural practices. In their accounts, basketry functioned as the central reference around which lessons are organized, with specific basket features (Figures 2 and 3) used to introduce and explore mathematical concepts through patterns, designs, and problem-solving tasks. For instance, a teacher from Mbarara explained how symmetry can be taught using observable patterns in baskets:

> I can bring different baskets [e.g. Figures 3(a–c)] and ask learners to identify repeating shapes and designs. By using these, they can visualize reflections and rotations …

This statement links directly to the visible repeating motifs in the referenced basket sections (Figure 3), where alternating patterns and mirrored designs provide concrete instances of reflection and rotation. Similarly, a teacher from Gulu associated proportional reasoning with observable structural relationships in baskets: '*By analyzing the weaver's measurements* [e.g. Figures 2(d) and 3(b)], *learners can observe that every increase in diameter necessitates an equal adjustment in height …*' This observation reflects how basket dimensions change proportionally during the body weaving stage, a pattern also documented during field observations of basket construction.

Another teacher from Mbarara connected circular geometry to basket bases: '*When learners examine a basket's circular base* [e.g. Figure 3(d)], *we can introduce concepts like radius, circumference, and area …*' These examples demonstrate that participants did not describe basketry in abstract terms; rather, they consistently grounded their pedagogical suggestions in specific, observable features of baskets. In addition, a teacher from Gulu noted: '*In our Acholi designs* [e.g. Figure 2(c)], *learners can trace patterns to find lines of symmetry …*' This reinforces how cultural designs themselves served as empirical entry points for mathematical reasoning. Across these accounts, the data show that basketry provides a culturally grounded context through which learners can engage with mathematical ideas such as symmetry, proportion, and measurement, as evidenced in both participant explanations and observed basket structures.

5.1.2. Basketry as an instructional aid

Participants described basketry as an instructional aid that supports the explanation and reinforcement of mathematical concepts already introduced through formal teaching. In their accounts, basketry was used alongside other teaching resources, with specific basket features and weaving processes serving to clarify abstract ideas through hands-on tasks, demonstrations, and pattern analysis. For example, a teacher from Wakiso District explained: '*After teaching the formulas … I can show learners how basket weavers calculate the amount of raw material needed …* [Figure 2(b)]'. This illustrates how observed features of the basket, particularly inner and outer circumferences, can be used to reinforce measurement concepts introduced in class. Similarly, a teacher from Mayuge linked basket patterns (Figure 3(b)) to linear relationships: '*This can help learners connect the concept of slope with something visual and familiar*'. This interpretation was grounded in the repeated and incremental strand patterns observed in the basket designs, which can be translated into tabular or graphical representations.

Participants also emphasized hands-on engagement. For instance, a Wakiso teacher noted: '*Learners can estimate the final height … using ratios and proportions*'. This aligns with observed weaving processes where height increases incrementally through repeated coiling. An MTE from the Eastern region further highlighted: '*Basketry offers natural ratios …*' This was supported by visible color alternations in basket patterns (Figure 3(a)), which provide concrete representations of ratios. These accounts indicate that basketry functions as a mediating tool that connects abstract mathematical representations to observable and manipulable cultural artifacts.

5.1.3. Basketry as an assessment tool

Participants identified basketry-based tasks as effective tools for assessing learners' mathematical understanding in applied and culturally meaningful ways. In their accounts, basketry functioned as an assessment tool through authentic, performance-based activities, such as basketry-inspired exercises, assignments, projects, and investigative tasks, grounded in specific classroom practices and observable basket features. For example, a teacher from Mbarara described a project in which learners design basket models and calculate dimensions, allowing assessment of spatial reasoning and measurement. Similarly, a teacher from Gulu explained how basket images can be used for formative assessment: '*I can ask learners to identify and explain different forms of symmetry …*' This approach links directly to visible symmetrical features in baskets (e.g. Figures 2(c) and 3(a)), enabling teachers to assess conceptual understanding through explanation rather than recall.

An MTE from the Central region emphasized: '*When learners demonstrate mathematical understanding through familiar cultural artifacts, assessment becomes more meaningful …*' This perspective was echoed across FGDs, where participants highlighted how basketry-based tasks reveal reasoning processes through explanation, construction, and dialogue. Observations of weaving practices further supported this, particularly in stages involving pattern formation and proportional adjustment, where mathematical reasoning is made explicit through action. These findings suggest that basketry enables forms of assessment that capture both procedural and conceptual understanding, grounded in observable practices and participant interpretations.

5.2. Linking basketry processes to S.1 - S.2 mathematics curriculum content

The second objective of this study was to identify the specific S.1–S.2 mathematics content that can be taught through basketry. To achieve this, the study first examined the mathematical processes embedded in basket-making practices and then mapped these processes onto the S.1–S.2 mathematics curriculum. This two-stage analytical approach enabled a systematic alignment between indigenous craft knowledge and formal school mathematics.

5.2.1. Mathematical processes embedded in basketry

The findings revealed that basketry is a mathematically rich and culturally significant practice characterized by systematic reasoning, planning, estimation, and problem-solving. A thematic analysis of field observations and interviews with indigenous weavers from four Ugandan districts, Mayuge, Wakiso, Mbarara, and Gulu, identified six interrelated stages of basket production: material selection and collection, material preparation, base construction, body weaving, shaping and finishing, and decoration and assessment. Each stage reflects distinct mathematical processes embedded within culturally situated weaving practices.

