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The Importance of Ethnomathematics Education

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Abstract

Cultural values, traditions, and symbols are manifested in the life of every society. Culture, therefore, occupies a very important place in human life and society, affecting economic, social, religious, and educational activities. Education in general and mathematical education in particular is also affected by cultural values. This essay discusses the importance of the development and implementation of math curricula that integrates cultural and folkloric elements and values from the daily life and society of the students, including Geometry in Bedouin embroidery. This article discusses the essence of the ethnomathematics approach and its importance in mathematics education.

Keywords

Ethnomathematics, Geometry, Academic Achievements, Bedouin Embroidery

1. Introduction

Ethnomathematics is a part of mathematics which is a link between formal concepts and practice in culture, so that students' understanding of material is easier because the material is directly related to culture which is their daily activity. The aim of ethnomathematics is to recognize that there are other and different ways of expressing and doing mathematics which so far have only been confined to formal education in schools by adopting various societal cultures (Putra & Prasetyo, 2022). With the objective of the ethnomathematics approach, students are expected to be able to construct an understanding of mathematical concepts through their previous experience. One aspect of the goals of learning mathematics is understanding the concept. Conceptual understanding is an ability related to understanding comprehensive and functional mathematical ideas (Fahrudin et al., 2018). Understanding of concepts is an important component of

ability, because mathematical concepts are hierarchical in nature (Juniantari et al., 2019). With mathematical concepts that have a hierarchical nature, students who have a strong understanding of concepts are the main milestones in helping students to solve problems related to mathematics.

In addition, one of the challenges currently facing math teachers is how to impart to students the mathematical rules and content in a more effective, enjoyable, and successful manner. Arguments in recent years have revolved around the contribution of culture to the promotion of the math taught in schools. The question debated was and remains,

"Can the instruction of mathematics that includes cultural values from the students' daily lives contribute to a more meaningful education, to better student achievement, and higher motivation?"

In order to answer this question numerous studies have been conducted and various curricula have been implemented by mathematics educators and researchers around the world. One solution to this problem was proposed by researchers who support the ethnomathematics approach and who testified to the importance of integrating cultural elements and values in mathematics instruction. In their view, an ethnomathematical curriculum contributes to the development of student skills and talents, to a more meaningful comprehension of the material, and to better achievements in math (Amit & Abu Qouder, 2017). Geometry is perceived as one of the most complicated mathematical areas to teach (Hoffer, 1981).

2. The Definition of Ethnomathematics

The term ethnomathematics was coined by D'Ambrosio (1985) to describe the mathematical practices of identifiable cultural groups and may be regarded as the study of mathematical ideas found in any culture. D'Ambrosio (1990) defined ethnomathematics in the following way: "The prefix ethno is today accepted as a very broad term that refers to the social cultural context and therefore includes language, jargon, and codes of behaviour, myths, and symbols. The derivation of mathematic is difficult, but tends to mean to explain, to know, to understand, and to do activities such as ciphering, measuring, classifying, inferring, and modelling. The suffix tics is derived from techno, and has the same root as technique" (p. 81). In other words, ethno refers to members of a group within a cultural environment identified by their cultural traditions, codes, symbols, myths, and specific ways used to reason and to infer (Rosa & Orey, 2007). Mathematics means to explain and understand the world in order to transcend, manage and cope with reality so that the members of cultural groups can survive and thrive, and tics refer to techniques such as counting, ordering, sorting, measuring, weighing, ciphering, classifying, inferring, and modelling. Rosa and Orey (2003) stated that the mathematic develops the tics within the context of ethnos because it consists of daily problems people face, larger problems of humanity, and endeavours of humans to create a meaningful world. According to D'Ambrosio (1990), the search for solutions for specific problems

