Article

Journal of Interdisciplinary Studies in Education

Volume 13, Issue 2 (2024), pp. 81-100
Journal of Interdisciplinary Studies in Education
ISSN: 2166-2681Print 2690-0408 Online | https://ojed.org/jise

Integrating Akan Traditional Art to Enhance Conceptual Understanding in Mathematics: Perspectives of Educators and Artisans

Seth Amoako Atta, Ebenezer Bonyah, Francis Ohene Boateng
Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Ghana

ABSTRACT

The study examined how local artisans and mathematics teachers think the Akan traditional art might help senior high school students learn geometry. The Akan people live in Ashanti Region of Ghana. The study targeted experienced mathematics teachers and Akan traditional art experts. Seven experienced mathematics teachers and three craftsmen were chosen using purposive sampling. We conducted interviews with participants using a semi-structured guide to collect detailed data. The data was thematically analysed. The analysis revealed four themes; demonstrating how teachers use students' experiences to build new knowledge and help them apply it to new situations. We conclude that geometry is linked to the Akan culture and encourage instructors to adjust school geometry accordingly and also encourage ethnomathematics research.

Keywords: Akan traditional Art. Conceptual understanding. Culturally Relevant Pedagogy. Craftsmanship

INTRODUCTION

In mathematics, conceptual understanding is a comprehensive and in-depth understanding of connected concepts. It means being aware of the links between different ideas and processes as well as the basic ideas of mathematics. The five strands of mathematical competency include procedural fluency, strategic

competence, adaptive thinking, and productive disposition. Conceptual understanding is one of these threads (Nahdi & Jatisunda, 2020). Students are better able to make sense of mathematics and apply their knowledge to new tasks when they have a conceptual understanding of the topic. It emphasises the connections between different facts and approaches, going beyond the simple memorising of procedures and discrete facts. Students that grasp concepts well are better able to tackle real life problems in mathematics (Ayoub Mahmoudi et al., 2014).

There are various approaches to teaching mathematical conceptual knowledge however, giving students a variety of visual aids to depict and model mathematical ideas aids in their problem-solving (Gervasoni et al., 2021). By employing an assortment of both routine and nonroutine questions, students can apply mathematics in a flexible manner to many scenarios (Dempster, 2022; Tossavainen & Helenius, 2024). These programmes include exercises and teachings that encourage a thorough comprehension of mathematical concepts. To encourage discussion and assist students in comparing their ideas with those of others, teachers can also employ various tools and techniques (Atta & Bonyah, 2023a). The advantages of teaching conceptual comprehension outweigh the difficulties. Students who comprehend mathematics conceptually possess the ability to tackle complicated problems and apply their knowledge to real-life circumstances. They comprehend the material more thoroughly and are better equipped to apply the concept in solving real life problems innovatively. Students are able to consider and assess why a process is effective when they participate in class discussions regarding procedural skills. Mathematics education pedagogies like ethnomathematics offers illustrations of mathematical concepts in students cultural background (Meaney et al., 2021; Tekin-Sitrava et al., 2023)

Ethnomathematics pedagogy is the study of the relationship between mathematics and culture (Albanese, 2021)**.** It is also defined as a kind of mathematics practiced among specific cultural groups. Ethnomathematics aims to foster both the understanding of culture and the understanding of mathematics in a way that can lead to an appreciation of the two (Meaney et al., 2021). D'Ambrosio (1985) developed the term ethnomathematics to characterize the mathematical activities of recognised cultural groups and the study of mathematical ideas in any culture. When ethnomathematics first appeared as a field of study, it was a reaction to historical evidence of a conscious devaluing of the mathematics produced and advanced by non-European civilizations (Chahine, 2013). That was the era when people thought that the only path to understanding mathematics was to come from Western civilization. The field of ethnomathematics was founded to refute the view that Western mathematics was superior to the contributions made by other cultures to the development of mathematics. Researchers that believe in ethnomathematics and mathematics education believe that it is essential to recognize the cultural context of mathematics for students through teaching

culturally relevant mathematics (Rosa, 2020; Rosa et al., 2016). In order for mathematics education to influence the political and social dynamics of culture, mathematics instruction must be founded on cultural relevance and personal experiences that help students get a deeper understanding of reality, culture, society, and themselves (Atta & Bonyah, 2023a).

Throughout history, the mathematics education curriculum has been designed, developed and delivered within Eurocentric philosophy (Scott, 2018). The mathematical constructs, concepts and ideas are western dominated in culture. Ethnomathematics has been around for a while, yet many studies have not been done in Ghana on how to incorporate it into the Ghanaian mathematics curriculum to facilitate the learning process. Meanwhile studies have proven that culture relevant mathematics education has the tendency to boast student mathematics interest which has been identified as a major catalyst for student mathematics achievement (Atta & Bonyah, 2023a).

A couple of other researchers have demonstrated interest in exploring curiosity in cultural role in the teaching and learning of mathematics (Carr et al., 2023; Owusu-Darko et al., 2022, 2023; Turugari, 2022). It is worth noting that much attention has not been fixed on diving deeper into individual topics like Geometry which is practically demonstrated in all facet of the daily life activities of an Akan. Even though there are a lot of real-life application of geometry in the Akan traditional way of life, studies have not been conducted to find out how a linkage could be created to enhance smooth classroom instruction that fosters conceptual understanding. Since, Ethnomathematics in is not mentioned in the formal curriculum, teachers continue to teach geometry as an abstract concept. This has made the topic look very difficult for many Senior high school students. The WASSCE Chief Examiners' report for mathematics attest to this fact.

