

Ethnomathematics in Ethiopia: Futile or Fertile for Mathematics Education?

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ABSTRACT

The role of ethnomathematics in mathematics educations is not realized in Ethiopia. However, about 85% of the nation's population exists in rural settings where the cultural background of students could have a contribution to make teaching effective and learning meaningful. Curriculum experts (designers and developers), and teachers appear to have little or no awareness of the subject ethnomathematics and its role in mathematics education. To address this issue, the concept ethnomathematics is described in general and it is discussed how it can be used to enrich a curriculum in a holistic manner, that is, in developing a curriculum that is not overly academic, rather that leaves room for students to explore and interpret mathematical knowledge based on their socio-cultural background.

Keywords: Cultural Roots of Mathematics; Ethnomathematics; Female Domain; History of Mathematics; Male Domain; Mathematics Education; Philosophical Perspectives.

1. INTRODUCTION

A considerable number of students who conventionally struggle with the basic aspects of mathematics have little or no concept of mathematics as a human/cultural product. Thus, it is common to hear that students at all levels of the education system mentioning that they have usually found mathematics a difficult subject to understand, “dreary” subject to learn, and having “little” application to the outside world (Weldeana, 2008). Even, the worst situation is that, many students think they are really “dull or slow” at school mathematics. Obviously, this leads to bad publicity of mathematics which in turn cause students develop negative attitude towards the subject and thereby demonstrate low attainment in mathematics.

In spite of the many factors that might have contributed towards students making such comments, including, teaching styles teachers used to deliver their classroom instructions, the nature of tasks offered for students, and the specific instructional strategies teachers put into effect, this paper argues that the limited knowledge about students cultural background and the role of ethnomathematics in mathematics education take a considerable share towards students' learning difficulties in mathematics. Without realizing these latter factors as contributors of student learning difficulties, Ethiopia has been experienced many reforms in the education system, where no exception is made to mathematics education. Indeed, these varied reforms have

been driven by the interest to cope up the dynamic situation of the world. But none of these were research based and consequently, neither of them proclaims success in students' attainment of mathematics. Thus, the changes diminished quickly after terms, as a result of public frustrations, teachers' hesitancy, and unreliable assessment results.

If it is believed that reform in the education system in Ethiopia is relevant, this paper suggests the inclusion of students' cultural background and their modes of mathematical reasoning into classroom discourse to make teaching effective and learning meaningful by broadening the role of ethnomathematics in the current mathematics curriculum. Indeed, such a perspective lends support from well-known works (e.g., the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989).

In doing this effect, the discussion of the dimensions of ethnomathematics will be held for consideration in the curriculum. First, an analysis of ethnomathematics, together with the perspectives on the cultural roots of mathematics will follow. Second, a methodology section will follow. Third, under the topic of discussion, an example from traditional activity that entails a rich array of mathematical contents and the mathematical pedagogy related it will be discussed briefly. In this same section, the fine points of the history of mathematics will be dealt with. Additionally, modern history of mathematics in Ethiopia, early developments of mathematics in Ethiopia, and the roles of history of mathematics in mathematics education will be discussed at some length. In the section that deals with domain focused activities, it will be necessary to take an in-depth look at some examples as manifested in a certain community. Fourth, finding a mechanism to increase the role of ethnomathematics is extremely important. This will also be dealt with under the heading implications for the curriculum. Fifth, a conclusion will be drawn based on the discussions. Finally, the acknowledgement and references will follow.

2. ETHNOMATHEMATICS AND CULTURAL PERSPECTIVES ON MATHEMATICS

2.1 Ethnomathematics

The subject ethnomathematics is broad to understand and thus, difficult to give single most depiction for others to comprehend it easy. Izmirli (2011) has compiled a good deal of definitions offered by best-known writers on the subject that differ slightly. However, the summary of these definitions indicated that there is much in common to describe the concept than to give a single, lucid, and intelligible definition of ethnomathematics. Therefore,

ethnomathematics is: (a) the study of the relationship between mathematics and culture (Izmirli, 2011), (b) the cultural or everyday practices of mathematics of a particular cultural group, and also program that looks into the generation, transmission, institutionalization and diffusion of knowledge with emphasis on the socio-cultural environment (Matang, 2002), (c) the study of mathematical ideas found in any culture (Rosa and Orey, 2010), and (d) the study of mathematics' connection to culture and culture's effect on mathematics teaching and learning (Bush, 2005).