that help the development of mathematics are always imbedded in a cultural context: in order to understand how mathematics (tics) is created, it is necessary to understand the problems mathematic that precipitate it. It is necessary to understand those problems (mathematic) by considering the cultural context (ethnos) that drives them. D'Ambrosio (1993) stated that the mission of the ethnomathematics program is to acknowledge that there are different ways of doing mathematics by considering the appropriation of the academic mathematical knowledge developed by different sectors of the society as well as by considering different modes in which different cultures negotiate their mathematical practices. Barton (1996) stated that in this conception, ethnomathematics is a program that investigates the ways in which different cultural groups comprehend, articulate, and apply concepts and practices that can be identified as mathematical practices. Moreover, ethnomathematics may be described as a way in which people from a particular culture use mathematical ideas and concepts for dealing with quantitative, relational, and spatial aspects of their lives (Borba, 1997). This way of viewing mathematics validates and affirms all people's experience of mathematics because it demonstrates that mathematical thinking is inherent to their lives. Further evidence of this assertion is given by Orey (2000), who stated, "The paradigm that diverse cultures use or work within evolves out of unique interactions between their language, culture and environment" (p. 248). Within this context, D'Ambrosio (2006) argued that in an ethnomathematical perspective, mathematical thinking is developed in different cultures in accordance to common problems that are encountered within a cultural context. In D'Ambrosio's (1993) perspective, in order to solve specific problems, ad hoc3 solutions are created, generalized methods are developed from those solutions to solve similar problems, and theories are developed from these generalized methods. In the context of ethnomathematics, many cultural differentiated groups know mathematics in ways that are quite different from academic mathematics as taught in schools. The tendency has been to consider these ad hoc mathematical practices as non-systematic and non-theoretical. In contrast, the study of ethnomathematics underlies a structure of inquiry in ad hoc mathematical practices by considering how these practices and problem-solving techniques can be developed into methods and theories. Since different types of problems are common in different cultures, the kinds of solutions, methods, and theories that are developed may differ from culture to culture. In this regard, what is recognized as a problem and a solution in one culture may have no meaning at all in another one.

3. The Ethnomathematical Approach and Its Effect on Geometry Instruction

One of the leading and most successful approaches in the field of mathematics education is the ethnomathematical approach, in which instruction is based on the integration of cultural-educational elements that express mathematical values from the students' daily life. Numerous researches have been conducted

around the world in support of the ethnomathematical approach in order to develop effective and engaging instruction and learning strategies and in order to prove their positive effect on successful student learning. The Brazilian researcher and educator, D'Ambrosio, is one of the most renowned researchers supporting the ethnomathematical approach, and he has made significant contributions to its development and dissemination throughout the world. D'Ambrosio developed and proposed a new curriculum in the 1984 called "The socio-cultural basis for mathematics education" (D'Ambrosio, 1984). This proposal emphasized the importance of integrating cultural aspects of the instruction of mathematics within the learned subjects. This practice helps students absorb the materials and understand them better. He suggested recognizing three aspects: reading and writing, mathocracy and technocracy.

Through ethnomathematics which is linked to human life, learners can be more active in solving problems because they are related to their lives (D'Ambrosio, 1987).

According to (D'Ambrosio 2002) educators are responsible for the learning process and therefore they must develop informal curricula that refer to the reality in which the student lives, while integrating traditional values in their cultural-educational context in the mathematical instruction and learning process.

According to (Gilmer, 1990) teaching math without cultural context on the pretext that it is perfect, abstract, and universal is the reason for students' declining achievements and their failure. To remedy this situation, we must find ways to help students learn about their cultural mathematics. When students are exposed to different mathematical cultural values and reflect upon them together they discover that they know more than they thought they knew when they were judging them-selves by the formal, traditional mathematics. Furthermore, in this way they develop a desire to learn and their self-confidence grows. Also ethnomathematics helps them solve more complex problems (Powell & Frankenstein, 1997). Implementing situations from the local culture in the classroom is one way in which to assist students in seeing the relevancy of math to their culture, and subsequently use this link to assist in teaching math. One project that does this is a project called "Increasing the Participation of Native Americans in Higher Mathematics", conducted in Oklahoma (Aichele, Douglas, & Downing, Carl, 1985).