Ethnomathematics according to studies (Kyeremeh et al., 2023; Owusu-Darko et al., 2023) enhances students' methods for learning and fosters the growth of social and personal skills, increases students' self-esteem and their capacity to collaborate with others while studying. A study conducted by Kyeremeh et al., (2023) indicated that the countries that have taken up ethnomathematics are Indonesia, Israel, Zimbabwe and Nigeria. Ghana and Nigeria both write WASSCE and its worth noting that Nigeria has been out perfuming Ghana. Hence there was the need to find out the perception of how the Akan traditional Art can contribute the conceptual understanding of geometry at the senior High Schools. The objective of the study was therefore to answer the following questions;

1. How does the Akan traditional Art utilize mathematical concepts?
2. How do mathematics educators perceive the contribution of the Akan traditional Art to conceptual understanding in geometry?

LITERATURE REVIEW

Theoretical Review

The theory underpins this study is the constructivist theory. Information processing theorists follow Piaget-Vygotsky constructivism, which teaches ideas through interaction and prior learning. Constructivism emphasizes problem-solving, cooperation, research, and creativity (Altaftazani et al., 2020). Constructivism is an extension of cognitivism, acknowledging the role of prior knowledge in learning and the fact that individuals interpret what they experience within the framework of what they already know (Atta & Brantuo, 2021). It is believed that knowledge is constructed by the individual learner, and learning is unique to the individual learner. Two popular constructivism are radical constructivism, which believes learning should be created, and social constructivism, which researches worldview shaping by social interactions (Luong, 2022).

Radical constructivism promotes group learning through individual cognition and active learning, while social constructivism focuses on identity, family, community, and culture shaping perception and behaviour. Zone of Proximal Development (ZPD), is the difference between a child's development level determined by independent problem-solving and their potential development determined through problem-solving under adult guidance or collaboration with a capable peer. Social constructivist problem-solving promotes teamwork, which improves effort, relationships, and mental health more than competitive or individualistic learning. Collaborative learning helps small groups achieve goals and maximize potential, and peer aid helps students internalize external knowledge and critical thinking for intellectual functioning (Altaftazani et al., 2020).

The aim of education is to foster democratic values through self-governance, collective decision-making, and social justice. Teachers should allow students to interact with teaching materials and the environment in dialogue, linking prior experiences with new knowledge, skills, and attitudes. Constructivist teachers act as guides or coaches, facilitating learning by developing supportive activities and environments. They should design and present lessons to promote active construction of knowledge, modify teaching tasks and strategies, and assess learning achievements. Teachers should provide scaffolding, develop meta-cognitive skills, and guide learners in assimilation, accommodation, adaptation, and reflection on conflicting ideas. A paradigm shift is needed, with the teacher's role shifting from knowledge provider to learning facilitator, and the student's role shifting from information collector to active practitioner (Agyei Brantuo et al., 2023)

Empirical Review

Ethnomathematical approaches aim to make mathematics relevant and meaningful for students and improve education. There is the need to developed a mathematics curriculum based on students' understanding, allowing teachers more freedom and creativity in choosing class subjects. Teachers can develop the mathematics curriculum through conversation with students. Teachers might involve students in an ethnomathematical investigation of the dominant culture and their own. Studies have advocated for, customs, and mathematical practises of a particular social group to be incorporated into the curriculum. However, (Naresh, 2015) found that teachers' lack of training and ethnomathematical knowledge gaps cause them to be unconfident while using these techniques in the classroom. Madusise, (2015) argues that adequate and sufficient mathematical/geometrical content knowledge is necessary for the successful integration of ethnomathematics approaches; insufficient knowledge limits the flexible and intricate use of school mathematics to read and comprehend cultural activities.

Massarwe et al., (2012) conducted a study in Israel as part of the continuing project called "Joymetry: Learning Geometry and Culture through Joyful Activity of Analysis and Construction of Ornaments." The objective of the project was to raise mathematics teachers and students' understanding of how geometry and culture interact as a means of promoting intercultural and geometry education. Teachers and students in secondary schools were engaged in ethnomathematical activities rooted in both their own and other cultures in order to achieve this goal. A brand-new course called "Issues in Ethnomathematics: Teaching Geometry in Socio-Cultural Context." was introduced. The culmination of the Programme was a workshop in which each student teaches students of diverse cultures from Arab and Jewish schools on the creation and study of decorations from other cultures. The study found that that the course helped the students greatly increase their skills for teaching comprehension of geometry and as subject matter. The course also helped the students understand the relevance of different ethnomathematical learning activities that had connections to both their own and other cultures. From the outset, an increasing number of people are realizing that mathematics education reform must be focused on providing solutions to the demands of contemporary cultural and economic advancements as well as reality.

