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Mathematical Constructs – What are These, and Their Interconnection with Ethnomathematical Concepts

Isaac Owusu-Darko[1], Henry Kwami Apoenchir[2], Justice Yawson Mensah[2]

[1]Valley View University, P. O. Box 183, Techiman, Bono-East, Ghana
[2]SDA College of Education, P. O. Box 18, Asokore-Koforidua, Ghana
E-mail: iowusudarko@vvu.edu.gh

Abstract

The interconnection of ethnomathematical concepts in connection to school formal mathematical construction is viewed by many mathematics educators with a different interpretation. Some consider mathematical construct to connote the content discussion on mathematical construction as a topic relating to Euclidean geometry. To some, a mathematical construct is the concept frame that serves the bases of the topic taught. We discuss a few reviews of selected mathematical constructs from formal teaching position in connection to ethnomathematical construction from the informal position. Mathematical construct is viewed as the topical concepts that govern the understanding of problem-solving skills and the mathematical topic the teacher facilitates and introduces to students. To some extent, mathematical problem-solving skills is best executed under routine and non-routine procedures when constructs and concepts are best understood. The study adopted the qualitative research design to investigate some existing mathematical concepts portrayed in the teaching of secondary mathematical concepts adopted from the Ghanaian syllabus under Akan ethnomathematics. A content analyses is given in the perspective of Akan ethnomathematics for the selected Ghanaian standard secondary based syllabus. The study revealed that, mathematical construction can be better understood in the context of Akan ethnomathematics not only on geometry, but algebra, calculus and other measurement and timelines. It is recommended that mathematics educators integrate ethnomathematics education in the teaching and learning of formal westernized mathematics teaching in the curriculum implementation process.

Keywords: Curriculum Implementation, Ethnomathematics, Mathematical Concept, Mathematical Construct, Problem-Solving

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Introduction

The approach in teaching and learning of mathematical concepts is framed in mathematical language systems that is constructed, conceptualized, and idealized in westernized unique form. African communities have peculiar cultures and ethnomathematical construction that could guide our understanding of mathematical content. The connection between cultural diversity and subject-based concept teaching has been explored by several researchers (D'Ambrosio, 1985; Bishop, 1990; Orey et al., 2004; Rosa et al., 2016; Davis & Seah, 2016; Machaba, 2018; Sunzuma & Maharaj, 2019). The recent conversional method of teaching mathematics is westernized, Eurocentric and whitish and hence need to be brought to the doorstep of the African child.

What is a Mathematical Construct?

Issues relating to mathematical construct has been viewed by severally as the topic "construction", which conform to Euclidean geometry. Quite contrarily to this is to look at mathematical construct as the conceptual frame surrounding topics taught under the mathematics curriculum. It is the basis by which mathematical contents are developed to form a mathematical topic by which the mathematics curriculum specifies for teachers to teach (Clement, 2008). Perception and attitudes attached to mathematics content has been concluded by researchers as negative, perhaps, because of the nature of the content. This has thrown a challenge to mathematics educators to find various ways of controlling and attracting people to love studying mathematics. Students who are believed to possess positive attitudes towards learning mathematics can understand mathematical content better than with negative attitudes (Mokgwathi, Graham, & Fraser, 2019).

Mathematical construct plays several roles in learning situations. Staut and Stern (1997) argue about Mathematical constructs can have a dual role. They see mathematical constructs as instruments used to model real-world situations and events, or as an object of reasoning. Mathematics is a particularly abstract domain because the affordances and constraints underlying the use of mathematical constructs may be the difference between the affordances and constraints in real-world situations. The content-based of mathematics is seen by many as the topical issues by which the curriculum dictates to instructors. The teaching syllabus for Ghanaian High school for example has little concern in suggesting ethnomathematics pedagogical approach in the teaching and learning of the subject. The application of mathematical concepts and its connection to assessment has been westernized alienating learners from their culture.