Many empirical studies point to the improved achievements of students from diverse ethnic and cultural backgrounds in mathematics tests after taking part in an ethno-mathematics program.

In addition several researchers developed and implemented a theoretical structure to analyze student's lack of desire to participate in a cultural course for teachers (Verner, Massarwe, & Bshouty, 2013). Participants were pre-service and in-service teachers, Arabs and Jews, religious and secular, who studied geometry through inquiry into geometric ornaments drawn from diverse cultures, and acquired knowledge and skills in multicultural education. The methodology of engagement structures recently proposed by (Goldin et al., 2011) was used to

analyze the emotional behaviors in the course. The research findings showed that engagement structures were a powerful tool for examining the student's lack of motivation to study math. The constructivist ethnomathematical approach highlighted the structures that matched our instructional goals and diminished those related to students' feelings of dissatisfaction and inequity. The researchers suggested a new engagement structure "Acknowledge my culture" that nurtures math education. Findings also showed that the participants perceived this type of learning as a meaningful experience that, contrary to other learning methods, enhances their positive feelings toward other students and teachers and contributed to a lively discourse among them and raised their level of motivation. Studies show that knowledge based on faith and affiliation to a group leads to cultural coexistence and inner peace (Amit, Fried, & Abu-Naja, 2007), which in turn improve the students' self-conception and achievements.

4. The Effect of Integrating Cultural Values on Learning Mathematics

We believes that, educators are responsible for the learning process, which includes the development of curricula and learning strategies based on the integration of cultural elements and values, and particularly ethnomathematical units of measurement, geometric shapes from the Bedouin woman traditionally embroidered, in math instruction. The use of units measurement and geometric shapes from the students' culture and of cultural values and previous knowledge in this endeavor may contribute greatly to the students' learning process, help them better understand the study material, raise their motivation and, ultimately, improve their achievements in math. This process may also contribute to an increase in students' sense of belonging to their immediate environment and their cultural values and traditions.

The effectiveness of math education and its effect on student achievements is high on the agenda of numerous countries (Keitel, Damero, Bishop, & Gerdes, 1989), which is one reason why numerous researchers have developed and implemented ethnomathematics curricula. Studies that have been conducted on such curricula testify to its effectiveness in various aspect of math education.

For instance, (Lipka, Wong, & Ihrke, 2012) Presented findings from an educational project conducted among American Indians and American-Alaskans for the purpose of examining the effect of the local culture on math instruction for these students. The re-searchers worked with the elders of the Yup'ik tribe in order to include daily cultural activities in the school curriculum. Accordingly, the students initially learned in theory the traditional methods of math education and then implemented them in practice.

A Similar results we founds in our research among a Bedouin population in Israel. This study included the development and implementation of an ethnomathematics curriculum based on integrating Bedouin cultural values and elements for an especially constructed learning unit on the subject of units of measurement. Four 7th grade classes' two classes in the experiment and two as a control

were the research population. Findings showed a clear improvement for the experimental group in various outcomes such as motivation and self-conception, which were at higher levels after the implementation of the ethno-mathematics program compared to before. For the control group, these values did not change between the two measurements and in fact slightly dropped. The study also affected the student's positions toward their culture and the adults in their society, making these positions more positive (Amit, & Abu Qouder, 2017).

5. Ethnomathematics in Bedouin Cultural

In light of the numerous changes that have occurred in the structure of Bedouin society in Israel and the cultural customs of this population as a result of the process of modernization, many of the traditional socio-cultural characteristics and values have disappeared. For example, one of the basic characteristics of traditional Bedouin life was living in a tent and roaming the land. One can argue that today, in Israel, such a way of life no longer exists, as the Bedouins now reside in permanent homes. Nevertheless, despite the numerous changes in their way of life, the Bedouins have managed to preserve to some degree several of their traditional social and cultural values and practices. One of these practices is the sewing and embroidery skills of Bedouin women, which were passed informally from mother to daughter, from one generation to another, until very recently.