RESEARCH METHOD

The study employed a qualitative case study to obtain in-depth information on the perception of mathematics educators and artisans how the Akan traditional Art contribute to student mathematical understanding of concepts. Case study design is a popular methodological technique for a number of reasons. A case study

is a reliable resource that facilitates the comprehension and investigation of complex phenomena when a thorough and comprehensive investigation is required (Merriam, 1998). Furthermore, Yin (2009) pointed out that a case study is a qualitative approach that tackles the how and why questions in situations where the researcher lacks control over the variables. Creswell (2011) established the study's boundaries by observing the abilities of a single prospective teacher. Its goal was to describe a phenomenon that fell within this limit. Of the various types of case studies, the instrumental case study is the one under consideration

Participants

The study was conducted in the Ashanti Region of Ghana, which is the third-largest region in the country. It is located in the southern part of Ghana and covers 10.2% of the country's land area. The region has a population of 4,780,380 people, making it the most populous region in Ghana. The Ashanti Region is known for its production of gold bars and cocoa. The capital city of the region is Kumasi. The region is bordered by six other regions in Ghana and is divided into 27 districts. The Akan culture is the indigenous culture for the people of the Ahanti region of Ghana. The target population is the aggregate of cases about which the researcher would like to make generalizations, and it is the unit from which a sample is required and actually studied (Kothari, 2017).

The respondents were purposefully selected based on their knowledge, experience and their contributions to the development of mathematics education in Ghana. There was the need for individual who possess the wherewithal to contribute immensely to the study (Creswell & Creswell, 2018). A qualitative study requires small sample sizes that have been selectively or purposefully determined. There were seven public school mathematics educators and three local Artisans. The three Artisans are all well experienced and knowledgeable in their field. Apart from Afa K who has five years' work experience, the rest have twenty years work experience each. On the mathematics educators, the number of work experience ranges from ten years to 30 years. REV, WAB, and Bonsu have PhD in mathematics education while, the rest have Master's Degree Mathematics Education each.

Data collection method

Data collection was conducted through interviews to elicit responses from participants. A semi-structured interview guide was used to explore how Akan cultural practices can be incorporated into mathematics instruction, particularly in the teaching of geometry. This method ensures that all participants provide information on the same topics while exploring the issues in depth. Each participant was interviewed for a minimum of 45 minutes.

Methodological Rigor

The importance of rigor in qualitative research cannot be overemphasized because of its greater worth and trustworthiness in ensuring that the responses and experiences of participants are accurately reported. It also ensures that the conclusions of researchers are the correct representation of participants' responses in a qualitative study (Creswell & Creswell, 2018). Even though there are several measures of ensuring trustworthiness in qualitative research, studies have proven that credibility, transferability, dependability, and confirmability are the main strategies to ensure rigor in qualitative studies (Sjoberg et al., 2020), hence the adopted for use.

The credibility of interpretative research is established when its findings are acknowledged and accepted (Gani et al., 2020). Interpretive research can be enhanced by the researcher's thorough fieldwork, the use of multiple data sources or collection methods to validate findings, and careful management and analysis of data. In order to ensure credibility, the interview data was transcribed word for word, maintained accurate records of contacts and interviews, and keeping detailed notes on theoretical and methodological choices for easy review. Throughout the study due diligence was followed to ensure credibility of the study. Construction of the instrument was done in consultation with experts and with approval from the Research Ethics Committee of the Graduate school AAMUSTED. The analysis was done thematically using approved process.

Readers may assess the transferability of the findings on their own due to the detailed descriptions of the study environment ("thick description") and the structures, assumptions, and procedures of the data(Creswell & Creswell, 2018) . To enable the transferability of the findings to other locations, this study included detailed explanations of the contextual aspects pertaining to the research site, procedures, analysis, and participant backgrounds (Creswell & Creswell, 2018). Because of this, readers and other researchers may be able to apply the findings of the study to other situations if they share characteristics with the current study.

To achieve dependability, the researchers took time to explain the process of data collection so that other independent researchers can replicate the study at different jurisdictions. If two researchers independently follow similar process with the same evidence and arrive at identical findings or observations on separate occasions, then their interpretation of the data is deemed trustworthy. Inter-rater reliability pertains to the level of agreement among several researchers, whereas test-retest reliability focuses on the agreement between two observations made by a single researcher

In order to allow the reader to evaluate the rationale behind the judgements made, this study included reasons for methodological, theoretical, and analytical decisions made throughout. Interpretive research lacks objective reality, hence the concept of "inter-subjectivity" is used to determine if study participants agree with

the researcher's results. Upon completion of reading a paper or report, study participants are deemed confirmed if they agree with the researcher's conclusions. Interview data was sent to participants to verify after the data was transcribed. This was to ensure that the information provided by each participant was intact; not summarized, paraphrased nor tempered with.

Data Analysis

The key to qualitative analysis is thematic content analysis. Thematic content analysis is a qualitative analysis method used to identify, analyze, and report patterns in collected data. Thematic analysis helps in the organization and detailed description of data as well as the interpretation of gathered data (Kiger & Varpio, 2020). Data analysis was done alongside data collection using thematic content analysis. The collected data was analyzed using a modified version of Braun and Clarke method of data analysis. According to Braun and Clarke (2006) as cited in (Byrne, 2022), thematic content analysis comprises six stages: "familiarisation with the data, generation of initial codes, searching for themes, reviewing of themes, definition and naming of themes, and production of a report as demonstrated in table 1.