Zhang, Zhang, and Ma (2014) see mathematical construct as something connected to “Automatic Generation of Combinatorial Test Data”. They present some typical mathematical methods that are commonly used in the construction of orthogonal arrays and covering arrays, as well as some bounds on the size of such arrays in various mathematical constructs. Zhang et al. (2014) discuss various mathematical constructions beyond Euclidean geometry but a discrete form of mathematics such as juxtaposition, Hadamard construction, zero-sum construction, simple constructions, recursive constructions. Hence mathematical constructs go beyond geometry. It takes various form best known to the mathematics educator. The ideal approach suggested to help teach mathematics discourse, a content based with realistic mathematics education systems (Peni, 2019; Sutisna et al., 2019; Widada et al., 2018) is to integrate ethnomathematical concepts to link the most dominated formal system (Bishop, 1998).

The concepts of mathematics taught however should be linked to the level in which the curriculum prescribe for. The basis of the constructs defined on mathematics could be linked to theories, algorithms, lemmas, prepositions, postulates and among another computational form of the content based on the subject under discussion. In Ghanaian secondary schools, the content is specified by what Ghana Education Service (GES) under the Ministry of Education (MOE) outlines as mathematics curriculum for the various class teachers (MOE, 2012; Mereku, 2004). The content scope of the mathematics syllabus is geared towards seven broad areas: Numbers and Numeration. Plane Geometry, Mensuration, Algebra, Statistics and Probability, Trigonometry, Vectors and Transformation in a Plane, Problem solving and application (mathematical processes). Cultural diversities and ethnomath support all these mathematical topics. Among all these, most prominent topics which are supported by ethnomathematics may include mensuration, trigonometry, statistics, number, and numeration concepts.

The nature of mathematics concepts cannot be separated from science. Students view of mathematical concepts makes them appreciate the beauty of mathematics or otherwise, make them hate the subject causing abysmal performance. Successful academic achievement of students in mathematics depends upon the kind of attitude they deployed towards mathematical content (Farooq & Shah, 2008). Farooq et al., affirms that students who even fear the subject mathematics even extend some level of hatred for the teacher who teaches it. To Russo and Hopkins (2018), students having a positive reaction towards the mathematics teachers depends on classroom culture that embraces the struggle of understanding the mathematical concepts, high teacher expectations as well as consistent classroom routine processes (Mahpudin & Sunanto, 2019).

Conventional mathematics education leads to a fabricated view of students who think that mathematics is an isolated field of science from their daily lives this is because they hardly find any relevance of what they learn to their day-by-day life situations. Learning mathematics through the precepts of ethnomathematics can bring mathematical ideas closer to students' daily lives so that students can better understand and interpret the learning outcomes they get from the mathematics educator. In addition to this, Mahpudin and Sunanto (2019) agrees with Orey et al. (2016) that ethnomathematics can promote and develop multicultural competencies in students. Students can better know and appreciate cultural diversity and its interplay informal education systems.

Teachers' choice of topic to teach is based on what he already knows from his hay days in the previous school. Curriculum developers think to mathematical structure content from a hierarchy of mathematical content learning task. For example, Ghana Education Service CDDR tries to structure mathematics content from pre-school number system to primary school, JSS and move higher into the Senior secondary school level. The concept of the topic set from primary class one is different from that of JHS and slightly different from that of SHS. It is generally acknowledging that mathematical constructs are related to what content or task is specified and what mathematical concepts guide its understanding. Hence epistemological believers put it as "part of teachers' professional competence" and this impact their selection of learning tasks as well as their instructional activities in the classroom (Depaepe, De Corte, & Verschaffel, 2016). Many researchers have the conviction that, mathematical concepts and constructions dictating teachers' lessons is based on epistemology which is not indifferent from every teacher's move towards what is to be taught to class (Blomeke, Felbrich, Muller, Kraiser, & Lehmann, 2008; Kunter et al., 2013; Feucht & Bendixen, 2010; Depaepe et al., 2016).