In particular, D'Ambrosio (1985;2006), who is the building father of ethnomathematics, described the subject Ethnomathematics as an amalgamation of three broad constructs: Ethno+Mathema+tics-ethnomathematics, whereby the prefix *ethno* describes "all of the ingredients that make up the cultural identity of a group, *mathema*-means "doing/knowing" the mathematics and *tics* are "methods/techniques" that involve ways and styles. Based on this description of ethnomathematics, Vithal and Skovsmose (1997, p.133) offered an all-encompassing and comprehensive definition that cluster the varied dimensions of ethnomathematics: "Ethnomathematics refers to a cluster of ideas concerning the history of mathematics, the cultural roots of mathematics, the implicit mathematics in everyday settings, and mathematics education." Thus, ethnomathematics is the way different cultural groups mathematize (e.g., count, measure, relate, sort, compare, infer, hypothesize, problem pose, generalize, communicate, data gather and process, predict, analyze, record, evaluate, verify, and construct) (Weldeana, 2015).

It seems reasonable to say that, ethnomathematics aims not only to highlight the role of all cultures inputs to mathematics equitably but also to entertain methods and strategies of doing mathematics in varied cultures. After a thorough analysis of the literature on ethnomathematics, specifically that of Rosa and Orey (2010); Matang (2002); Bush (2005); as well as Izmirli (2011), an attempt was made to outline the list of benefits that can be served from incorporating ethnomathematics in the mathematics curriculum, namely it: improves the learning of academic content and promotes higher level thinking skills; provides students with the opportunity to think logically and creatively; fosters students' achievement and improves their ability solve mathematical problems; improves students' strategies for acquiring information; develops personal and social skills; boosts students' self-esteem; improves students' ability to work with others during learning; helps students experience self-reliance; increases gender relations; allows

students' own decision-making; increases students ability in making connections between everyday practice and school mathematics; improves students ability in finding relevant meaning to many abstract mathematical ideas taught in schools; and ensures high pledge of cultural consideration.

2.2 Philosophical Perspectives on the Cultural Roots of Mathematics

For the most cases, culture is referred to as the knowledge, stances, and routine activities shared and conveyed by the members of a society (Pollard, 2002: Cited in Weldeana, 2015, P.1334). Perceptions about the cultural nature of mathematics are directly related to these aspects that make up it. However, there is difference of opinion among mathematicians whether mathematics is free of social dynamics and cultural influences or not. Educationalists have attempted to analyze the consequences of these disagreements on the nature, teaching, and learning of mathematics and come up with the category of philosophies- *traditional* or *progressive* in accordance to their attempt to define the situation.

Platonism, which is labeled as *traditional*, assumes that mathematics expresses perpetual relationships between objects that are intuitive as well as objective (Voigt, 1996; Gold, 2011). With regard to this philosophical position, mathematical knowledge exists separate from the learner- that mathematical knowledge is “out there” in the world, fixed, and made up of discrete and irrefutable piece of information or facts. Obviously, there is relatively little room for interpretation because knowledge is seen as being fixed or stable-where facts are considered as permanently true and represent reality. This view point will have no space for entertaining the cultural background of learners because, as mentioned earlier in this paragraph, knowledge is considered to be pre-determined and fixed.

In line with the *progressive* perspective, philosophers such as Lakatos (1976) maintained that, mathematics is the product of social processes and that it is liable to correction in case when subjected to the processes of agreement and refutations. Through these processes, students negotiate meanings and communicate thoughts that contribute for their learning of mathematics. This philosophical position assumes that mathematical knowledge is produced or made meaningful through the interaction between the learner and the world around her or him, where the learner's background and experience are considered as mainstays for further learning.

This interaction of the learner with the environment leads to interpretation and understanding, not just on memorization of basic facts, procedures, and algorithms as pre-determined, fixed, and

accumulated. The world of mathematics is not seen as being made up primarily of fixed facts; rather, all mathematical knowledge is seen as being unstable and that depends on the interpretation of the learner. Further, mathematical knowledge is viewed as being holistic, unified, coherent, and interrelated rather than being made up of separate bits and pieces of information. It emphasizes on analysis and interpretation based on students' socio-cultural backgrounds where, some mathematical facts can be seen as being relatively fixed or stable, thus, the instructional process in mathematics is on using those facts in a creative, analytical or critical way rather than just absorbing them for the purpose of repetition. In this case, when students analyze and interpret, they will also produce or construct knowledge or new ways of looking at mathematical ideas based on their cultural background.

This latter philosophy assumes that mathematical discoveries and objects are cultural products which arose out of the real needs and interests of people regard less of their: ethnicity, location, and time of experience. Bishop (1988), and Zaslavsky (1993), who are, amongst the leading writers on culture and mathematics, support the position that mathematics is a cultural product that has developed because of many activities within a culture. They argue that, all people mathematize, with corresponding language to communicate their mathematical rigor to others.

3. METHODOLOGY

This study utilized a qualitative research approach based on Barton's (1996) model of ethnomathematics research which involves descriptive, archaeological, mathematizing, and analytical. More specifically, this current study used a blend of the archeological and mathematizing research approaches in ethnomathematics research to fit the purpose of this research study.