Table 1: Thematic Analysis

S/N	Phase	Description of the process
1.	Familiarizing yourself with your data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2	Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3	Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4	Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic ‘map’ of the analysis.
	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.

6	Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

Source (Braun & Clarke, 2006)

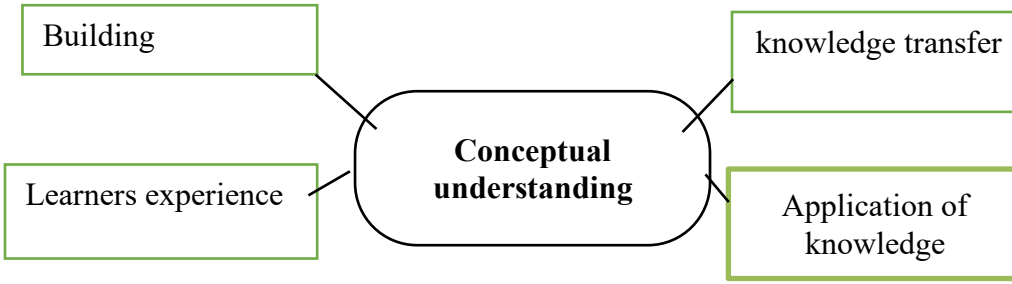
The responses that were elicited in the English language and were first transcribed verbatim. Those that were received in the local "Twi" language were translated and transcribed verbatim into English by the researcher with the help of a translator to avoid distorting the data. The transcripts of the interviews were then read and re-read. The team of researchers went through the thematic analysis process and came out with five themes that informed the research report and provided accurate answers to the research questions (Thompson, 2022)

RESULTS

The analysis was targeted at finding answers the research questions;

1. How does the Akan traditional Art utilize mathematical concepts?
2. How do mathematics educators perceive the contribution of the Akan traditional Art to conceptual understanding in geometry?

Figure 1: identification of themes



The interview data revealed four main themes as the process involved in Conceptual; learners; experience, build new knowledge, transfer new knowledge and apply new knowledge. The participants were of the view that if students get the concept of geometry very well, they can latter apply it in real life in diverse ways since geometry itself has so many real-life applications. Geometry they

observed has been there since creation and these learners have been involved in activities that make use of geometric shapes.

Touching on learners' experience, it came up that there was the need to tap in tap into the experiences of students to as the school geometry is being introduced. For instance, in response to the question, Is there any relationship between Akan traditional and geometry? The mathematics Educators indicated in affirmative and all of them were of the view that since the Akan traditional art has a lot of geometric shapes like; lines, angles rectangles squares spheres among others

> *There is a particular game common to the Akan children in which they use Turkey berries known among them as "Kwahu Nsusaa." One will kick a berry and where it reaches, he/she will use his/her fingers as a measuring tool to measure the distance it reached. This game teaches them how to find the distance between shapes arbitrary which is also taught in schools under geometry using standard unit and measuring tools* ***(Boat, Mathematics Educator)****.*

> *Even certain games that are played in the Akan settings, depicts certain shapes. For instance, in the "Ampe game", there are different sides, so when you are able to identify the characteristics among the two sides, you are able to differentiate them (****WAB Maths Educator)***

> *"I will talk about circles, looking at the pot, when you look at the pot, the tip of the pot is circular, when you look at the earthen ware is circular, when you look at the even some of the symbols, the Akan symbols most of them have circular shapes so circles are the major shapes used"* ***(Rev, Mathematics Educator)****.*

> *The shapes they use mostly are either straight lines or circles, sometime they can inscribe circle with a triangle, with "adinkra" symbols such as the adinkrahene, the Akyikyidee akyi, the gye nyame are geometric symbols, so you can confidently say they use geometry a lot but unconsciously* ***(Ruf, Mathematics Educator)***

> *There are several applications of geometry in the Akan tradition, the houses they build, the dresses they wear, their cooking wares, their means of measurement, the symbols they use to communicate*

*and the games they play are in relation to the geometry being taught in schools (**Bonsu maths teacher).***

*... when you go to their local setting, this art they do, you see geometry being displayed in so many forms. For instance, when they are doing this earthenware bowl (apotoyowa), they are supposed to get focal point which we can say the center upon which they will mould the clay around it so that it becomes a three-dimensional shape. They take into consideration the distance from the centre to the outer layer (circumference) to determine the size **(Konadu maths teacher).***

*In the case of the Kente weaving, you have to start at a certain angle before you weave the required shape; whether triangular shape or parallelogram. So, they apply the kind of geometry we teach in the class even though they may not be aware, but it makes a lot of impact **(Pablo, Mathematics Educator).***

The artisans in response to the questions, revealed that there are artisans on their part believed that there were so many calculations and local reasoning in their art that are so basic and easy to learn

*There are of different shapes such as circles, rectangle, square, but it can be square but portions will be cut off based on the particular design they want to get, but the dimensions will show that it's a square and like "Adinkrahene", it is round that is a circle **(Doctor, Adinkra works)***

*In order to make certain shapes and symbols among the Akan, such as "Adinkrahene", "Gyenyame", the Moon (bosome) and star (Nsoroma), circles, spheres, rectangles and squares are drawn arbitrary before these shapes and symbols are cut out. This indicates that there is a relationship between Akan culture and geometry **(Doctor, Adinkra works)***