The content of mathematics in the formal setting is deemed difficult as perceived by some areas in mathematics. For instance, the concepts of measurement and fractions have been cited as being difficult for Ghanaian pupils are all deeply rooted in the Ghanaian culture (Davis & Hisashi, 2007; Davis, 2004; Davis & Ampiah, 2009). Mathematical construction is topically focused, and it behaves on mathematics educators to help learners crack the shell well in which level of education the curriculum suggests to be taught. Mathematical construct as something connected to generic skills that serve the bases of learners understanding of the mathematical concept taught (Zakaria, 2007). One of the skills that must be relatively hard by the learner after learning mathematics is the skill to think critically about what is taught in class. Critical thinking and computational skill, according to Zakaria (2007), is necessary to solve a mathematical problem that is confronted in daily life as supported by Uswatun (2016) and Isjoni (2010). Hence, Critical thinking skill principally is needed in solving mathematical problems. It is the key attention in the learning process of any mathematical concept.

In teaching mathematical concepts herein defined to conform to mathematical construct at class, the teacher has to instill problem solving skill. There is the need for student to think critically in mathematics by linking mathematics problem with daily life and culture tenets of the people in the society (Alangui, 2017; Cimen, 2014; Eyal, 2018). The learner is not only to get knowledge about mathematics but to know cultural values in society as well. This connection will undoubtedly foster students' cognition in mathematics lessons.

Mathematical Constructs in the Context of Ethnomathematics

Mathematical constructs could be viewed in some informal settings where cultural diversities seem to support or throw evidence on some components of mathematical concepts that are supported by traditions and culture. Mensuration and trigonometry as topics are seen to be associated with students' prior understanding of similar concept informed from cultural artefacts. A thesis report done in 2017, investigated into Basic mathematical concepts practiced by Danuwar community in Africa (Karki, 2017) which is quite like most of the Ghanaian tribal communities. The counting system, measurement procedures mensuration concepts like weight, volumes, areas, length and distance estimations as well as domestics' concepts of geometry was surveyed among the Danuwar community. Karki's study (2017) is carried on cultural, historical, pedagogical and mathematics methodological perspective by making intimate ethnomathematics connection to the formal one binding Danuwar community. Most African tribal communities have similar informal educational patterns which inform naturalistic philosophy of mathematics. To some extent, ethnomathematics from cultural diversity explain the essence of the new field and new era in the history of mathematics education where we see the relevance of culture of the people to the formal education system (Orey et al., 2016).

Mathematics and science have a similar but unique characteristic (Imswatama et al., 2018). To them, mathematics and science are embedded with “abstract object, the pattern on axiomatic and deductive thinking, and based on truth” as further surveyed by (Afandi, 2018; Mursalin et al., 2018; Fonna, 2018; Amalia et al., 2018). With such unique characteristic, mathematical content is covered with abstract constructs upon which content is developed. These arbitral constructs inherent within mathematics curriculum is useful in developing skill and creating not only the learner personality but also understanding the beautiful linkage to cultural diversity (Mawaddah, 2015; Flora, 2017; Setiawan, 2006; Trisnawati, 2018).

Staut and Stern (1997) refer to the extent to which developmental, educational, and experimental studies supports the view that a new understanding of mathematical concepts has cultural backings. Mathematical constructs serve as a powerful way of reasoning. This becomes conceivable from culturally arbitrated mathematical constructs. The belief of Staut and Stern (1997) links the notion that, to every level of the learners’ education of mathematical concepts, let the awareness of what is found locally, based on culture, direct our effort to structure the curriculum.