Barton's (1996) archaeological as well as mathematizing ethnomathematics research appears to emanate from Bishop's (1988), and Zaslavsky's (1993) perception that mathematics is a cultural product of all people regardless of their origin, time, and place of location. Archeological ethnomathematics research, thus, is historical in nature and describes how mathematics has been used to create cultural artifacts (Barton, 1996). Thus, archaeological ethnomathematics research reveals the importance of mathematics in developing local culture. A typical ethnomathematics research in study could answer the questions "*Why farmers use a circular surface as a Threshing*

Plot than other shapes?” and “How the Local People used concepts of geometry and measurement to design and create the Mud- and-wattle house as well as the local Solo.”

Mathematizing ethnomathematics research involves integrates the informal mathematics developed in a culture to ideas related to the school or academic mathematics; thus, the current study make use of this conceptualization to strengthen the research process. Though there is a lot in common with archaeological research, distinctions were keenly attended so as to focus on current cultural products of mathematical significance in the community. These were labeled as current histories of the community. For example, many cultural products designed and developed by members of the community that have mathematical significance are produced conditionally to meet the needs of the society that have to be served. At current times, the many abstract designs produced by females for the purpose of decoration can serve as current history of the community and as a source of many mathematical contents for discussions including: concepts like symmetry, similarity, congruence, transformations, rotations, reflections, fractals, parallel lines, geometric shapes, measurements of geometric shapes, and tessellations.

In this study, therefore, two sources of data have been used: primary such as objects and documents among others and secondary source including references accounts from textbooks and journals.

4. DEMONSTRATING THE SITUATIONS: DISCUSSION OF FINDINGS

4.1 An Example from Traditions

In this section, it will be demonstrated how a tradition-doing things as they have been done contain a context rich mathematical content. Traditions, as we are well aware of them are mostly based on an idealized past and in most cases they are practiced without any justifications either by the indigenous peoples or by the educated people, may be for some reasons- because they are historically distant from current realities and the complexities associated with them. But, when utilized appropriately, they could concretely resemble a rich context for mathematical pedagogy that makes sense for the community of learners.

Most of us, as part of the local people have been observing famers using circular surfaces instead of other shapes in the “threshing” process of crops. But, the question “why?” is rarely asked; thus, its richness in mathematical contents and its significance for mathematics education has been recognized least. For some people, specifically, students might not have an idea where to

begin and what the question is all about, the teacher could ask specific questions, yet engaging, such like: “What is the largest area that can be enclosed by a rectangle and a circle having 24 units perimeter as the length of their curves?” This problem can be used appropriately for elementary through tertiary levels by shaping the mode of inquiry (Ball, 1988). Apparently, the students will employ mathematical concepts and procedures in the service of its solution. Figuring out and manipulating various possible combinations of dimensions that can be made out of a given length will engage students in adding and multiplying as well as the ideas of turning points, and extreme values. Examining the areas that result from those different combinations afforded students of all levels an opportunity to consider what the measurement concepts of area and perimeter are each all about.



Figure 1. Local threshing plot.

Discernibly, it could offer students to present and justify solutions; thus create fertile ground for inquiry and arguments as learners searched for reasonable solutions that their peers would validate. The challenges they presented to one another could reveal the nature and power of proof — how can one persuade others in the mathematical community that one's solution is reasonable or sounding well? (Ball, 1988). For this Ball, the idea that mathematics entails puzzles and uncertainties and that mathematical thinking involves questions as much as answers will be represented vividly through the problem of knowing whether one has indeed optimized

the area. In doing this effect, students could be helped to acquire the skills and understandings required to judge the validity of their own ideas and results. Figure 2 is used to illustrate the case for a specific situation, when perimeter $p=24$, and the general perimeter p is considered for a rectangle of dimensions x and y and a circle of radius r .

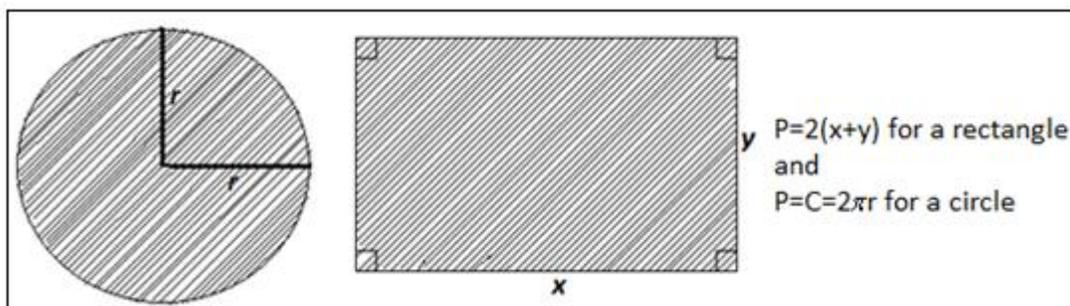


Figure 2. Geometric shapes for area comparison.