The process begins with material selection and collection, where weavers choose reeds, fibers, fronds, or bamboo based on maturity, flexibility, thickness, and strength. During observations in Mayuge and Wakiso, weavers were seen comparing lengths and widths of reeds before cutting them into approximately equal sizes using hand spans and visual estimation. The weaver from Wakiso explained, '*If the reeds are not almost equal in size and strength, the basket will bend on one side. We first compare them carefully before we start weaving*'. Another weaver from Gulu noted, '*We measure using our hands and eyes because we already know the right size depending on the basket we want to make*'. These practices demonstrate intuitive estimation, classification, comparison, and measurement using non-standard but internally consistent units. Such forms of reasoning reflect foundational mathematical processes related to proportionality, estimation, and measurement emphasized in lower secondary mathematics. During the material preparation stage, the materials are stripped, soaked, split, softened, and dyed before weaving begins. Observations revealed that weavers carefully regulated soaking time and dye quantities to achieve desired texture and color consistency. The weaver from Mbarara explained, '*When you add too much dye, the color becomes too dark. If you put in little, the pattern will not come out clearly. We normally estimate carefully*'. Similarly, the weaver from Mayuge stated, '*You must know the right amount of water and dye for the number of materials you are preparing*'. These responses indicate forms of ratio, scaling, sequencing, and proportional reasoning embedded within everyday weaving practices. The preparation stage, therefore, reflects mathematical ideas directly related to fractions, ratios, and proportional relationships.

Base construction typically involves arranging spokes radially to form a circular or near-circular foundation. During observations across all four districts, weavers repeatedly counted spokes and adjusted spacing to maintain balance and symmetry before weaving outward. The weaver from Wakiso remarked, '*If the spokes are not equally spaced, the basket loses shape and balance*'. Another weaver from Mbarara explained, '*We usually begin with even numbers because it helps the weaving pattern move well around the basket*'. These practices demonstrate geometric reasoning involving counting, symmetry, angle estimation, and spatial organization. The circular arrangement and balancing of spokes correspond closely to school mathematics topics such as circles, angles, rotational symmetry, and geometric construction. The body weaving stage builds the basket upward using spiral, concentric, or alternating woven patterns. Field observations showed weavers repeatedly following rhythmic sequences while alternating colors and weaving directions to maintain consistency in the design. The weaver from Gulu explained, '*The pattern must repeat in the same order. If you miss one step, the whole design changes*'. Similarly, the weaver from Mbarara stated, '*You count carefully as you weave so that the colors and shapes remain consistent*'. These processes reflect mathematical thinking related to sequencing, repetition, transformation, and pattern recognition. Incremental increases in basket height and repeated design structures resemble arithmetic progression and transformational geometry. The findings therefore suggest that basket weaving provides authentic and culturally meaningful contexts for teaching patterns, sequences, and geometric transformations, concepts that learners often experience as abstract within formal classroom settings.

During the shaping and finishing stage, weavers adjusted strand tension, weaving angles, and spacing to widen, narrow, or stabilize the basket structure. Observations revealed continuous monitoring and modification of the basket form during weaving. The weaver from Mayuge explained, '*If you pull harder, the basket bends inward. If you loosen the strands, it widens*'. Another weaver from Gulu noted, '*You must keep checking the shape from different sides so that it remains balanced*'. These actions involve proportional adjustment, spatial visualization, angle estimation, and reasoning about shape and form. Mathematics teachers (MTs) and mathematics teacher educators (MTEs) further noted that such processes could support classroom discussions on geometric modeling, slope, angles, measurement, and spatial reasoning. Finally, during the decoration and quality assessment stage, weavers carefully examined completed baskets for symmetry, balance, stability, and alignment. Observations showed weavers rotating baskets repeatedly while visually inspecting patterns and correcting irregularities. The weaver from Mbarara explained, '*When the pattern does not align properly, you can easily see the mistake and correct it before finishing*'. Another weaver from Wakiso remarked, '*A good basket must look balanced from every side*'. This stage reflects evaluative mathematical thinking involving reflection, transformational symmetry, error detection, and spatial reasoning. The process of reviewing and correcting design irregularities further illustrates how mathematical judgment and reflective reasoning are embedded within indigenous weaving practices.

5.2.2. Alignment with the S.1–S.2 mathematics curriculum

After identifying the mathematical processes embedded in basketry, these were systematically mapped onto the S.1–S.2 mathematics curriculum (Table 1). This alignment was not only theoretical but was also reflected in participant interpretations and observed weaving practices. For example, the base construction stage, which involves arranging spokes radially, was linked by participants to geometric concepts such as circles, angles, spacing, and symmetry (Table 1). During observations in Wakiso and Mbarara, weavers were repeatedly seen adjusting the spacing between spokes before tightening the weave to maintain circular balance. The weaver from Wakiso explained, '*If the spacing is not equal, the basket will not form a proper circle*'. Another weaver from Mbarara stated, '*We keep checking whether the shape is*

Table 1. Mathematical processes in basketry and the S.1–S.2 mathematics curriculum concepts.