Investigation into the impact of Ghanaian cultural way of measuring things by Davis (2016) suggests that people’s understanding and application of mathematical concepts is perceived in application of ethnomathematics on the understanding of mathematical concepts of measurement. Among the Ghanaian people surveyed through market and pupils’ pre-informed notions of measuring and sharing in an out-of-school situation, a connection was established to have influenced students understanding of mathematical concepts of measurement taught. Ethnomathematical constructs could be seen reflecting learners’ conceptions and practices in school and hence help them understand mathematical concepts taught. Davis’ findings from the study seem to endorse the local aspect of mathematical knowledge influencing the way pupils understand mathematical concepts on measurement. Davis (2016) however recommends the need for mathematics teachers to consider the implication of ethnomathematical study into the conventional means in which we deliver teaching. Integrating everyday life situations into school mathematical knowledge in the teaching and learning situation would enhance the understanding of mathematical concepts and construct within the curriculum.

Research have wondered about how richer mathematics education would become if all and sundry educators should include integrating social principle in learners’ education. Powell (1997) as cited in Devkota (2013, p. 46) for instance, states that “the inclusion of mathematical ideas from diverse cultures can make the mathematics very understandable and recognizes different practices of a mathematical nature in varied cultural, procedural contexts”. If students’ experience from their cultures can be linked to academic work in mathematics class, it will help bring meaningful learning to the students. The results of this would help them adjust to the related mathematics curriculum from all educational hierarchy ahead.

To Banks, and McGee (1989 p. 87), “culture is to apply to all features of life development, the entirety of implications, philosophies, and views shared by individuals within a group of people”. If learners do not get meaningful understanding from mathematical concepts taught in school and reconcile its relevance to their immediate environment, society, tradition, culture or perhaps technology, they will grow and hoot at mathematics as irrelevant and perhaps mock the mathematics teachers who taught them.

The relevance of mathematics has been the concern of humanity. The essence of new mathematical ideas initiated by scholars is based on a struggle to solve societal problems. Hence mathematics plays a significant role in the learners’ interest in meeting society’s survival of the fittest in this direction. According to Hayden (2010), one of the numerous roles of mathematics is to prepare learner to be able to face the changing condition or challenge in life, for which, notwithstanding academic focus, develops towards societal interest (Haydon, 2010; Woods, 2010). The curriculum structure of the people usually specifies the general goal of teaching mathematics. The learner is expected to be able to apply mathematics and thinks mathematical in daily life (Yusrina, 2017; Artut, 2009). In mathematics class, the learner is not only to understand the mathematical concept or construct, content, topic, and theory in solving problems but also to use it to solve societal problems. Mawadah (2015) sees students’ ability to solving a mathematical problem as having connections from knowledge and experience gained as they interact with mathematical concepts. For students to understand mathematical construction of contextual ideas that govern problem-solving, experience from what they know should be established. It is an indisputable fact that students experience is also connected to the culture of the people.

Methods

The study adopted a descriptive research design under a qualitative method. The existing teaching methods, problem solving skills in mathematics adopt the mathematical construction; a situation in which mathematical concepts need to be used for every operational algorithm. A content analyses of Ghanaian standard-based curriculum was used for a qualitative survey of mathematical constructs in the formal Eurocentric context with suggested Akan ethnomathematical constructs. The Akan tribal communities dominate the inhabitants of Ghana with several cultural dynamics that best explains ethnomathematical idealization parallel with the formal mathematics systems. To understand and apply the six fundamental activities that is argued to be universal and carried out by every cultural group which is necessary for the development of mathematical knowledge: counting, location, measuring, designing, playing and explaining, there is the need understand what ethnomathematical constructs there are to support the teaching of formal mathematics systems (Bishop 1988). Students’ failure in mathematics may be attributed to teachings using methods that alienate our culture (Mereku, 2013). Adopting a means to help students understand mathematical concepts is to think aloud, the essence of explaining mathematical construct through ethnomathematics.

Results and Discussion

Table 1 is the standard based curriculum (syllabus) for the teaching of mathematics among secondary schools in Ghana with Basic supportive Akan ethnomathematics (from informal position and mathematical concepts formation (formal).