*we have pre-defined measure known as **Kyereye**; that is what we use to set up the weaving. It comes in sides depending on the number of holes in it 100, 120, 130 or 140. You choose the type of **Kyereye** base on the how wide you want that particular cloth to be depending on who is who can use it, since humans have different sizes. The size of the kyereye gives one strip and 15 stripes make one full cloth for males. All that we done are from*

indigenous knowledge. All the tools are locally made and we do it through logical reasoning and critical thing ***(Vice Kente weaver)***

Since the Akan art is embedded in the Akan culture, Students come to class with the knowledge and experiences that are relevant to geometry lesson. Participants shared that if teacher try to build their lessons using student previous experiences, it will foster smooth acquisition of concepts since they see the lesson as an integral or very useful to their lives. New knowledge is absorbed better when linked to a previous experience

… students understand, appreciate the lesson and apply in daily life, if the lesson is linked to their local environment. The culture, the things the students see around must be presented in the classroom for the students to appreciate and relate well. ***(Bonsu, maths Educationist)***

Human beings in general find it difficult in accepting new things, hence most learning theories propose that we learn from known-to-unknown. Taking into consideration the vast knowledge demonstrated by the Akan community in relation to geometry, we can incorporate some of the things that we know pre-exist in the memories of the students. That is what is termed as the Relevant Previous Knowledge (RPK). We should let our learners appreciate and see mathematics as a part of everyday life. If the mode of instruction embodies cultural elements of which the learners cherish and practice, then the mathematics would not be abstract to them. They can link to their day-to-day activities ***(Boat, Mathematics Educator).***

... why do we go to school to learn? We learn so that we can really understand things around us. So, if I go to school and learn and I cannot relate to things around me, then to me learning has not has not taken place. I am acquiring the knowledge to really understand myself and the immediate environment before I go to the next environment, so the things around me, I must really understand them, if there are mathematics in them, I must understand before I can relate to the outside world ***(Rev, mathematics teacher)***

...the mode of mathematics instruction in schools need to be culturally responsive. Let us employ the Akan culture particularly in teaching geometry. Learners will appreciate the topic better and apply in real life. That is what they have been doing and seeing all around them at home. The school is only laying emphasis and bringing in terms to describe what they do already ***(Ruf, mathematics teacher)***

... teaching of geometry has become a problem because some teachers teach geometry without referencing the cultural background of learners. The Akan culture for example has some of the shapes embedded in their daily life activities. Yet teachers teach without bringing some of these shapes into the classroom. When teaching geometry, the money boxes, earthenware bowls etc that are geometric and students are familiar with, can be brought to the class for the students to know what you are talking about so that teaching will never become abstract. ***(WAB mathematics Educator)***

The other two maths educators encourage teachers to be abrest with the culture of the community in which they find themselves in order to apply students Relevant Previous Knowledge (RPK) to enable learners gain enough grounding to accommodate the new concept.

*The teaching and learning of mathematics in the twenty-first century are extremely constructive and practical. To further enhance teaching and learning, students are encouraged to find and catalogue these artefacts in their community while providing real-world examples in the classroom. This has been the tenants of the Akan culture in terms of how they pass knowledge from generation to generation (****Pablo maths teacher).***

*Mathematics teachers must try to be conversant with the Akan tradition itself. If you are teacher and you find yourself in the Akan system or network, you need to become knowledgeable in the culture. Also, you have to understand that when it comes to Akan, every community in the Akan has their own ways of doing things (****Konadu maths teacher).***

It is practically obvious since the Akan itself comprises the "Akim", the "Asante", the "Fante", the "Akuapem" and others but even within the "Asante" there are so many things that they do differently from community to community. So, a teacher must learn how to apply the things that he has seen in the community. If teachers know their students cultural background properly so that they can relate the lessons to their background and cite examples that are relevant. The artisans on their part shared that if teachers make the lesson practical, students will be able to grasp the concept very well.

> *At least the teachers must show visuals or realia of the geometric shapes under consideration. Teaching and learning will be smooth if students see, touch and feel the things they are learning about as seen in the Akan culture* ***(AFA K Tailor)***

> *But if the learner is able to understand that the pi (πr) Square is not something alien it is not something elsewhere, it is something that is around them, it is just a symbol that we are using to represent something that they already know, then it comes in to bring the "aha learning factor." (Doctor)*

> *Unlike school where they only read from papers and cannot apply, here, everything it is practical. When you take weaving for instance, we have what is called reed (operated by hands) and hurdles (operated by legs). You have to check and make sure that the holes in the reed matches holes in the hurdles. The apprentice their masters, participate alongside and tries to imitate; hence they are able to retain the knowledge and become proficient (****Vice Kente weaver)***

Again, based on the interview data, all the seven maths teachers were of the view that if the concepts are introduced by building it on their previous experience, learners are able to transfer the knowledge to solve non-routine problems and also problems in related subjects. Some of the participants have this to say;

> *whenever teachers are teaching new concepts, they have to dwell on what the learners already know, so that they can propel the students or the learners towards the new concepts the lesson intends to make students understand and further enhance the learner to learn more new concepts* ***(Boat maths teacher)***