Basketry stage	Mathematical processes involved	Relevant curriculum concepts (S.1–S.2)
Material selection and collection	Estimation, measurement, classification, proportion	Measurement (length and perimeter), data handling
Material preparation	Ratio, proportion, sequencing, scaling	Fractions, ratios, proportional reasoning
Base construction	Geometry, symmetry, counting, angle estimation	Shapes (e.g. circles), rotational symmetry, angles
Body weaving	Patterning, transformation, scaling, sequencing	Patterns, sequences, 2D and 3D figures, transformations, progressions
Shaping and finishing	Proportion, slope, spatial reasoning, trigonometry	Angles, gradient, trigonometric ratios, area, and volume
Decoration and assessment	Reflection, balance, symmetry	Coordinate geometry, reflection, transformational symmetry

balanced on all sides before continuing'. These observations and participant explanations demonstrate how concepts related to circles, radial symmetry, and spatial organization emerge directly from the weaving process. Such features were also visible in baskets such as those shown in Figures 2(a) and 3(d), where circular structures and radial balance are clearly evident. Similarly, the body weaving stage, characterized by repeated patterns and alternating colors, aligns with sequences, transformations, and patterning (Table 1), as reflected in the basket designs shown in Figure 3(b).

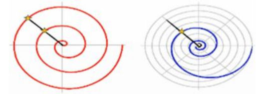
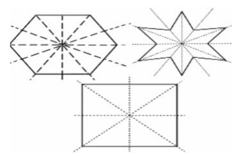
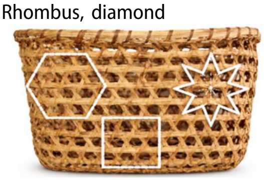
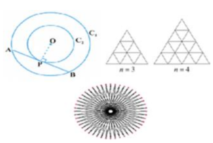
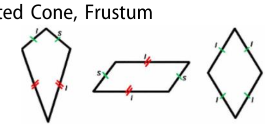
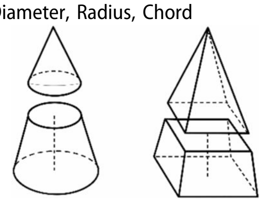
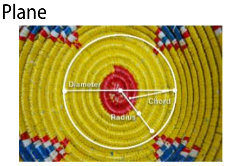
During field observations, weavers were seen counting weaving intervals and carefully repeating color arrangements to preserve consistency in the pattern structure. The weaver from Mbarara remarked, '*The colors must follow the same order throughout the basket. If you skip one step, the whole pattern changes*'. A mathematics teacher (MT) from Wakiso further noted, '*The repeated weaving patterns can help learners understand sequences because the arrangement follows a predictable order*'. These accounts illustrate how mathematical ideas related to repetition, sequencing, transformation, and pattern recognition are embedded within observable weaving practices rather than being introduced only through abstract classroom exercises.

Participants explicitly referenced several curriculum connections while interpreting basket forms and weaving processes. For instance, MTs and mathematics teacher educators (MTEs) noted that analyzing alternating-color strands supports learners' understanding of ratios, sequences, and proportional reasoning, while examining basket shapes supports reasoning about area, volume, and surface area. An MTE from the Northern region explained, '*When learners study the basket carefully, they begin noticing mathematical relationships naturally through the design*'. Another MT observed, '*The basket gives a real example where learners can physically see shapes, spacing, patterns, and measurement instead of only imagining them*'. In this way, Table 1 synthesizes both observed basketry practices and participant interpretations, demonstrating how indigenous weaving practices correspond directly to formal curriculum concepts.

The analysis of interview data, classroom-oriented discussions, and observations of basketry practices further revealed three recurring mathematical domains embedded within basket making, geometry and measurement; patterns, symmetry, and transformations; and ratio, proportion, and scale. These domains were consistently identified by MTs and MTEs when examining specific basket types and designs (Figures 2 and 3). For example, participants associated the millet basket (Figure 2(d)) with geometric reasoning and patterning, noting the presence of circular forms, repeated motifs, and structured arrangements. During observations, participants frequently traced circular outlines and pointed at repeating motifs while discussing mathematical ideas embedded in the baskets. An MTE from the Central region commented, '*The circular arrangement and repeated designs can help learners discuss geometry and patterns using familiar objects*'. Similarly, the food basket (Figure 2(b)) was linked to concepts of area, surface coverage, and volume based on its observable shape and practical capacity-related use. An MT from Gulu explained, '*Different baskets hold different amounts, so learners can estimate and compare sizes and capacities*'.

Decorative baskets (Figures 3(a) and 3(d)) were frequently referenced during discussions of symmetry and transformation, with participants highlighting visible instances of reflection, rotation, and tessellation within the design structures. An MT from Mbarara observed, '*When you rotate the basket or observe it from different sides, the same patterns keep appearing repeatedly*'. These interpretations were grounded in participants' analyses of the baskets and supported by observed features such as pattern repetition, spatial arrangement, rotational balance, and proportional scaling during weaving. Table 2 synthesizes these

Table 2. Linking basketry with school mathematics.