Table 1. Formal strands of school mathematical concepts and Basic Akan ethnomathematical concepts

S/n	Strands from the formal system of curriculum	Curriculum structure for school level	Basic supportive Ethnomathematics	Mathematical Concept formation
1	Numbers and Numeration.	SHS 1 &2	1. Finger counting 2. Oral numeration 3. Debt tallying 4. Counting-based games	Number and counting system from the informal perspective, grouping, ordering, sorting etc
2	Plane Geometry	SHS 1, 2 & 3	1. Production of mats, tables and stool chairs 2. Measurement through foot and finger length and arm 3. Measurement of land for Farming, fathom 4. Demarcation of plots and lands	Measurement of Length and Distance
3	Mensuration	SHS 1, 2 & 3	1. Area and perimeter of home-based artefacts 2. Volumes of pots 3. Construction of indigenous circular technology 4. Earth-ware bowls	Areas volume, capacity
4	Algebra	SHS 1 & 2	1. Sales 2. Riddles and puzzles 3. Games, eg. Drafting	Abstractions
5	Statistics and Probability	SHS 1 & 2	1. Counting systems 2. Grouping and sorting things 3. Arranging items in ascending or descending order 4. Tracing and drawing emblems 5. Tallying for debts 6. Games, eg. Ahyehyeaba, pilolo	The body of numbers and the possibility of occurrence of events
6	Trigonometry	SHS 2 & 3	1. Indigenous building technology 2. Measurement through foot and finger length 3. Measurement of land for Farming 4. Demarcation of plots and lands 5. Games. Eg. Riding kite.	Distance apart, turnings as angles, traditional indigenous technologies. Eg. buildings
7	Vectors and Transformation in a Plane	SHS 2 & 3	1. Dancing 2. Movements and turning about points 3. games	
8	Words Problem solving	SHS 1, 2 & 3	1. Storytelling 2. Riddles 3. Puzzles 4. Role-playing	

Table 1 gives the outline of the standard based curriculum (syllabus) for the teaching of secondary mathematical concepts among secondary schools in Ghana with Basic supportive Akan ethnomathematics (from informal position and mathematical concepts formation (formal) position. Among selected few concepts are outline table 2 where placed value concepts under normal base ten is highlighted.

Table 2. Place-value concepts of Formal mathematics and informal Akan ethnomathematics systems

Illustrative example	Place Value (Formal Illustration)	Place-value (Informal Illustration)
1	Once	Baako
10	Tens	Edu-so
100	One Hundreds	ɔha-so
1000	One Thousand	Apem
10,000	Ten Thousand	Mpem-du
100,000	Hundreds Thousand	Mpem-ha
1,000,000	One million	ɔpe
10,000,000	Ten million	ɔpe-du
100,000,000	Hundreds million	ɔpe-ha
1,000,000,000	One billion	ɔpe- pe
10, 000,000,000	Tens billion	ɔpepe-du
100, 000,000,000	Hundreds billion	ɔpepe-ha
1,000, 000,000,000	One trillion	ɔpe-pe-pe
10, 000, 000,000,000	Tens of trillions	ɔpe-pe-pe du
100, 000, 000,000,000	Hundreds of trillions	ɔpe-pe-pe ha
1,000, 000, 000,000,000	One quadrillion	ɔpe-pe-pe-pe
…	…	…

From Table 2, the Akan language system in the numeration part of speech represent their knowledge in mathematics in the form of oral counting. Any number representation of the Hindu-Arabic formal representation was seen to be equally represented in the Akan informal numeration. Counting system seen from Table 2 sequences to infinite count of numeration to match the place value system illustrated in Table 2. To Akans, the number one (1) represents baako with the concept of once been baakoso. The concept of tenth (10th) connotes edu whiles 100th, 1000th and millions (1,000,000) are represented by Oha, apem and Ope respectively.

Table 3 shows some Basic formal Akan ethnomathematical concepts with Formal descriptions and westernized representations.