If teaching can be relational and not the instrumental type, then teachers will consciously employ cultural responsiveness during introduction of concepts in geometry. They can bring cultural artefacts to the classroom and illustrate their concepts so learners can relate the concepts to solving problems in other topics and other subjects ***(WAB, Maths teacher).***

The final theme was application of knowledge in solving real life problems and the participant believed that if learner get the concepts very well they have the opportunity to apply the knowledge in solving real life problem. If our school system can incorporate the traditional systems the learner already knows, if we incorporate the things that the learners are conversant with into the contemporary learning, learning of new concepts does not become problematic or alien. But learning becomes a part of the learner, and it encourages the learner to learn and also apply it to solve problems. Learners should be given the chance to apply what they have learned to solve problems in our society. Hence teaching and learning should be practical oriented, just as the case of the Akan. Learners will be able to solve a problem if they do relate what is being taught to existing things, what they know already, so, when the students are able to see the relevance, then they will be able to apply it. This enhances their conceptual understanding. The mode of mathematics instruction in schools need to be culturally responsive. Let us employ the Akan culture particularly in teaching geometry. Learners will appreciate the topic better and apply in real life, participants noted.

DISCUSSION AND CONCLUSION

The first research question was how does the Akan traditional Art utilize mathematical concepts? The study has revealed that the Akan tradition is embedded with a lot of mathematics concepts especially geometry. This is demonstrated in their games, vocations like Kente weaving wood curving, among others. It is believed that the students are already familiar with the Akan culture, once the concept of geometry is link to the culture it makes the lesson so real and thereby increase student interest, remove fear and improve on academic achievement as found by (Arthur, 2019; Arthur et al., 2022). The goal Constructivist learning is to maximise students learning achievement by equipping learners to construct knowledge through their environment and culture. Researcher across Africa have also come up with similar studies in their jurisdictions where local practices were linked to mathematics concepts (Nur et al., 2020; Sharna et al., 2021; Turugari, 2022). It must be noted that, where the environment of the student becomes avenue for learning the learning transcend the classroom. The interview data has revealed that a culturally-responsive mathematics instruction such as linking the Akan culture to the teaching of geometry enhance learners

conceptual understanding. As demonstrated by some researchers (Atta & Bonyah, 2023a; Bonner, 2021), taking student background into consideration when it comes to mathematics education is a prerequisite for relational understanding.
The second research question was on how mathematics educators perceive the contribution of the Akan traditional Art to conceptual understanding in geometry. We found that integrating the Akan culture into the teaching of geometry will promote conceptual understanding and improve academic achievement through life-long learning. Participants believed that linking the Akan culture to the teaching of geometry enhance learners' relational understanding thereby equipping learners to apply what they have learnt into solving practical problems. Some studies have demonstrated that using students background to teach mathematics concepts enhance students' creative skills, critical thinking and innovation problem solving strategies (Arthur, 2019; Atta & Bonyah, 2023b). for instance, students participating in collaborative learning perform better on critical-thinking tests and drill and practice tests. Teachers should provide scaffolding, develop meta-cognitive skills, and guide learners in assimilation, accommodation, adaptation, and reflection on conflicting ideas. There is therefore the need for a paradigm shift is needed, with the teacher's role shifting from knowledge provider to learning facilitator, and the student's role shifting from information collector to active practitioner.

Using the Akan culture to teach geometry will revive the dying culture of the Akan due to modern technology and the over reliance on foreign goods. Even though the core mathematics curriculum of Ghana was built on problem solving (Nabie et al., 2013), other studies have shown that teachers teach through abstraction because the curriculum itself is theoretical and abstract (Oppong-Gyebi et al., 2023). However, this study revealed that geometry teaching must be practical oriented since it has a lot of application to real life, similar to the assertion by Baah-Duodu et al., (2020). This outcome also adds to the voice of the other researches who have been advocating for a paradigm shift in the instructional delivery at the Senior High School (Desai et al., 2021; Owusu-Darko et al., 2023)

IMPLICATIONS

The study makes a great contribution to knowledge especially in the area of ethnomathematics. The pre-tertiary mathematics curriculum of Ghana is premised on problem solving and constructivism, however since it does not make mention of ethnomathematics, teachers continue to teach geometry the abstract way following the textbooks. This may be due to the fact that there has not been much exploration of the link between the Akan art and the school geometry. Using the Akan culture to teach geometry will help learners achieve conceptual understand and see the Akan culture as a dynamic tool to achieve 21st century

skills. This will help in the realization of the aims of the mathematics curriculum of training learners who become innovative, creative in their thing and problem solvers.

REFERENCES

Abd Gani, N. I., Rathakrishnan, M., & Krishnasamy, H. N. (2020). A pilot test for establishing validity and reliability of qualitative interview in the blended learning English proficiency course. *J Crit Rev*, *7*(5), 140–143.

Agyei Brantuo, W., Amoako Atta, S., Kwasi Klu, T., & Ohene Amoako-Atta, S. (2023). Viability Problem-Solving Approach in Teaching Mathematics at This Era: Retrospection of the Six Decades of Mathematics Education in Ghana. *Mathematics Letters*. https://doi.org/10.11648/j.ml.20230901.11

Albanese, V. (2021). Bundles of Ethnomathematical Expertise Residing with Handicrafts, Occupations, and Other Activities Across Cultures. *Handbook of Cognitive Mathematics*, 1–34.