Table 1. Area relationship between a circle and a rectangle having the same curve length

Specific case, $P=24$ units	General case, P
<p>1. The perimeter, $P=2(x+y)$ and Area, $A=xy$ for a rectangle. Therefore, $24=2(x+y)$ or $x+y=12$ or $y=x-12$. From this relationship, $A=xy=x(12-x)=12x-x^2$ $\therefore A(x)=12x-x^2$ - A function of x only. $A'(x)=12-2x$ and $A'=0 \Rightarrow x=6$. And $A''(x)=-2 < 0 \Rightarrow$ the area can be maximized at $x=6$. The value of y from the relationship is also 6. The rectangle will attain maximum area when it is a square of side 6 units. $A_{max}=36$ square units.</p>	<p>1. For a rectangle, the perimeter $P=2(x+y)$ or $y = \frac{P}{2} - x$. Thus, the area A_R of the rectangle is $A_R = xy = x(\frac{P}{2} - x) = \frac{Px}{2} - x^2$. Here, A_R is a function of x and $A_R(x) = \frac{Px}{2} - x^2$. Taking the first derivative of $A_R(x)$ and finding the critical values, we have: $A'_R(x) = \frac{P}{2} - 2x$ and $A'_R(x) = 0 \Rightarrow x = \frac{P}{4}$. From $y = \frac{P}{2} - x$ and $x = \frac{P}{4}$, we have $y = \frac{P}{4}$. Since $A''_R(x) = -2 < 0$ for all x in the restriction of the dimensions, the rectangle will have</p>

<p>2. With this specific perimeter as the circumference of the circle, the radius will be $r=12/\pi$ since $P=C=2\pi r$ or $24=2\pi r$.</p> <p>The area A of the circle will be,</p> $A = \pi r^2 = \pi(12/\pi)^2 = \pi(144/\pi^2) = 144/\pi \approx 46$ <p>square units.</p> <p>Clearly, the circle of the same circumference as the perimeter of a rectangle exceeds it by 10 more square units.</p>	<p>maximum area which is $A_R = xy = \frac{P}{4} \cdot \frac{P}{4} = \frac{P^2}{16}$.</p> <p>2. The area A_C of the circle of radius r and whose circumference is the equal to the perimeter P of the rectangle is given by:</p> $A_C = \pi r^2 = \pi \left(\frac{P}{4\pi} \right)^2 = \frac{P^2}{4\pi} \approx \frac{P^2}{12.56}, \text{ provided that}$ $r = \frac{P}{2\pi} \text{ from the relationship } P = 2\pi r.$ <p>\therefore Area of the circle, $A_C \approx \frac{P^2}{12.56} >$ area of the rectangle, $A_R = \frac{P^2}{16}$.</p>
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In the end, this can be made more formalized to the academic mathematics in schools to foster mathematical pedagogy-an approach in the teaching and learning of mathematics helpful in developing students’ mathematical power and to become active participants in mathematics as a system of human thought. Following is an improved version of Ball’s (1988, p.3) work.

Suppose you had 100 meters of fence with which you were going to build a grazing land for your fatty oxen, Hamar at your well cultivated farm land. What are some different shapes of grazing lands you can make if you use the entire fence? Which is the grazing land with the most grazing space for Hamar? Which grazing land allows him the least grazing space?

This offers students to have the experience of “doing” mathematics, developing and pursuing mathematical intuitions, inventing mathematics, and learning to make mathematical arguments for their thoughts. This sort of problems which are realistic and overtly used by the society lie a foundation for good mathematics teaching-an approach that results in meaningful understandings of concepts and procedures, as well as in understanding about mathematics: what it means to “do” mathematics and how one establishes the validity of answers (Ball, 1988). Also, they can

provide fertile ground for other sciences that intensively utilize mathematics, such as physics, as to why the “*Local Threshing Plot*”-“*Awidi*” significant.

4.2. The History of Mathematics Education in Ethiopia

4.2.1 Modern history of mathematics education in Ethiopia

Historically, many nations in the world have been experienced curriculum materials that are heavily drawn from other cultures (Bush, 2005). Ethiopia is among these nations that has been experienced a number of curriculum iterations in mathematics education repeatedly for the last 8-9 decades as a result of these cultural influences. Of course, these varied reforms in mathematics education have been driven by recognized national precedence, namely, the need to cope up the changing and competitive world. But such changes were not research based, rather on foreign political influences. For example, as soon as the Italian invasion was ended as lead by the fascist Mussolini in the early 1930s, the Ethiopian government established political relationship with the British government. In its attempt to enhance the national capacity in mathematics education, the government adopted mathematics curriculum from Britain which entails two series. While the first series was referred to as Durell and Hudson, the second series was known as High Way Mathematics Series (Behute, 1991). According to Behute, these series of curricula vanished shortly, because they fail to satisfy the needs of the society; in other words, public dissatisfaction, teachers’ reluctance, and unsightly assessment results brought it to an end. In 1967, “new math” program, which was also known as “The Entebbe Mathematics Program” introduced to ten African countries, including: Ethiopia, Ghana, Kenya, Malawi, Nigeria, Sierra Leone, Zambia, Tanzania, and Uganda. This ‘new math program’ basically initiated and developed by mathematicians/experts from the United States of America, which persisted explicitly until the early 1990s, had a different perspective of rigor- one that encourages students to absorb or memorize facts or pieces of information. In this program, the teacher’s task is to repeat or present these prescribed pieces of information from the syllabus or textbook as efficiently as possible.