Basket type (with Outline)	Extracted mathematics concept(s)/figure(s)	Concept explained
	Spiral, Circle, Concentric Circles 	Patterns, Sequences, Series, and Progressions Shapes, Designs, Symmetry, Reflections, and Rotation, Radial Symmetry, Angle Geometry
	Hexagon, Square, Star, In-circle, Circumcircle, Equilateral Triangles, Radial Star 	
		Transformations, Movements, Translations, and Reflective Translation, Circular Movement/ Path
	Kite, Rhombus, diamond 	
	Truncated Cone, Frustum 	Ratios, Proportions, and Scaling
		
	Circle, Diameter, Radius, Chord 	Measurement and Geometry (Area, Perimeter, Surface Area, Volume, Angles, Trigonometry)
	Cartesian Plane 	Coordinates and Change, Slope and Gradient, Cartesian plane, lines, graphing

relationships by explicitly mapping identified basketry processes and observable design features to corresponding S.1–S.2 curriculum concepts. The findings, therefore, demonstrate that the identified mathematical ideas are not abstractly imposed onto basketry but emerge from observable structural characteristics and participant interpretations of weaving practices.

According to MTs and MTEs, the mathematical concepts outlined in Table 2 become more meaningful when learners actively engage with basketry practices, particularly through analyzing existing designs and constructing their own baskets. This interpretation was strongly reflected in participants' accounts of possible classroom application. For example, an MTE from the Western region noted that when learners examine color patterns and structural features in baskets, such as those shown in Figure 3(a), they can '*see ratios instead of just calculating them*'. Similarly, a teacher from Mbarara District explained, '*Using actual basket designs allows learners to work out ratios from what they can observe rather than relying only on numbers written on the chalkboard*'. During discussions, participants repeatedly emphasized that learners are more likely to understand proportional relationships when they interact directly with visible basket features such as spacing, strand arrangement, color alternation, and repeated designs. An MT from Mayuge explained, '*The learners can count, compare, and observe directly from the basket itself, which makes the mathematics easier to understand*'. These accounts indicate that learners' engagement with tangible basket features provides concrete and culturally familiar representations of ratio, proportion, measurement, and spatial relationships, thereby supporting the interpretation that abstract mathematical concepts can become more meaningful when grounded in observable indigenous practices.

5.3. Developing a prototype lesson plan for integrating basketry into mathematics teaching

The third objective of this study was to design a prototype lesson plan illustrating how basketry can be systematically integrated into secondary school mathematics instruction. The development of this prototype was grounded in empirical data generated through video documentation of basket-making processes, participant interviews, focus group discussions (FGDs) with mathematics teachers (MTs) and mathematics teacher educators (MTEs), and document analysis of the National Curriculum Development Centre (NCDC) S.1 and S.2 mathematics syllabi. During FGDs, participants collaboratively examined selected video clips and basket samples (Figures 2 and 3) while discussing possible classroom applications of the observed basketry processes and designs. Participants frequently paused the video demonstrations to identify mathematical ideas emerging from particular weaving stages. For example, during one session in Wakiso District, teachers observed a weaving sequence involving alternating colored strands and immediately linked it to patterning and sequences. One participant remarked, '*The learners can predict what comes next if they follow the weaving pattern carefully*'. Another teacher added, '*This can help them understand sequences because the pattern keeps repeating in a structured way*'. Similarly, when participants examined circular basket bases shown in the videos and physical basket samples, discussions centered on concepts such as circles, angles, symmetry, and measurement. An MTE from the Central region explained, '*Even before formal calculations, learners can visually identify balance, spacing, and circular arrangement from the basket itself*'.

Field observations during basket construction further informed the lesson design process. During weaving demonstrations, participants repeatedly counted strands, estimated spacing, compared dimensions, and adjusted patterns while explaining their reasoning processes. In one observed session in Mbarara District, a weaver demonstrated how tightening or loosening weaving tension changes basket shape and width. An MT observing the process commented, '*This can help learners understand measurement and proportion because they can see how changing one part affects the whole basket*'. Participants also proposed classroom activities directly inspired by observed weaving practices. For instance, MTs and MTEs suggested tasks in which learners analyze pattern repetition in basket designs, identify lines of symmetry, estimate dimensions, compare basket sizes, and construct simplified woven patterns using locally available materials. An MT from Gulu stated, '*Instead of only drawing patterns in books, learners can physically create them and explain the mathematics involved*'. Another MT from Mayuge suggested, '*Learners can count color arrangements and calculate ratios directly from the basket patterns they observe*'.

The lesson plan was therefore not developed in abstraction but was co-constructed with participants, drawing directly on their interpretations, classroom experiences, and suggestions for pedagogical application. As one teacher from Wakiso District noted, '*We can turn these patterns into step-by-step activities for learners*'. Similarly, an MTE from the Western region emphasized that, '*The basket gives teachers a practical way of introducing concepts that learners usually find difficult when taught abstractly*'. The resulting prototype organizes these participant-generated ideas into structured learning activities aligned with competence-based curriculum outcomes. These include clearly defined learning outcomes, guided exploratory activities based on basket patterns and weaving processes, collaborative learner-centered tasks, opportunities for discussion and reflection, and formative assessment activities linked to observed basket features. To maintain the analytical flow of this paper, the full prototype lesson plan for S.2 mathematics is provided in Appendix 1 (p. 24). The prototype demonstrates how participant insights and observed basketry practices can be translated into contextually meaningful classroom instruction.

