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Ethnomathematics in Anatolia-Turkey: Mathematical Thoughts in Multiculturalism

Etnomatemática en Anatolia-Turquía: Pensamientos matemáticos en multiculturalismo

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Abstract

Mathematical thoughts are in interaction with culture and they, together, form an indivisible whole. Therefore, Ethnomathematics both helps us understanding the nature of mathematics and contributes to understanding of one's self as well as the other people sharing the same planet.
Ethnomathematics reflects the studies of mathematical thoughts of multicultural or traditional societies. Mathematical thought is an approach in which people try to find quick and systematic solutions to a problem in many ways. The role of Ethnomathematics, which studies mathematical thoughts, cannot be ignored in a historical-cultural context. This paper examines some reflections of Ethnomathematics in Anatolian culture through geometry perception in engineering field, carpet, rug motifs and intelligence games.

Keywords: Ethnomathematics; History of mathematics; Anthropology; Mathematics education; Geometry.

Resumen

Los pensamientos matemáticos están en interacción con la cultura y forman un todo indivisible. Por consiguiente la Etnomatemática nos ayuda a comprender la naturaleza de las matemáticas y contribuye a la comprensión de uno mismo, así como a las demás personas que comparten el mismo planeta.
La Etnomatemática refleja los estudios del pensamiento matemático de las sociedades multiculturales o tradicionales. El pensamiento matemático es un enfoque en que las personas intentan encontrar soluciones rápidas y sistemáticas a un problema de varias maneras. El rol de la Etnomatemática, que estudia los pensamientos matemáticos, no puede ser ignorado en un contexto histórico-cultural. Este documento examina algunas reflexiones etnomatemáticas en la cultura Anatoliana a través de la percepción de la geométrica en el campo de la ingeniería, las alfombras, los adornos de las alfombras y los juegos de inteligencia.

Palabras claves: Etnomatemática; Historia de las matemáticas; Antropología; Educación matemática; Geometría.

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INTRODUCTION

"Mathematics" ("mathematika" in Greek and "mathematics" in English) was first put in 550's B.C. by the members of Pisagor School in the meaning of "thing to be learned". Then, plural forms of it are as "*ta mathematika*" in Greek and "*mathematica*" in Latin. In English this plurality is shown with the letter "s" to the end of singular form and it is the reflection Pisagor's term "everything" (Tez, 2008). Ethnomathematics is a term which is used to explain the relationship between culture and mathematics. Research on mathematical thoughts of traditional societies has led to the emergence of ethnomathematics. The term "Ethnomathematics" was first, in the late 1960s, used by a Brazilian mathematician Ubiratan D'Ambrosio. He questioned an unquestioned acceptance up to that time as "*What is perceived as mathematics today is definitely a science which is globally used and unique to Western Civilization. The only way to found a civilization on earth is the regain of the lost respect of the losers as well as the joint movement of both winners and losers for a new mathematics. Thus, ethnomathematics is a step for peace".* This questioning made it possible for ethnomathematics -which makes use of data and findings of different disciplines like linguistics, sociology, history, philosophy, arts as well as mathematics and ethnology-become one of the major disciplines in time with the help of intense and qualified studies, see figure 1 (Ercan, 2005).

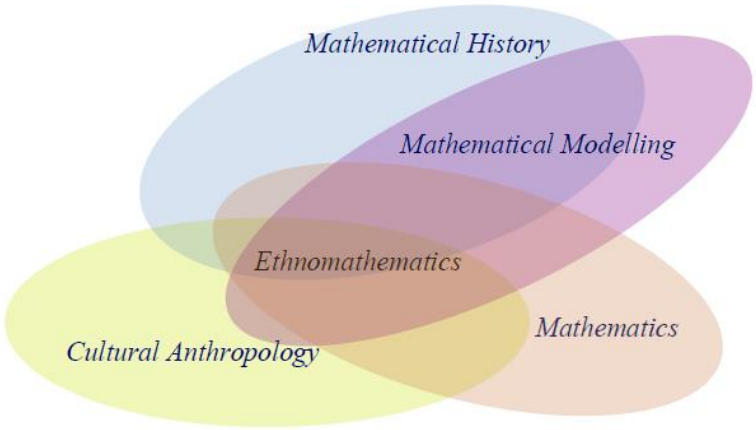


Figure 1: *Ethnomathematics as intersection of different disciplines*

D'Ambrosio (2001) made an etymological and morphological inquiry and remarked that ethnomathematics is composed of the combination of the following parts:

Ethno: the culture formed by a society.

Mathema: explaining, understanding, learning, managing, dealing, achieving and superiority.

tics: counting, ordering, differentiating, measuring, weighing, encoding, classifying, comprehending and modelling.