Policy documents that adhere to the commitment to active and learner-centered education emerged in 1994. These policy documents-*Education and Training Policy of Ethiopia* (Ministry of Education (MoE, 1994a & b) recognized the ethnic diversities in the country and declare their rights to learn in their mother languages. However, much of the mathematics education espoused and permeated remained Westerns focused, that is, what Moreira (2007) referred it as

mathematics from the “outside world”. In this case, the mathematics education seems to substantiate the prevalent view that the most worthwhile mathematics known is only that of the Westerns because little attention is given to nurture the cultural background of students of ethnic diversity to hoard mathematical ideas into a coherent whole. Additionally, the works of many mathematicians as textbook authors that aimed at helping students learn school mathematics and the curriculum experts reflect and promote much of the Western mathematics, which might lead to the erroneous interpretation of the history of mathematics merely as a progressive story of the isolated successes of the chosen few societies (Izmirli, 2011).

The above mentioned situation compelled to raise an interesting question to address, “Is the possibility to incorporate ethnomathematics in mathematics education in Ethiopia futile or fertile? As many scholars (e.g., D’Ambrosio, 1990; Zaslavsky, 1993; Bishop, 1992; Matang, 2002; Bush, 2005; Rosa and Orey, 2010) argue, every society has something to contribute to the development of mathematics and has the potential of mathematizing in its own culture; thus there definitely be a fertile not futile role of ethnomathematics in mathematics education at any cost. According to Bishop (1992, p.186-87), the cultural perspective, like the historical, “reaffirms the centrality of people in education, and demonstrates that mathematical knowledge is constructed, interpreted, and shaped by people”. When students’ cultural background is used in the teaching and learning of mathematics, it will address understanding in specific contexts and challenges the constraining view that positions mathematics as culture free and static.

A meticulous revision on the epistemology of mathematics education related to ethnomathematics may necessarily facilitate the learners’ realization that they can mathematize and think mathematically and develop the attitude that they can shine in academic mathematics and thereby, refute the false history that assumes non-Western mathematics are rather incomprehensible, and even distorted. A number of important items can be used to evidence this above statement using resources from students’ cultural background, that is, by increasing the role of ethnomathematics in mathematics education.

4.2. 2. Early history of mathematics in Ethiopia

If there are any written documents or artifacts that evidence the early history of mathematics education in Ethiopia, it is related either to the religious sector or to the indigenous people settled in rural areas. Past and current histories evidence that the people had: (1) perfect calendar different from the westerns, (2) ideas of probability, and (3) designs that involve geometric,

algebraic, or an integration of both and patterns of interest. In support of this position, Zaslavsky (1993, p.46), argues ‘*mathematical ideas and practices arose out of the real needs and interests of people in all societies, in all parts of the world, in all eras of time*’. Moreover, Bishop (1988), one of the foremost advocates of ‘mathematics as a cultural product’, observed activities common to all societies such as: counting, locating, measuring, designing, playing, and explaining.

One simple evidence from our history includes the artifacts that involve high quality architectural, engineering, and sophisticated mathematics concepts- 1700 years old Obelisks at Axum, Tigray, Ethiopia, and the 800 years old ground level rock-hewn churches at Lalibela, Amhara, Ethiopia. Figure 3 is the 12th -15th century rock-hewn church, “Bete Giorgis”, at Lalibela, Ethiopia. With regard to the mathematics embedded in this heritage, students might be helped to acquire knowledge of concepts and procedures, the relationship among them and why they work. Learning tasks and activities drawn from this cultural heritage may avoid or challenge the ordinary math class that is based on the assumptions that mathematics is only learned through repeated practice and drill, that “knowing” math means remembering procedures and concepts (Ball, 1988), where the role of the teacher is to show students how to do the procedures and give them methods that make it easier for the students to keep track of everything.