Altaftazani, D. H., Rahayu, G. D. S., Kelana, J. B., Firdaus, A. R., & Wardani, D. S. (2020). Application of the constructivism approach to improve students' understanding of multiplication material. *Journal of Physics: Conference Series*, *1657*(1), 012007.

Arthur, Y. D. (2019). The Effect of Background on Students' Interest in Mathematics: The Mediation of Students' Motivation and Perception in Ghana. *Asian Journal of Probability and Statistics*, 1–13. https://doi.org/10.9734/ajpas/2019/v5i330135

Arthur, Y. D., Dogbe, C. S. K., & Asiedu-Addo, S. K. (2022). Enhancing Performance in Mathematics Through Motivation, Peer Assisted Learning, And Teaching Quality: The Mediating Role of Student Interest. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(2), em2072. https://doi.org/10.29333/ejmste/11509

Atta, S. A., & Bonyah, E. (2023a). Teaching mathematics for social justice: The challenges and the prospects in the Ghanaian senior high schools. *Journal of Mathematics and Science Teacher*, *3*(1), em033. https://doi.org/10.29333/mathsciteacher/13082

Atta, S. A., & Bonyah, E. (2023b). Teaching Mathematics for Social Justice: The Challenges and the Prospects in The Ghanaian Senior High Schools. *Golden Ratio of Social Science and Education*, *3*(1), 50–60. https://doi.org/10.52970/grsse.v3i1.231

Atta, S. A., Bonyah, E., & Boateng, F. O. (2024). *Exploration of the Benefits of Linking the Teaching and Learning of Geometry at the Senior High School to the Akan Cultural Practices*. https://doi.org/10.21203/rs.3.rs-3811653/v2

Atta, S. A., & Brantuo, W. A. (2021). Digitalizing the Teaching and Learning of Mathematics at the Senior High Schools in Ghana; the Case of Flipped Classroom Approach. *American Journal of Education and Practice*, *5*(3), 29–37.

Ayoub Mahmoudi, D., Khoshnood, A., & Babaei, A. (2014). Paulo Freire's critical pedagogy and its implications in curriculum planning. *Journal of Education and Practice*, *5*(14), 86–91.

Baah-Duodu, S., Osei-Buabeng, V., Cornelius, E. F., Hegan, J. E., & Nabie, M. J. (2020). Review of Literature on Teaching and Learning Geometry and Measurement: A Case of Ghanaian Standards Based Mathematics Curriculum. *International Journal of Advances in Scientific Research and Engineering, IJASRE (ISSN: 2454-8006)*, *6*(3), 103–124.

Bonner, E. P. (2021). Practicing culturally responsive mathematics teaching. *Mathematics Teacher: Learning and Teaching PK-12*, *114*(1), 6–15.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, *56*(3), 1391–1412. https://doi.org/10.1007/s11135-021-01182-y

Carr, M. E., Davis, E. K., & Seah, W. T. (2023). An exploration of Ghanaian students' valuing in mathematics: How does it evolve across school levels? *EURASIA Journal of Mathematics, Science and Technology Education*, *19*(10), em2332.

Chahine, I. (2013). *Mathematics teachers' explorations of indigenous mathematical knowledge systems through immersion in African Cultures*. http://funes.uniandes.edu.co/4070/

Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Dempster, T. S. (2022). Addressing Concerns Related to Low Student Understanding in Mathematics in Manitoba. *BU Journal of Graduate Studies in Education*, *14*(1), 4–9.

Desai, S., Bush, S., & Safi, F. (2021). Mathematical Representations in the Teaching and Learning of Geometry. *The Electronic Journal for Research in Science & Mathematics Education*, *25*(4), 6–22.

Gervasoni, A., Roche, A., & Downton, A. (2021). Differentiating Instruction for Students Who Fail to Thrive in Mathematics: The Impact of a Constructivist-Based Intervention Approach. *Mathematics Teacher Education & Development*, *23*(3).

Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Teacher*, *42*(8), 846–854. https://doi.org/10.1080/0142159X.2020.1755030

Kothari, C. R. (2017). *Research Methodology methods and techniques second edition*. New Age.

Kyeremeh, P., Awuah, F. K., & Dorwu, E. (2023). Integration of ethnomathematics in teaching geometry: A systematic review and bibliometric report. *Journal of Urban Mathematics Education*, *16*(2), Article 2. https://doi.org/10.21423/jume-v16i2a519

Luong, P. A. (2022). Applying the Concepts of "Community" and "Social Interaction" from Vygotsky's Sociocultural Theory of Cognitive Development in Math Teaching to Develop Learner's Math Communication Competencies. *Vietnam Journal of Education*, 209–215.

Madusise, S. (2015). Cultural villages as contexts for mediating culture and mathematics education in the South African curriculum. *Revista Latinoamericana de Etnomatemática Perspectivas Socioculturales de La Educación Matemática*, *8*(2), 11–31.