The findings, therefore, suggest that culturally grounded resources such as basketry may support the development of pedagogically meaningful and contextually relevant mathematics instruction within competence-based education. At the same time, participants acknowledged that successful implementation would depend on factors such as teacher preparedness, time availability, instructional resources, and alignment with existing assessment practices. An MT from Wakiso cautioned, '*Teachers need support and preparation because not everyone is familiar with how to teach mathematics using cultural activities*'. Overall, the findings highlight the potential for integrating Indigenous Knowledge into mathematics teaching in ways that promote learner engagement, contextual understanding, and meaningful participation while remaining attentive to classroom and institutional realities.

6. Discussion

Rather than merely demonstrating the existence of mathematical ideas within indigenous basketry, the findings illuminate how culturally situated practices can mediate learners' engagement with formal mathematical concepts in epistemically meaningful ways. In particular, basket weaving reveals how mathematical reasoning emerges through embodied and socially situated activity, where processes such as pattern formation, proportional adjustment, spatial organization, and symmetry are enacted through practice rather than encountered solely as abstract representations. These findings support prior studies highlighting the educational significance of indigenous cultural artifacts in mathematics education (Ali & Davis, 2018; Thompson, 2023; Ubana et al., 2017), while extending this scholarship by illustrating how such practices can be systematically aligned with Uganda's lower secondary mathematics curriculum and translated into pedagogical design. From an ethnomathematics perspective, the study contributes to ongoing debates regarding the nature and legitimacy of mathematical knowledge. Ethnomathematics challenges the Universalist assumption that mathematics exists primarily as an abstract, culture-free, and value-neutral discipline by recognizing mathematical practices as historically and culturally situated forms of knowing (D'Ambrosio, 1985; Gerdes, 1998). The findings of this study reinforce this position by demonstrating that basket weaving is not merely decorative craftsmanship but a site of mathematical production in which reasoning, estimation, proportionality, measurement, iteration, and spatial structuring are embedded within cultural activity. In this sense, basketry functions not only as a pedagogical aid but also as an epistemic resource through which mathematical ideas are generated, negotiated, tested, and refined within community practice.

The participants' descriptions of maintaining symmetry, regulating spacing, adjusting strand tension, and preserving design consistency demonstrate how mathematical reasoning is enacted through iterative and context-responsive decision-making. This extends sociocultural perspectives on learning (Vygotsky, 1978) by showing that culturally mediated activity does not simply support the acquisition of pre-existing mathematical knowledge but also shapes the ways mathematical understanding itself is constituted and communicated. The findings, therefore, resonate with broader ethnomathematical debates concerning whose mathematics counts, how mathematical knowledge is legitimized, and the extent to which school mathematics recognizes or marginalizes culturally embedded forms of reasoning. The identification of mathematical concepts relevant to S.1–S.2 mathematics, including geometry, measurement, ratio and proportion, symmetry, and pattern recognition, further illustrates how abstract mathematical ideas can be grounded within culturally familiar contexts. Basketry may therefore be conceptualized as a living mathematical text through which mathematical structures are embedded within everyday material and social practice. This finding aligns with Gerdes's (2011) work on African cultural artifacts as repositories of mathematical thinking and reinforces arguments that culturally situated tasks can support conceptual understanding by connecting school mathematics to learners' lived experiences.

At the same time, the regional variation in basket designs and weaving techniques highlights the dynamic and pluralistic nature of indigenous mathematical practices. Rather than presenting indigenous knowledge as fixed or homogeneous, the findings reveal how mathematical ideas vary across cultural communities while maintaining underlying structural principles. This observation contributes to broader curriculum debates concerning contextualization, cultural relevance, and the tension between standardized curricula and localized knowledge systems. In many education systems, including Uganda's, curriculum structures have historically privileged centralized and universalized forms of knowledge, often limiting opportunities for local epistemologies to meaningfully shape classroom practice. The present study, therefore, contributes to curriculum scholarship by illustrating how indigenous cultural practices can function not merely as supplementary examples but as legitimate curricular resources capable of supporting competence development and conceptual learning. From a curriculum studies perspective, the findings speak directly to the aspirations of Uganda's Competency-Based Curriculum (CBC), which advocates learner-centered, contextualized, and application-oriented learning (MoES, 2019). However, while policy documents frequently emphasize contextualization and relevance, teachers often face challenges translating these principles into concrete classroom practice (Masunungure & Maguvhe, 2025). The prototype lesson plan developed in this study responds to this implementation gap by providing an illustrative model for operationalizing culturally responsive mathematics instruction. In doing so, the study contributes to ongoing discussions regarding curriculum enactment, demonstrating how policy aspirations surrounding competence-based and learner-centered education can be mediated through culturally grounded pedagogical practices. This aligns with research emphasizing the role of culturally meaningful tasks in promoting cognitive engagement, learner participation, and affective connection to mathematics (Bishop, 1988; Fredua-Kwarteng & Ahia, 2015; Powell & Frankenstein, 1997; Vithal & Skovsmose, 1997).