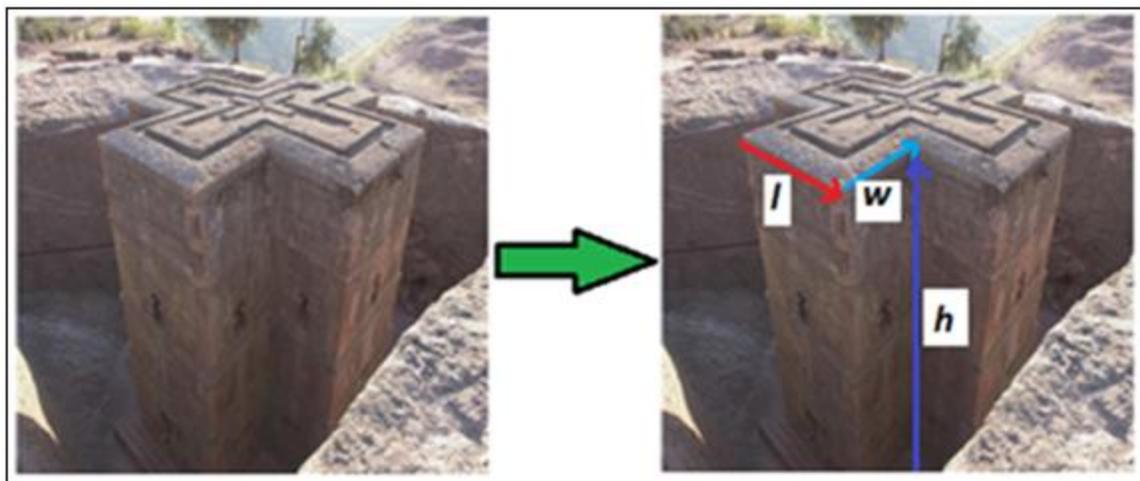


Figure 3. Rock-hewn church at Lalibela and measurements.

To keep students interested and actively involved in constructing their own understandings, in discovering and inventing mathematics, students should work collaboratively and cooperatively so that they can examine and articulate their ideas through the teacher’s guiding directions,

balance, and rhythm using questions that probe their students' thinking in ways that will be extended to other heritages with rich mathematical content, such as the Obelisks. Examples include:

- What is the shape?
- How can the surface area and the volume of this shape be determined?
- If dissection along each valley is performed, how many solids will be produced?
What will be the volume and the surface area of each solid?
- What should be the area of the region enclosed by the outer most line of the cross on the top of the roof?

4.3 The role of history of mathematics in mathematics education

An increasing report of student's inability to apply the mathematics learned in schools prompted a shift toward accommodating ethnomathematics in the school curriculum. Ethnomathematics as described by Vithal and Skovsmose (1997) clusters around four major areas of which the history of mathematics is among others. Allies of the history of mathematics generally agree that this emphasis not only prepares for the specific content studied but that questions which refer to the 'real world' from an ethnomathematical base provides learners as a bridge between the abstract role of mathematics and their role as a member of society.

The history of mathematics contains many context-rich problems that challenge student thinking and initiate the invention of new ideas and the discovery of related mathematical propositions. Obviously, people on any part of the world have such assets handed to them from their past generations; otherwise they could have their own as recent histories. Thus, these assets must be used as catalysts to learn the academic mathematics through discussions that involve questions such like: who was created them and for what? Why were invented? What is used for now? And how is this related to a specific topic that students deal in their formal mathematics? The use of context-rich problems from students' cultural background or related history is supported educationally. For instance, Davis (1996) suggests focusing on such 'novel' mathematics problems because students would come to these problems without prior instruction in how to solve them. For Davis, it would be the experience of inventing a way to deal with such problems that would enable the students to learn what mathematics really is, and what it means to "do mathematics". It is generally agreed that the history of mathematics constitutes an essential component of ethnomathematics and thus, ethnomathematics offers sociohistorical approach to

mathematics education. That means an ethnomathematics approach to the teaching and learning of mathematics minimizes the risk of reducing mathematics learning to simple, isolated behaviors; rather it appreciates learning in the social, time specific context in which it occurs. To separate the history of mathematics of ethnic groups from the mathematics they experience at school seems somewhat futile. Izmirli (2011, p.34), argues that: “*an interdisciplinary and transcultural approach to the history of mathematics is important to address Eurocentrism, the oversimplified and yet the prevalent view that most worthwhile mathematics known and used today was developed in the Western world*”. Thus, using history from the ethnomathematical perspective appeals students to learn school mathematics because it helps them develop the view that: mathematics is really discoverable, mathematics is a human product, mathematics is what all people share in common, and mathematics is a continuous and growing subject. In this regard, mathematics is a human product should be evident from students’ cultural background which might be apparent through the role of ethnomathematics. Matang (2002) presents an excellent example of common ethnomathematical practice that help students learn a lot of abstract mathematics taught at school more meaningfully.

Different cultures have these opportunities to practice these advantages favorably with current and long histories. For instance, current histories depicted in the diagram in Figure 4, can play significant role enriching the academic mathematics. Several questions of mathematical nature can be drawn from these cultural artifacts and be integrated with academic mathematics at schools to building real understanding of mathematics (Gerdes, 1991; Ascher, 1991; Barton, 1996). Also, the inclusion of these cultural heritages of mathematical content will add flavor and inspiration to the community of learners in the classroom and elsewhere because they can talk and negotiate about mathematical ideas of rich context. For instance, students can be challenged to name shapes to the nearest shape in academic mathematics and determine measurements. Further, using the object in the second column and in the second row many parallel lines and congruent angles can be drawn.