The embroidery traditionally practiced by Bedouin women included numerous shapes and objects, such as flowers, plants, geometric shapes, numbers, round letters, line types, and animals all of which were hand-embroidered very precisely, using various methods and colors, several types of cloths, needles, and a special white net. This essay details these tools and the way they embodied ethno-mathematical knowledge that was used to consistently embroider precise geometric shapes.

6. Examples of Integrating Bedouin Embroidery in Math Instruction

1) The isosceles triangle

The various properties of the isosceles triangle can be used to prove that the triangle in Bedouin woman embroidery is indeed an isosceles triangle. One such property is that in an isosceles triangle, the altitude bisects both the base and the angle of the apex and is also perpendicular to the base. Further, in an isosceles triangle, the base angles are equal.

How Bedouin women traditionally embroidered the isosceles triangle?

In order to embroider the shape of an isosceles triangle, the Bedouin woman uses a counting method in which an odd number of squares are stitched one beneath the other, beginning with the apex. For example, if the embroiderer desires to create a triangle from 16 stitches, she begins with one stitch at the apex of the triangle, then embroiders three stitches and then five stitches. Finally, she

finishes by embroidering a line of seven stitches, which forms the base of the triangle. The result is an isosceles triangle as defined above and as shown graphically in Figure 1. Figure 1 shows such an isosceles triangle in an actual Bedouin dress.

2) The Square

The properties of a square: A square is a regular quadrilateral that has four equal sides and four equal angles of 90˚.

How Bedouin women traditionally embroidered a square?

In order to embroider a square, Bedouin women begin with any number of stitches, whether odd or even, in a horizontal line. For example, and as shown in Figure 2, an embroiderer could begin with a horizontal line made of six stitches, and then embroider a vertical, 6-stitch line on the right side of the horizontal line. The second vertical 6-stitch line on the left would follow, and then, finally, the embroiderer returns to the first vertical line on the right and embroiders a horizontal line of six stitches from one vertical line to the other, thereby completing the square. When Bedouin women embroider a square, they are concerned with using an equal number of stitches on all sides. Therefore, we can argue that the Bedouin cultural method of embroidering a square applies the two basic properties of the square shape: first, that all the sides in the square are equal, and second, that all angles are right angles. Figure 2 shows such a square embroidered on a dress.

3) The Rhombus

The properties of a rhombus: All sides have equal length; all the opposite sides of the rhombus are parallel and all the opposite angles are equal; the diagonals of a rhombus bisect each other at right angles, creating four right triangles within the rhombus.

How Bedouin women traditionally embroidered a rhombus?

In order to embroider the rhombus shape, Bedouin women employ the method of counting the number of squares they embroider on the "mirka" in order to determine the desired lengths of the sides and the overall size of the rhombus. Bedouin women embroider the rhombus in two steps. In the first step, an isosceles triangle is embroidered as described above. In the second step, after completing the first triangle, the exact same triangle is embroidered on the base of the first triangle. The embroider starts this second triangle by embroidering five stitches on the base of the first triangle. Following this, three stitches are embroidered and the triangle is completed with one stitch that is actually the apex of the new, second triangle. As shown in Figure 3, the diagonals of the embroidered rhombus divide it into four equal, right triangles, which is one of properties of the rhombus.

4) The Kites:

The properties of a kite: A kite is a quadrilateral with two sets of distinct, adjacent, congruent sides. The diagonal that goes through the vertex angles is the angle bisector for both angles, and the non-vertex angles of a kite are congruent.

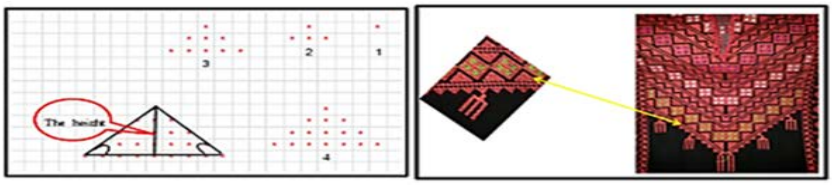

Figure 1. Traditional Bedouin method for embroidering an isosceles triangle.