Nevertheless, the integration of basketry into mathematics instruction must be understood within broader institutional and systemic realities. Teachers frequently work within examination-oriented systems that privilege procedural fluency, standardization, and curriculum coverage (Batiibwe, 2025). Although the CBC formally promotes learner-centered pedagogies, its implementation has remained uneven due to challenges related to teacher preparedness, instructional resources, large class sizes, and assessment pressures (Manyiraho et al., 2020). Consequently, the incorporation of culturally responsive pedagogies cannot be viewed simply as an individual pedagogical choice but must be situated within wider debates concerning curriculum policy, institutional structures, teacher agency, and educational reform. Without systemic alignment between curriculum intentions, assessment frameworks, teacher preparation, and classroom realities, culturally grounded approaches risk remaining rhetorically endorsed but practically marginalized. The study also contributes to decolonial perspectives in mathematics education by foregrounding indigenous knowledge systems as legitimate and intellectually valuable sources of mathematical understanding. In many postcolonial educational contexts, school mathematics continues to privilege Eurocentric epistemologies while positioning indigenous knowledge as informal, peripheral, or non-academic (Gula & Jojo, 2024). By positioning Ugandan basketry as a valid mathematical and pedagogical resource, this study challenges hierarchical distinctions between formal and informal mathematics and contributes to broader efforts to decolonize curriculum and knowledge production. In this regard, the study aligns with decolonial scholarship advocating for epistemic plurality and the recognition of historically marginalized ways of knowing within formal education systems (Akbar, 2024).

However, the findings also support caution raised within decolonial and ethnomathematics scholarship regarding the potential superficial appropriation of indigenous practices. As Madusise et al. (2022) argues, the integration of indigenous knowledge into formal schooling must move beyond tokenistic inclusion and preserve the integrity, meanings, and sociocultural significance of such practices. There is, therefore, a need to avoid reducing basketry to a mere instructional technique detached from its cultural, historical, and communal contexts. Meaningful integration requires careful engagement with communities, sensitivity to cultural meanings, and recognition of indigenous knowledge holders as legitimate contributors to curriculum and pedagogy. This notwithstanding, the implications of these findings should be interpreted cautiously. The study is based primarily on practitioner perspectives, cultural analysis, and prototype lesson development rather than direct classroom intervention or systematic measurement of learner outcomes. Consequently, claims regarding instructional effectiveness remain exploratory and indicative rather than conclusive. While engagement with basketry suggests potential to support cognitive, affective, and collaborative dimensions of learning (Kaahwa, 2021), further classroom-based and longitudinal studies are necessary to examine how such approaches influence learners' mathematical understanding, participation, and achievement over time. Additionally, previously identified challenges related to teacher preparedness, assessment systems, and resource availability (Ali & Davis, 2018; Wachira & Mburu, 2019) further underscore the importance of sustained professional development and institutional support (Manyiraho et al., 2020). Overall, the findings suggest that integrating indigenous basketry into mathematics instruction offers a promising yet context-dependent pathway for making mathematics more meaningful, culturally responsive, and epistemically inclusive. By linking abstract mathematical ideas to learners' lived experiences and cultural environments, such approaches may contribute not only to improved learner engagement but also to broader educational efforts aimed at curriculum contextualization, epistemic inclusion, and the decolonization of mathematics education.

7. Conclusion

This study explored the potential of indigenous basketry as a culturally responsive approach to the teaching and learning of mathematics in S.1–S.2 classrooms in Uganda. The findings suggest that basketry may provide meaningful cultural contexts through which selected mathematical concepts, including geometry, measurement, ratio and proportion, symmetry, and patterns, can be explored and interpreted. Participants' experiences and the analysis of basket artifacts indicated that indigenous basket-weaving practices contain mathematical ideas that could potentially support learners' conceptual engagement by connecting school mathematics to familiar cultural experiences. The study further demonstrated possible ways through which basketry-informed activities may be incorporated into mathematics instruction, as illustrated in the prototype lesson developed from the findings. Rather than serving as a prescriptive instructional model, the lesson prototype should be understood as an exploratory pedagogical illustration intended to stimulate further reflection, adaptation, and experimentation within specific classroom contexts. The findings therefore point to the potential value of culturally grounded pedagogies in competence-based mathematics education, particularly in promoting learner participation, contextual relevance, and conceptual meaning-making. At the same time, the study does not claim that the integration of basketry into mathematics teaching automatically improves learner achievement or instructional effectiveness. The extent to which such approaches may influence learners' understanding, engagement, or performance depends on multiple contextual factors, including teacher preparedness, pedagogical competence, curriculum alignment, availability of instructional resources, classroom conditions, and broader institutional support. Consequently, the findings should be interpreted cautiously and within the specific socio-cultural and educational contexts in which the study was conducted.