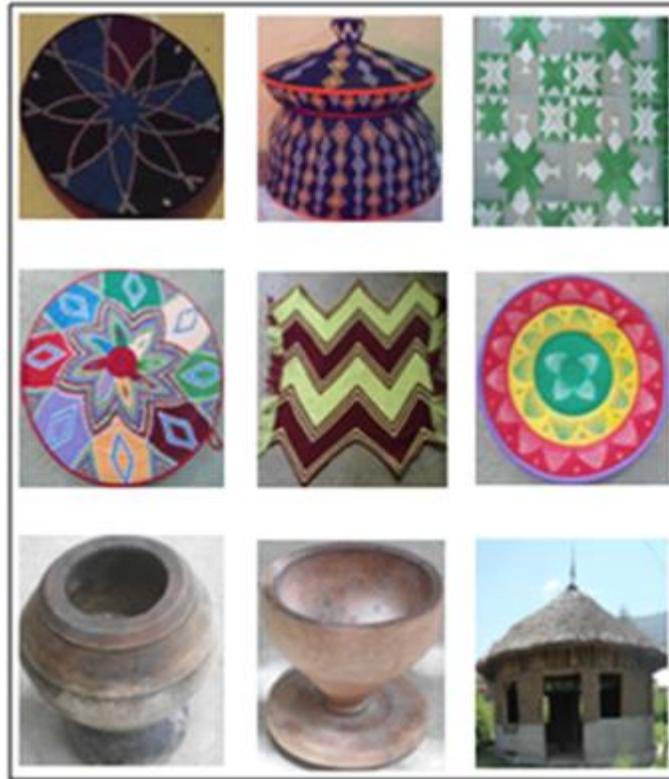


Figure 4. Current histories of mathematical significance

4.3. Domain Based Activities in Some Culture

The impact of increasing the role of ethnomathematics in the mathematics curriculum, which uplifts students' ability in meaning construction and learning mathematics with meaning through the provision of open activities, has not been subjected to scrutiny for its consideration of social roles, for example gender roles, in everyday activities and their impacts in mathematics performance in the society. In everyday activities of the underrepresented societies, social groups seem to have their domain restricted or domain oriented practices, while there are some activities that they practice equally well. If there is disparity in practicing societal activities of mathematical significance in underrepresented or traditional societies, they are equally likely to be affected by these restrictions. James Bank, one of the foremost authors of this subject, (quoted in Zaslavsky, 1993, p.50) talks about these disparities in modern education as well.

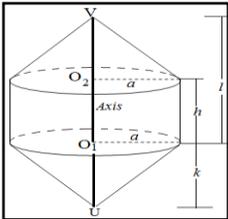
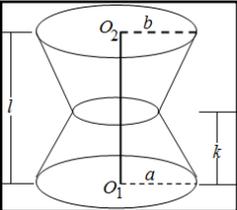
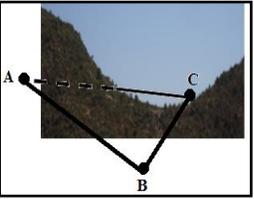
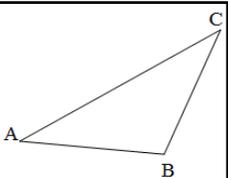
“The Western-centric and male-centric canon that dominates the school and university curriculum often marginalize the experiences of peoples of color, Third World nations and cultures, and the perspectives and histories of woman.”

Here, James Bank tends to emphasis on disparities between and among Western and the non-Western, the developed and the Third World, as well as men with women in modern societies. However, it lacks identifying the role of social groups in the society and study the predicted impact on academic mathematics to narrow the gaps in attainment. Mathematics as a cultural product evidences various societies developed their own mathematics to satisfy their needs. The study of mathematics as a cultural product and the mathematics of non-European mathematics have got common seat in mathematics education research, however, not exhaustively explored. For Zaslavsky (1993), not to include such contributions is to imply that these people had no mathematics or science. The same applies to women of all races and ethnic backgrounds. A recent work by Hailu Nigus Weldeana (2015, p.8) details the in-depth discussion of everyday activities of culture into: *male-domain*, *female-domain*, and *domain-neutral* and their mathematical significance as well as the predicted roles they could play in the mathematics curriculum upon inclusion (see Table 2).

Cultural applications must form an integral part of the mathematics curriculum. They must inspire students to think critically about the reasons for these practices, to dig deeply into the lives and environment of the people involved. To do this effect, works must be thorough, well-planned, and organized in order to help student learn mathematics in a sense making way.