Massarwe, K., Verner, I., & Bshouty, D. (2012). Ethnomathematics and multi-cultural education: Analysis and construction of geometric ornaments. *Journal of Mathematics and Culture*, *6*(1), 344–360.

Meaney, T., Trinick, T., & Allen, P. (2021). Ethnomathematics in education: The need for cultural symmetry. *Handbook of Cognitive Mathematics*, 1–29.

Nabie, M. J., Akayuure, P., & Sofo, S. (2013). Integrating problem solving and investigations in Mathematics: Ghanaian teachers' assessment practices. *International Journal of Humanities and Social Science*, *3*(15), 46–56.

Nahdi, D. S., & Jatisunda, M. G. (2020). Conceptual understanding and procedural knowledge: A case study on learning mathematics of fractional material in elementary school. *Journal of Physics: Conference Series*, *1477*(4), 042037.

Naresh, N. (2015). The role of a critical ethnomathematics curriculum in transforming and empowering learners. *Revista Latinoamericana de Etnomatemática Perspectivas Socioculturales de La Educación Matemática*, *8*(2), 450–471.

Nur, A. S., Waluya, S. B., Rochmad, R., & Wardono, W. (2020). Contextual Learning with Ethnomathematics in Enhancing the Problem Solving Based on Thinking Levels. *Journal of Research and Advances in Mathematics Education*, *5*(3), 331–344.

Oppong-Gyebi, E., Amoako Atta, S., Kwadwo, A.-A., Belbase, S., Bonyah, E., & Peprah Opoku, M. (2023). High School Teachers' Perceptions and Practices of Mathematics Curriculum in Ghana. *Education Research International*, *2023*, e4304267. https://doi.org/10.1155/2023/4304267

Owusu-Darko, I., Apoenchir, H. K., & Mensah, J. Y. (2022). Mathematical Constructs–What are These, and Their Interconnection with Ethnomathematical Concepts. *Indonesian Journal of Ethnomathematics*, *1*(2), 89–104.

Owusu-Darko, I., Sabtiwu, R., Doe, F., Owusu-Mintah, B., & Ofosu, E. K. (2023). Akan ethnomathematics: Demonstrating its pedagogical action on the teaching and learning of mensuration and geometry. *Journal of Mathematics and Science Teacher*, *3*(2).

Rosa, M. (2020). Correction to: Ethnomathematics in Action. *Ethnomathematics in Action*, *44*, 240.

Rosa, M., Alangui, W. V., D'Ambrosio, U., Gavarrete, M. E., Orey, D. C., Palhares, P., & Shirley, L. (2016). *Current and Future Perspectives of Ethnomathematics as a Program* (1st ed. 2016). Springer International Publishing : Imprint: Springer. https://doi.org/10.1007/978-3-319-30120-4

Scott, B. L. A. (2018). *African American High School Students' attitudes Toward Mathematics And Perceptions Of Extant Culturally Relevant Pedagogy And Ethnomathematics*. https://scholarworks.lib.csusb.edu/etd/698/

Sharna, S., Sharma, S., Doyle, P., Marcelo, L., & Kumar, D. (2021). Teaching and learning probability using games: A systematic review of research from 2010-2020. *Waikato Journal of Education*, *26*(2), 51–64.

Sjoberg, G., Orum, A. M., & Feagin, J. R. (2020). *A case for the case study*. The University of North Carolina Press. https://muse.jhu.edu/pub/12/monograph/book/77227

Tekin-Sitrava, R., Isiksal-Bostan, M., & Çatman-Aksoy, E. (2023). The Interplay between Professional Noticing and Knowledge: The Case of Whole Number Multiplication. *Mathematics Teacher Education and Development*, *25*(2), 5.

Thompson, J. (2022). *A guide to abductive thematic analysis*. https://napier-repository.worktribe.com/output/2865363/a-guide-to-abductive-thematic-analysis

Tossavainen, A., & Helenius, O. (2024). Student Teachers' Conceptions of Fractions: A Framework for the Analysis of Different Aspects of Fractions. *Mathematics Teacher Education and Development*, *26*(1). https://eric.ed.gov/?id=EJ1415729

Turugari, M. (2022). *Integration of ethnomathematics in the teaching of probability in secondary school mathematics in Zimbabwe* [PhD Thesis].

SETH ATTA Ph.D. Candidate at the Department of Mathematics Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Kumasi Ghana. His main research interest lies in the area of mathematics problem solving, ethnomathematics and the integration of technology in mathematics education. Email: sethamoako@rocketmail.com

EBENEZER BONYAH Ph.D., is a full Professor at the Department of Mathematics Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Kumasi Ghana. Department of Mathematics and Applied Mathematics, University of Johannesburg, Johannesburg 2006, South Africa. His research interests are Mathematical Biology, Fractional Differential Equations, Optimal Control Theory, Dynamical Systems, Chaotic Theory and Ordinary Differential Equation and Mathematics Education. Email: ebonyah@aamusted.edu.gh

FRANCIS BOATENG Ph.D. is an Associate Professor of Applied Mathematics at the Akenten Appiah- Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Kumasi, Ghana. His main research areas are Computational Mathematics, Mathematical Modelling with Differential Equations, Computer Applications in Mathematics Education and, Integration of ICT in Teaching and Learning of Mathematics.
Email: foboateng@aamusted.edu.gh