Parallel to the increase in our experiences, new problems arise inevitably leading to the emergence and development of sciences. This is the main source of the science. Today, the quality, causality and the formality of scientific knowledge and science are major research areas. One of the definitions of scientific knowledge is that it is justifiable. What is more, science might be defined as an activity, in which scientific knowledge is gathered systematically (or in paradigms), new questions arise, and those questions are tried to be answered by giving way to the emergence of new information in a unique methodological way. Not paying too much attention to the definitions, scientific knowledge is a product of human and it is verified and accepted considering findings of the era it is produced. Thus, scientific knowledge, also, can change or can be reformulated more precisely (Bora, 2005). Since science, as a product of human mind, is falsifiable in nature, it is not independent of ideology, religion and culture quite contrary to what is claimed. Moreover, scientific knowledge does not need to be universal; it might be local as well. Both universal and local knowledge complement each other. It gained great support from history of science (Ercan 2005). For example:

- The analysis of numeration systems development is one of the most interesting topics of mathematics history. Today, we use base 10 numeration systems. The justification of this is we have ten fingers. However, some American or Oceanian local tribes use base 4, 5, 6, 8 or 20 numeration systems with the similar reasons. 4 stands for the number of used fingers except from thumb; 5, the number of fingers in a hand; 6, two times counting of thumb; 8, the number of fingers in two hands except from thumbs; and 20, total number of fingers in hands and feet.

- The methods used by Oceania inhabitants and Eskimos in sea or in endless glaciers to find their ways show the local feature of mathematics which can be adapted to globalism (Bora, 2005).

With these in mind, ethnomathematics pursues the goal of viewing mathematics from a multicultural perspective by enlarging its historical background. There have been numerous studies in the literature which emphasize the importance of ethnomathematics (Achor, Imoko & Uloko, 2009; Gerdes, 2001; Barkley & Cruz, 2001; Barta, 2001; Brenner, 1998; Arismendi-Pardi, 2001; Kara, 2005; Moses-Snipes, 2005; Strutchens, 1995).

This paper examines some reflections of ethnomathematics in Anatolian culture through geometry perception in engineering field, carpet, rug motifs and corresponding mind games.

ETHNOMATHEMATICS IN ENGINEERING FIELD

It is possible to observe different mathematical thoughts of human in many diverse residential districts, especially in bridges, fountains and mosques in Anatolia. For instance, these differences might be seen in the bridges which were constructed in 1230s and which are still in use in Giresun, Yağlıdere and Ulu Cami (mosque) which was built in 1229 in Sivas, Divriği. What might be the real secret behind these long-lasting, even centuries long, bridges and buildings while 50-60 years of durability is estimated to the ones constructed with today's technology? In fact, it would be wise to comment that apart from those days' engineering knowledge; mathematical thought is also a crucial factor in answering that question. When we analyses the shape of construction and architecture of bridges, it is generally seen that bridges were built in a narrow area where water runs, its feet were located on hard rocks and it has a paraboloid surface with parabolic curve normal sections. The reason behind it is to make bridges more resistant to flood and other natural disasters and make them with less oscillation (Picture 1, 2 and 3). In fact today's bridges do not have such features (Pictures 4 and 7).

Some pictures regarding these bridges are:

Picture 1. *13th century bridge (restorated).*

Picture 2. *13th century bridge (not restorated).*

Picture 3. *13th century bridge (not restorated).*

The bridges in the first three pictures were built in the same century with identical engineering and architectural features. But great differences were observed in construction of bridges and, therefore, in engineering and architectural thoughts of people who lived in the 19th and 20th century. Bridges are mostly straight and suspended with much oscillation (Picture 4 and 5).

Picture 4. *A 20th century suspension timber bridge.*

Picture 5. *A 20th century suspension bridge*.

In relation to the changing thoughts of the people in 21th century it is observed that bridges are straight, long, and not high, its feet are placed just above where the water runs and it is constructed in a wide area resulting in a risky position which is irresistible to big natural disasters like flood (Picture 6 and 7).

Picture 6. A *21st century bridge during which is under construction.*

Picture 7. *A collapsed bridge flood*

Similar thought have also been observed in fountains. So as to let people and animals drink water easily fountains were built from carved stone, again with a paraboloid surface (Picture 8). However similar features are seldom seen in 21st century fountains (Picture 9).

Picture 8. 19th century fountain.

Picture 9. 21st century fountain.

On the other hand, power of the earth is always in a circle and everything tries to be circular. Space, earth and stars are always round. Very strong winds turn around themselves. The sun and the moon, both of them are round, rise and set from a circle. The change of seasons and movements of planets happen in a round shape and always go where they come from (Ascher, 2005). These engineering and architectural thoughts might be seen in Ulu Cami which was built in the 13th century in Sivas, Divriği. The fact that geometrical shapes on the walls and in a circle are fractal makes us think the eternity might be observed in these monuments (Picture 10, 11 and 12).

Picture 10. *Geometrical Shapes used in the decoration of Ulu Cami*

Picture 11. *Geometrical Shapes used in the decoration of Ulu Cami*

Picture 12. *Geometrical Shapes used in the decoration of Ulu Cami*

The column in front side of the mosque in Picture 12 was constructed to find out whether there is a collapse in the mosque and it might be turned even with a finger. Yet stemming from the landslides due to new residential areas around the mosque the column lost its feature.