However, Matang (2002) argues that it is the process, not the finished product that is significance to the mathematics. This and other cultural products are traditional structures of distinct cultures that represent the knowledge and skills of the indigenous people (Gerdes, 1985). The production of these everyday materials involves a lot of geometric ideas that are of particular relevance in making correspondence with the school mathematics and making the academic mathematics realistic. After all, these productions involve determining shapes and sizes, perimeter and area, estimation and approximation and even the great advantage of problem solving, while at the same time, access to practice to the opposite domain was denied clearly.

Table 2. Local pictures, rough corresponding global pictures, and mathematical significance.

Local Material	Rough corresponding global picture	Domain type	Local Name	Mathematical significance
		Male domain	“Gottera” or “local solo”	• Volume and surface areas of cones and cylinders from a realistic perspective.
		Female domain	“Seat for coffee pot”	• Volume and surface areas of frustums.
		Domain Neutral	“Aquarach”	• Shortest path postulate and triangle inequalities.

Patterns that should be attended in producing these everyday materials of mathematical significance can be used as sources of student learning experiences (Zaslavsky, 1993; 1994). Once we as teachers make the learning environment open, some contributions of mathematical relevance may come from students themselves. According to Zaslavsky (1993), such a classroom practice brings the world into the mathematics class by introducing both cultural applications and current societal issues which have the potential of motivating students. Such mathematical content offers wonderful opportunities for project work, cooperative learning, connections with other subject areas, and community involvement. Thus, mathematics learning is that of trying to get pupils involved in a mathematical activity that makes sense for them within the context of their socio-cultural activity.

5. IMPLICATIONS FOR THE MATHEMATICS CURRICULUM

Current mathematics curricula should incorporate students' cultural background to offer opportunities for all students to learn and achieve as well as to promote students' spiritual, moral, social, and cultural development and prepare all students for the opportunities, responsibilities, and experiences of adult life. In support of this position, the National Council of Teachers of Mathematics, in its Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989, p.68) argues that "Students' cultural background should be integrated into their learning experiences". The aim is to produce not only learners who are well empowered and informed citizens but who capably participate in a democratic society to resolve problems and difficulties. To attain this above objective, Davis (1996); and Boaler (1993) suggest mathematics leaning in context-rich situations. Both of these authors argue that students should spend their time solving novel or context-rich problems open to reflection after the solutions to the problems are invented. For these authors, an enhanced role of ethnomathematics in the mathematics curriculum is the best cure for the ill-thought or wrong view that "school mathematics is not a part of the world outside school" because ethnomathematics offers the opportunity for students to combine and integrate the self-generated methods they use in 'real' situations with school taught algorithms and procedures. To that end, Boaler (1993, p.345) argues that:

Ethnomathematics is seen as a means with which to free the curriculum from ready answers and solutions, providing the opportunity for students, not only to generate problems, but to understand how and why other problems are generated. Through discussion and analysis of self-generated methods students therefore develop an enhanced awareness of all mathematics in given and general situations.

Thus, mathematics is a part of students' social and cultural lives and the social and cultural is a part of their experience in the mathematics classroom. In particular, D'Ambrosio (1985), the leading author in ethnomathematics seems to be suggesting that if students are encouraged to use self-generated methods and to explore their usefulness they will develop an enhanced mathematical understanding because they are starting from a perspective which is their own. Thus, ethnomathematics offer students the opportunity to combine and integrate the self-generated methods they use in 'real' situations with school taught algorithms, integrate process

and content, acknowledges students' cultural values, and involves students in discussions and negotiation of meaning through open activities.

6. CONCLUSION

The view that mathematical ideas are fixed, predetermined, and that they exist outside the realm of the learner has been challenged since decades before. Boaler (1993) maintains that mathematics curricula which fail to recognize the individual construction of meaning within the domain of the social, the value of negotiation, and challenge and the need for a balanced and holistic perspective, probably initiate and maintain students' inability to transfer the mathematics they learn in school to real world situations.

The realization of students' cultural background in mathematics instruction in general and ethnomathematics in particular provides bridges between school mathematics and students' everyday practice in ways that help break social and individual barriers. In order to put the role of ethnomathematics into effect, curriculum experts should at least be aware of its relevance, in ensuring effective teaching and meaningful learning in the mathematics classroom and thus, should offer some space for accommodation. According to Matang (2002, p.35),

Utilizing students' rich ethnomathematical in the classroom encourages the development of a conceptual knowledge base amongst students. It also enables students to develop wide-ranging problem-solving strategies that require both teachers and students further verify their validity in a variety of both familiar and unfamiliar situations, thereby making mathematics a meaningful and reflective subject.

Of course, these problems that brought to the class by the students and that incorporated in the curriculum by the experts, as Davis (1996) as well as Boaler (1993) have suggested, should be 'novel' that magnify the role of ethnomathematics in providing context-rich problems that enhance students' problem solving strategies and offer much opportunity in providing the necessary contextual meaning to many abstract mathematical concepts.

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