This study also has several limitations that shape the interpretation and transferability of the findings. First, the small purposively selected sample of sixteen participants across four Ugandan regions limits the extent to which the findings can be generalized beyond the studied contexts. The findings are therefore better understood as contextually situated insights rather than representative national conclusions. Second, while the study developed a prototype lesson informed by the findings, there was limited classroom implementation and no systematic measurement of learner outcomes. As such, claims regarding instructional effectiveness remain exploratory and require further empirical investigation through classroom-based intervention studies and longitudinal research. Third, because the study focused on specific cultural communities and indigenous practices, transferability to other cultural or educational settings requires careful contextual consideration rather than direct replication. Despite these limitations, the study contributes to ongoing discussions on ethnomathematics, culturally responsive pedagogy, and indigenous knowledge integration within mathematics education. It provides an exploratory foundation for future research examining how culturally embedded practices may be thoughtfully incorporated into mathematics teaching, teacher education, curriculum development, and competence-based learning frameworks in Uganda and similar contexts.

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Ethical approval

Ethical clearance for this research was obtained from the Makerere University School of Public Health Research Ethics Committee (MakSPH REC) on June 22, 2023, under approval number SPH-2022-333.

Author contributions

CRediT: **Marjorie Sarah Kabuye Batiibwe**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft; **Johan Lie**: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – review & editing.

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Data availability statement

The data generated in this study is available on reasonable request from the corresponding author.

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Appendix A

Table A1. Prototype lesson plan.

S.2 Mathematics Lesson: Exploring Mathematics in Basketry
Class: S. 2
Duration: 80 minutes
Subject: Mathematics
Topic: Mathematics in Basketry
Sub-topic: Patterns, Symmetry, Fractions, Sequences, Measurement
Teacher: ….
Date: …

A. Learning Outcomes

By the end of this lesson, learners should be able to:

1. Identify geometric shapes, patterns, and symmetry in basket designs.
2. Apply fractions and proportions to basket sections.
3. Measure dimensions (height, diameter, and circumference) of baskets.
4. Analyze and continue weaving sequences.
5. Solve practical problems using baskets as a mathematical context.

B. Key Competencies

1. Critical Thinking and Analysis: Learners will analyze basket designs to identify patterns, sequences, and structural relationships, making informed judgments about the application of mathematical ideas in the weaving process.
2. Mathematical Reasoning and Problem-Solving: Learners will identify and explain the mathematical concepts present in basketry, recognize and describe repeating patterns and sequences, and apply logical, step-by-step reasoning to explain how basket designs are constructed.
3. Pattern Recognition and Sequencing: Learners will identify and extend repeating patterns, complete incomplete patterns, and recognize simple arithmetic sequences, such as rows of weaving that increase by a constant value.
4. Spatial Awareness and Geometric Thinking: Learners will identify two-dimensional shapes and three-dimensional forms in baskets, recognize lines and types of symmetry (including reflectional and rotational symmetry), and explain how symmetry contributes to balance and stability in basket structures.
5. Fractions and Proportional Reasoning: Learners will interpret sections of baskets as fractional parts (e.g. $^1/_2$, $^1/_3$, $^1/_4$ of a circular base), divide circles into equal sectors similar to the spokes of a basket, and compare the proportions of colored and uncolored segments in basket patterns.
6. Measurement and Estimation: Learners will measure and estimate the dimensions of baskets, including diameter, circumference, and height, estimate the lengths of weaving materials, and apply concepts of scale (e.g. predicting how dimensions change when the size of the basket is doubled).
7. Practical Application of Mathematics: Learners will apply their mathematical knowledge to real objects by measuring, calculating, and predicting outcomes using baskets and weaving materials as concrete representations.
8. Creativity and Innovation: Learners will design original basket-inspired patterns using geometric shapes, colors, sequences, and symmetry; adapt existing designs; and explore mathematical representations inspired by the baskets in the different regions.
9. Communication and Collaboration: Learners will work collaboratively to observe, analyze, and document basket patterns; use appropriate mathematical language to explain their reasoning; and present their group findings clearly through oral, written, and visual means.
10. Cultural Appreciation and Application: Learners will recognize basketry as an expression of Ugandan Indigenous Knowledge, appreciate the role of traditional crafts in mathematical thinking, and connect classroom mathematics to real-life cultural practices and livelihoods.

C. Teaching and Learning Materials

1. Assorted Real Baskets (varied sizes and patterns, as shown in Figures 1 and 2): These will be used for direct exploration of symmetry, patterns, measurements, fractions, and sequences present in the selected basket structures for the lesson.
2. High-Quality Images or Poster Prints of Baskets: These resources will support groups that lack access to physical baskets. They will enable close observation of intricate designs and help highlight hidden sequences, fractional divisions, and symmetry.
3. Paper Strips, Raffia, or Banana-Fiber Strings: These materials will be used to simulate weaving processes, construct simple repeating patterns and sequences, and explore how fractions and proportions emerge when circular forms are divided.
4. Shape Cut-Outs or Pattern Blocks: These are two-dimensional shapes (e.g. circles, triangles, squares, hexagons, and diamonds) that will model tessellation-like arrangements found in the selected basket designs.
5. Manila Paper or Flip Charts with Markers: These will facilitate group presentations, allow for the drawing of patterns and lines of symmetry, help in constructing fractional sectors, and provide a means to record measurements and sequences.
6. Geometric Instruments (Compasses, Rulers, and Protractors): These tools will enable learners to construct symmetrical circular designs, draw fractional partitions (e.g. $^1/_2$, $^1/_4$, $^1/_8$), and measure diameters, radii, and angles in the selected baskets.
7. Rulers and Measuring Tapes: These will be used for accurate measurements of basket dimensions, the width of weaving rows, and the lengths of strands.
8. Chalk/ whiteboard, Chalk/ whiteboard marker, and Graph Paper: These will support whole-class demonstrations, plotting of patterns and sequences, and the recording of numerical relationships.
9. Fraction Circles or Circular Cut-Outs: These will be used to model basket bases, divide circles into equal parts, and visualize proportions in pattern coloring and design.
10. Worksheets: These include structured tasks like completing symmetrical designs, extending patterns, dividing circles into equal parts, measuring and recording weaving dimensions, and extending numerical sequences.
11. Flashcards (Geometric Shapes, Fractions, and Sequences): These will assist with quick identification, reinforce key concepts, and provide opportunities for formative assessment activities.
12. Optional Digital Tools: Where available, projectors or smartphones will be used to display short videos on basket weaving, zoomed-in images of patterns, and simple applications for exploring symmetry and pattern creation.