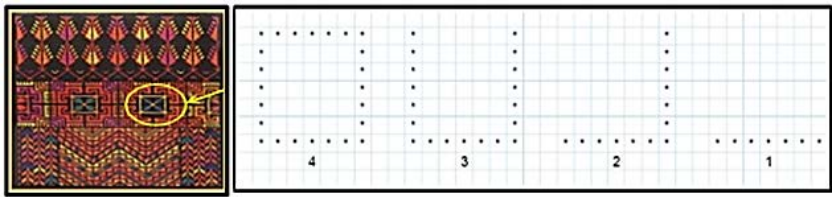

Figure 2. Traditional Bedouin method for embroidering a square.

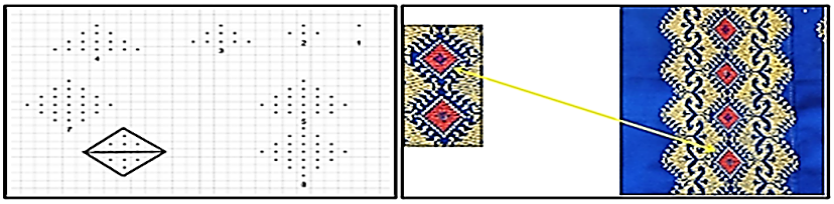

Figure 3. Traditional method of embroidering a rhombus.

How Bedouin women traditionally embroidered kites?

Bedouin women use two steps to embroider the kite shape. In the first step isosceles triangle is embroidered as explained above. In the second step, a second triangle is embroidered by copying the base of the first triangle in the row adjacent to it, as shown in Figure 4, step 6. While the base of the two triangles is identical, the rest of the second triangle is embroidered with fewer stitches. Thus, as seen in Figure 4, the base of the two triangles has nine stitches but the next rows in the second triangle consist of fewer stitches; in this case five stitches are used in the second row instead of seven in the first triangle. To complete the second triangle, the embroiderer adds stitches in an unorganized series, to ensure that the second triangle is of a different size from the first triangle. Thus, since the Bedouin woman embroiders two triangles of different sizes, with each triangle embroidered in the opposite direction to the other, she has embroidered a kite. Figure 4 shows this shape on a dress.

Slide symmetry: This is the method by which some form is copied or "translated" by mirroring the form without tilting, flipping, or resizing, also called translation symmetry.

How Bedouin woman traditionally employed slide symmetry in embroidery?

In this type of embroidery, the embroiderer begins with one shape that she wishes to repeat. Then she moves several spaces and embroiders the same shape. This pattern is repeated with the embroiderer taking care to preserve the same distance between copies of the same shape, and the same direction and size of each

copy. Examples of this type of symmetry are shown in Figure 5 and Figure 6.

Rotational symmetry: In this type of symmetry, the copied form is rotated with respect to the original form with one point, which called the rotational point, serving as a joint axis for all the rotated copies.

How Bedouin woman traditionally employed rotational symmetry in embroidery? In rotational symmetry Bedouin women use the odd or even counting method. They begin with one central stitch and then stitch around it in an expanding circle. Examples of this type of symmetry are shown in Figure 7 and Figure 8.

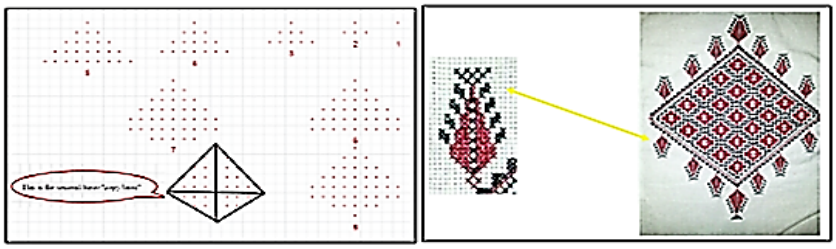

Figure 4. Traditional method of embroidering a kite.