Table 3. Depiction of indigenous Akan discourse connotation for some algebra concepts

Ethnomathematical concepts	Description	Formal Representations
Biribi	Something (a variable x)	x
Ebi	Some [percentage (%) of x]	$x\%$
Nohwoaa/awie3	infinity	∞
Ɛfa bi	half (of x)	½ x
nyinaa	all	100% of x
Ahodo)	*Different replications*	x.y
akyiri	limits	$\lim_{x \to \infty} x$
Ntifirimu	Difference (of numbers)	$x - y$
Nkabom	Sum (of numbers)	$x + y$
Nkyemu/nkyekyemu	Division (of numbers)	$\frac{x}{y}$
Mmohoo-mmohoo	Multiplication (of numbers x, and y)	$x \times y$

The Akan ethnomathematics of algebra concepts is also orally expressed to connote their mathematical discourse as seen from table 3. The concept of a variable x means biribi. Percentage of x is expressed as ebi ($x\%$). The concept of all also represent 100%. The concept of limits and infinity is seen as akyirikyiri nohoaa. Akan use the discourse nkabom, ntefirimu, mmohoo-mmohoo, and nkyekyemu to show the sum (+), difference (-), multiplication ($\times$) and division of numbers in terms of x and y respectively.

The conceptual meaning that initiated a naturalistic view of mathematics regarding ethnomathematics is perceived well by D'Ambrosio (1985) as a research program in the history of and philosophy of mathematics with pedagogical implications. The focus of it, according to D'Ambrosio (2001) is to focus on the art and techniques of using cultural principles to cope with mathematics teaching. We exemplify other geometric and mensuration concepts with Akan ethnomathematics as seen in Figure 1.

Figure 1. Exemplification of Mensuration Problems with Ethnomathematics Application

Creating linkage of ethnomathematical construct from Informal mathematics with school mathematics or (formal curriculum) formal mathematics is quite difficult for most mathematics educators. The suggestive way of bridging the gap between formal and informal mathematical constructions and concepts is through Mathematization and Realistic Mathematics Education (RME) principle (Peni, 2018). These buildings from Figure 1 were observed from some part of the Akan communities and modelled with school formal mathematics constructs and conceptualization. The selected formal idealization is seen below to link the geometrical figures in these ethno-technological edifices with respect to their area dimension, Volumes of the building, total surface areas as well as perimeters associated with the westernized concepts, presented in Figure 2.

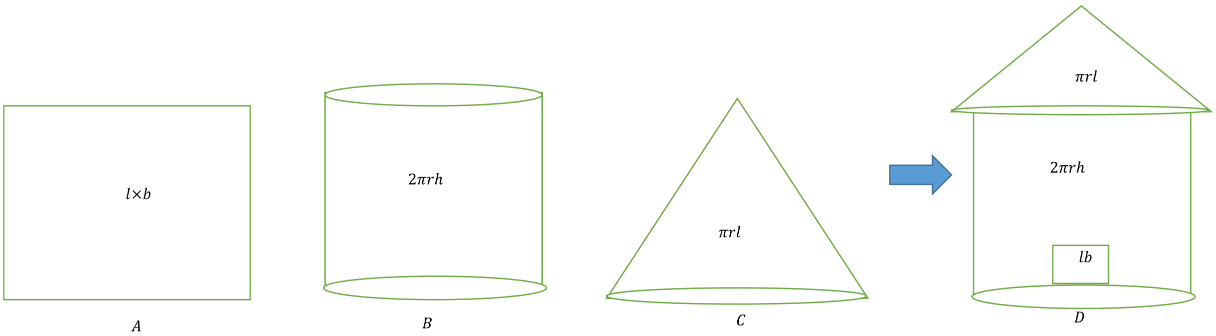

Figure 2. Mathematics representation from Figure 1

When students were asked to observe their buildings and frame a mathematical problem with theses, majority of the students agreed to theses selected frameworks. The selected formal idealization helped them to link the geometrical figures in these ethno-technological edifices to the concept of area investigation, volumes of the building, total surface areas as well as perimeters associated with the formal concepts and representations. We illustrate from selected Akan *adinkra* symbols used in making *kente* cloth with ethnomathematics in teaching mathematical concepts on geometry, as seen in Figure 3.