D. Lesson Development

(*continued*)

Time	Activity	Teacher Role	Learners Activity	Mathematics Focus
0–10	Introduction and Motivation	Display baskets, ask observation questions	Observe baskets, discuss patterns, shapes, and colors	Pattern recognition, observation
10–20	Identifying Patterns	Guide identification of repeating sequences and motifs	Examine baskets in groups; describe patterns	Counting repetitions, sequences
20–30	Finding Geometric Shapes	Highlight and demonstrate shapes in basket designs	Sketch shapes from baskets; label shapes	Geometry, spatial visualization
30–40	Demonstrating Symmetry	Demonstrate reflective and rotational symmetry	Identify lines of symmetry; check rotational symmetry	Symmetry
40–50	Measuring and Recording	Show measuring techniques (height, diameter, circumference)	Measure baskets; record data	Measurement, units, circumference
50–60	Exploring Fractions and Proportions	Explain how basket sections relate to the whole; model fractions	Calculate fractions of colored sections	Fractions, ratios, proportions
60–70	Identifying Sequences and Mathematical Processes	Show strand counting and pattern prediction	Count strands, continue sequences, predict next elements	Sequences, arithmetic operations
70–80	Reflection and Application	Lead discussion; review worksheets	Share observations; complete exercises	Critical thinking, application

Sample Worksheet for S.2: Mathematics in Basketry
Name: … … … … … … … … … … … … … Date: … … … … … … … … … …
A: Observing Patterns
1. Identify the repeating patterns (if any) in the baskets in Figure 2:
Pattern 1: … … … … … … … Pattern 2: … … … … … … … Pattern 3: … … … … … … … … …
2. Count how many times each pattern repeats:
Pattern 1: … … … … … … … Pattern 2: … … … … … … … Pattern 3: … … … … … … … … …
B: Geometric Shapes
1. List geometric shapes visible in the basket in Figure 2(a): … … … … … … … … … … … ….
2. Sketch a basket section of Figure 2(c) and label the shapes: … … … … … … … … … … …
C: Symmetry
1. Draw the line of symmetry for the basket in Figure 2(a) (if any).
2. State its order of rotational symmetry (if applicable): … … … … … … … … … … … … … ….
D: Fractions and Proportions
1. The basket in Figure 2(b) has 2 colored sections (red and green). Write the fractions:
Red: … … … … … … … … … … … … … … … … Green: … … … … … … … … … … … … …
… … ….
2. If 2/8 of the basket is green, which fraction is not green: … … … … … … … … … … … … ….
E: Sequences
1. If the pattern in the basket in Figure 2(b) alternates 3 red strands and 2 green strands:
a) What is the total number of strands in 4 repetitions? … … … … … … … … … … … … … … …
b) What is the color of the 10th strand? …
2. The repeating sequence in the basket in Figure 2(a) is: brown, cream, purple:
a) What is the 15th color? … … … … b) What is the total of cream in 24 colors? … … … …
F: Measurement
1. Measure the height and diameter of the basket in Figure 1(b):
Height: … … … … … … … … … … ….cm Diameter: … … … … … … … … … … … … … … … … … cm
2. What is its circumference? … … … … … … … … … … … … … … … cm ($C = \pi \times d$, $\pi \approx 3.14$)
3. If the basket is colored and the colored section covers 1/5 of the circumference, what is the length of the colored section?
… cm
G: Reflection
1. What was the easiest concept? ….
2. What was the hardest concept? ….
3. What real-life applications did you learn? … … … … … … … … … … … … … … … … … …
Project-Based Assignment
1. Create a small basket or design on paper showing: two repeating patterns, two geometric shapes, and symmetry.
2. Measure its approximate dimensions and calculate the fractions of its quarter, half, an eighth, and a sixteenth sections.
3. Present to the class, explaining the mathematics in your basket.
Problem-Based Activity (To be done outside the class)
1. Visit a local market or home where baskets are sold.
2. Record: the types of patterns, number of colors, and shapes visible in three baskets, along with their approximate sizes.
Answer the following:
1) Identify at least three patterns in these baskets and their repetitions.
2) Calculate the fractions of the specific colored sections in each basket.
3) Sketch each basket and label its shapes and symmetry lines.
4) Calculate the area, volume, and circumference of each basket relative to the other.