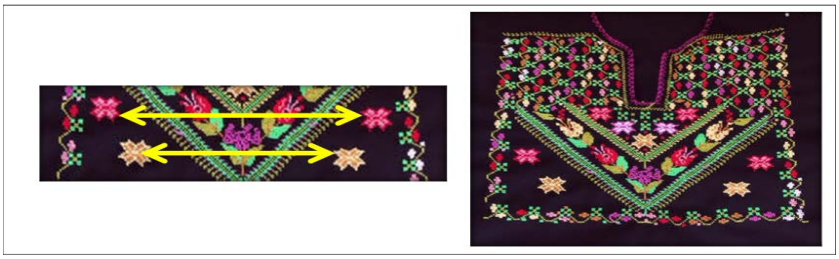

Figure 5. The top of a Bedouin dress uses slide symmetry.

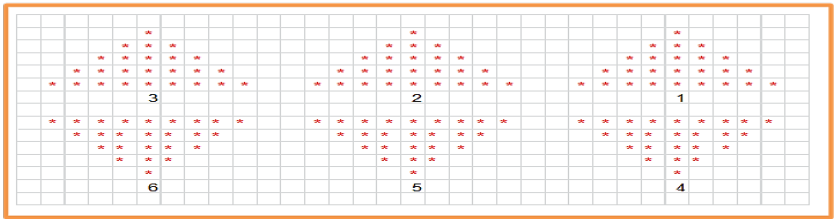

Figure 6. Traditional Bedouin method of embroidering slide symmetry.

Figure 7. The top of a Bedouin dress uses rotational symmetry.

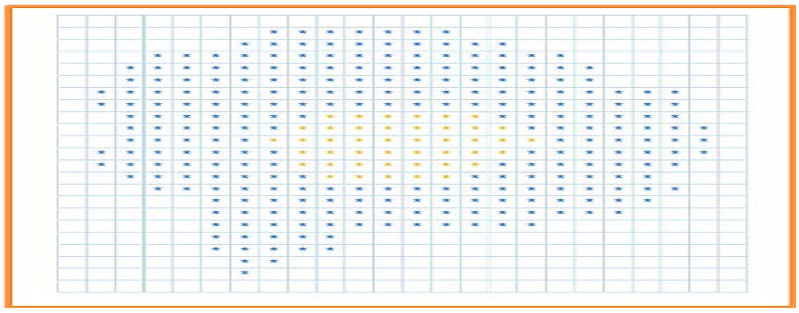

Figure 8. Traditional Bedouin method of embroidering a rotational symmetry.

7. Conclusion

Following the development of the ethnomathematical trend as an educational-cultural field, several proposals were suggested and numerous attempts were made to develop curricula with multicultural mathematical ideas that include traditional cultural values, traditions, symbols, and mechanisms for the purpose of aiding the instruction of mathematical subjects. This trend testifies to the importance and centrality of ethnomathematics, which appears now not only as a matter of enrichment or the property of a certain society of power, but as a matter that requires an overall effort to develop. Therefore, cultural values must be utilized in mathematical education and instruction, out of solidarity and respect for all cultures as such, while preserving their future existence (Shirley, 2001).

According to D'Ambrosio (2002), educators are responsible for the learning process and therefore they must develop informal curricula that refer to the reality in which the student lives, while integrating traditional values in their cultural-educational context in the mathematical instruction and learning process. As he stated:

"Education must impart respect of culture and take into account cultural values. This matter requires much more than is offered in the regular curriculum. The situation of math is particularly grave. It has no relation to the experience of children. We need more mathematical content that creates interest" (pp. 3-5). Teaching mathematics without cultural context on the pretext that it is abstract and universal is the reason for the failure of students in this subject. On the other hand, when students are exposed to various cultural links and reflect upon them together, they develop a desire to learn and their self-confidence grows. A similar result was found in a research we conducted and that included the development and implementation of an ethnomathematical curriculum among two groups of Bedouin students in Israel (Amit, & Abu Qouder, 2017).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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