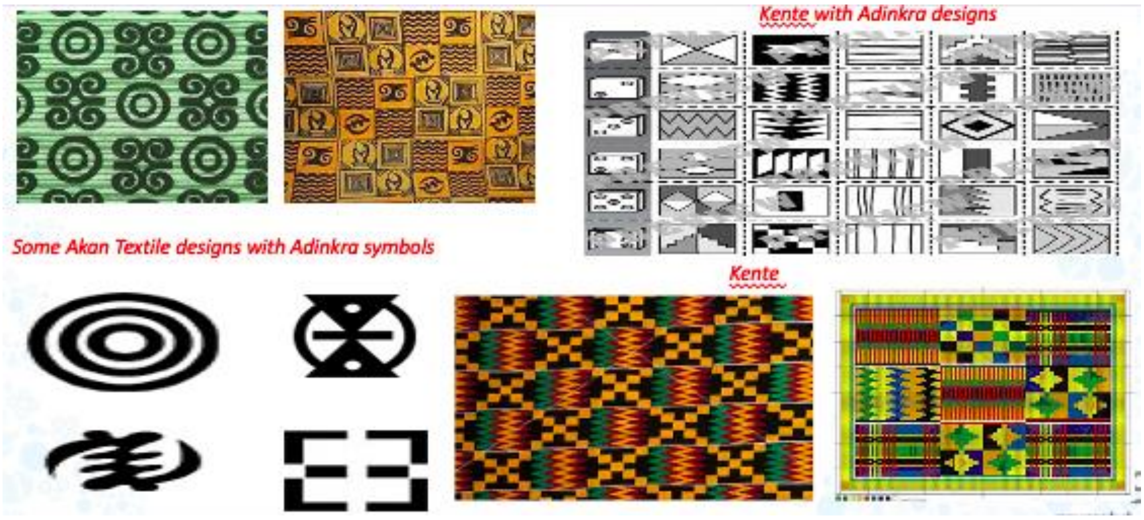

Figure 3. Akan adinkra symbols with kente cloth designs showing various geometrical concepts

Students were put in groups to select various geometrical shapes they could identify. They were made to graph and construct some of the selected shape. Meaningful graphing and tracing and construction were made since they understood these symbols form their cultural perspective.

The Implication of Mathematical Construct to Mathematics Educators

Students understanding of the content based of mathematics has been the concern of most mathematics educators. Mathematics educators seek to find diverse ways of improving methodology in helping learners adjust to its understanding. Pedagogical development of the teacher is developed under the dictates of what content is needed to transmit to the learner. Teachers' choice of appropriate pedagogy in teaching mathematics and science is influenced by the level of content or concepts defined by the curriculum (Mereku, Nabie, Awanta, & Appiah, 2011).

Preparation of teaching and learning materials to help the teacher teaches well is directed by what manner of content worth it. Abadi, Asih, and Jupri (2018) investigated into "The Development of Interactive Mathematics Learning Material Based on Local Wisdom" Learning materials used by students and schools in Serang district are lacking because they do not contain local wisdom content. To Abadi et al. (2018), the aim was to improve the deficits in teaching and learning aids used by students by making interactive teaching aids based on indigenous knowledge of the local people. The results were proving to contribute positively towards the teaching and learning of the concept initiated in making these interactive learning materials by the stages of the ADDIE study. The results of their study included interactive learning materials based on local wisdom prove to help students understand the content. Anggraini and Kusniarti

(2015) recommend that the learning materials that the mathematics educator should make should have local wisdom additional interactive content. Recent technology in education has offered educators a variation of new tools used in the classroom to facilitate learning (Akbar, Firman, & Rusyati, 2017). Interactive learning materials should be used on smart android phones and computers.

Mathematics teaching material based on ethnomathematics proves useful toward solving problem skill and student mathematical critical thinking. Besides, by applying mathematics teaching material that are improvised from cultural environment, that is from ethnomathematics can raise student involvement in class activities during mathematics lesson (Imswatama, 2018). Others are of the view that, modern form of teaching should go beyond improvisation, but rather employ the current form of technology in the teaching of science related subject (Ormanci & Cepni, 2019). Mathematics teaching is not quite different from science. Sometimes, mathematics teaching and learning goes beyond the use of modern technology. It seeks to employ basic primary tools and materials. Artifacts and among others that have connections to culture of the learners (Orey, 2016).

The essence of ethnomathematical studies that guide mathematics educators for streamline teaching of mathematical constructs and concepts is to fulfill curriculum implementation. Hence, mathematical constructs help teachers to adapt and implement the curriculum that suggest specific content discussion to specific class, level or grade assert that so far as teachers remain the forefront practitioners of education (Ríordáin, Paolucci, & Lyons, 2019). It is important to maintain a focus on the development of not only specialized content knowledge but also the essential skills and practices necessary to enrich our competent teaching to fulfil the aim of curriculum.

Mathematical construct, as a conceptual framework surrounding the teaching of mathematical contents has the Role of ethnomathematics in support of content teaching. It is in the light of this that (Mawadah, 2015) recognizes the core mandate of the mathematics teacher to be able to assist the learner and give meaning to mathematics concepts learnt. This would help build the skill of student mathematical problem-solving skills to deepen student’s understanding toward mathematical skills and concepts. The importance of teacher knowledge on formal mathematics and informal ethnomathematics must be known before teaching it (Ríordáin et al., 2019). Hence the development of teachers’ core practice both in-field and out-of-field practices give the opportunities to incorporate appropriate pedagogical skills in the teaching of mathematical concepts. Many of “out-of-field” practices suggested by Ríordáin et al. (2019) adopt an implicit approach to the role of cultural diversity in as much as teachers explore the environment to support in-field teaching of mathematical concepts.

Teachers’ knowledge of mathematical concepts would help them adopt Meaningful teaching of mathematics content. For example, MacDonald, Lord, and Miller (2019) used a small set of both teachers and students discourse moves as meaningful teaching approach of mathematical concepts. To them an appropriate teaching method centers on English Language Learners where discourse analyses would help deepens students mathematical reasoning. Thus, one advantage of mathematical concepts is for teachers to adapt meaningful learning strategies in ensuring students understanding of mathematical concepts and problem-solving skills (MacDonald et al., 2019).

Conclusion

Mathematical construct quite different from mathematical contextual concepts, is the conceptual framework surrounding the teaching and learning of mathematical content. The role of ethnomathematics in support of content teaching of theses construct help support the realistic education of mathematics to exemplify the most Eurocentric and whitish one. Mathematical processes in executing problem solving is strategically govern by clearer understanding of what construct is hidden as a solution. The interconnection of formal mathematical concepts and informal mathematical concepts in the curriculum implementation process is clearly seen. Many Akan ethnomathematics exist in an informal position to have most connection with the school curriculum standard. It is seen that, bridging the gap between school mathematical constructions from formal position with the ethnomathematics application from informal position needs to be the concern of all mathematics educators. One way of doing so is to adopt mathematization process under Realistic Mathematics Education (RME) suggested by Peni (2018).

Recommendations

Evidence from this study suggest that mathematics educations should consider creating linkages with exemplification of local ethnomathematical constructs and concepts to link with the formal idealization of mathematics teaching in the curriculum implementation process. It is recommended that mathematics educators integrate ethnomathematics education in the teaching and learning of formal westernized mathematics teaching. We encourage further research into how to bridge the gap between formal school mathematics and informal ethnomathematics teaching of mathematical concepts in the cause of encouraging the integration of ethnomathematics in the curriculum implementation process.

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