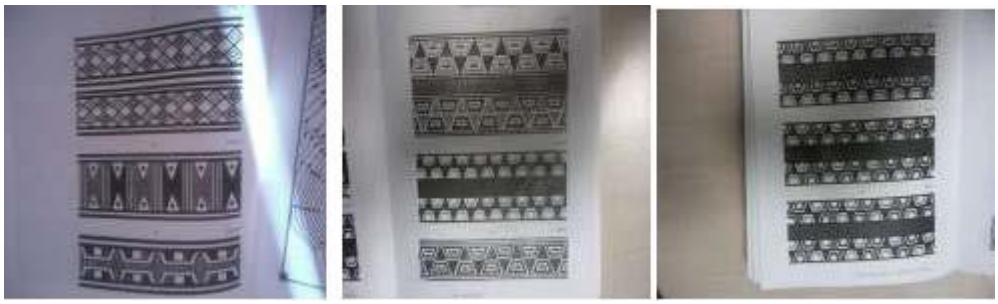
ETHNOMATHEMATICS IN ANATOLIAN MOTIFS

The kipus and bands made by Inca people and, carpets and rugs made by Anatolian people have deep meanings in their lives. They are invaluable and unique to those societies. Inca people are believed to live approximately through the years 1400 and 1560 with a sophisticated culture. Their population is estimated 3-5 million people. (Their territory was today's Peru, and some parts of Ecuador, Bolivia, Chile and Argentina.)

Picture 13. *A completed and enwrapped kipu.*

Picture 14. *Unwrapped kipu*

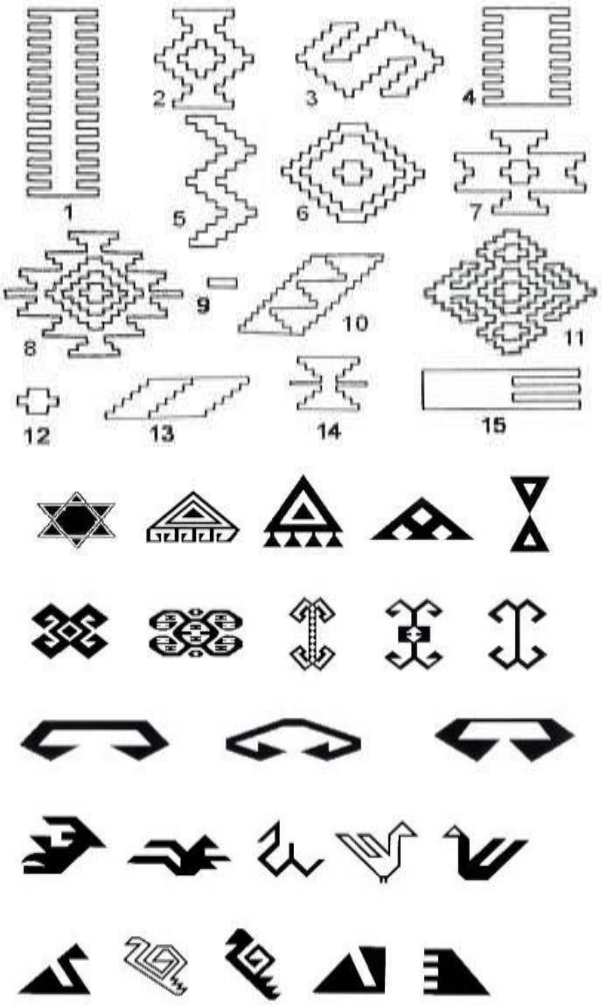
Colour of the ropes, binding shapes to each other, placements, gaps between each other, knotting shapes in individual bindings and placement of knots are all parts of a logical-mathematical record. Inca people were believed to make calculations in agriculture and in trade with these.



Picture 15. Some band models of Inca people

Likewise the relationship between kipu, bands and Inca people, carpet and rug weaving have a similar role in the life styles of the Anatolian people. These carpets and rugs not only have a decorative value but also have an important role in village life because each of them is a work of art. They reflect hopes, moods, missing, sorrow, beliefs, in short, all lives of those people. A unique culture and life is hidden in these carpets. Observing these carpets and rugs is a way of comprehending village life and culture in a sense. However, although motifs and geometrical figures in these works of art have deep meanings many of us don't even think of these realities. Therefore this paper seems valuable in terms of examining ethnomathematics through some reflections of thousand year old geometry perception in carpet and rug motifs in Anatolian culture. Some of them are as follow:
http://www.cerezforum.com

SOME GEOMETRICAL SHAPES USED IN CARPET AND RUG MOTIFS WEAVED IN ANATOLIA



Picture 16. Some geometrical shapes used in carpet and rug motifs weaved in Anatolia.

Some geometrical shapes used in carpet and rug motifs and their meanings are given below.

The Geometrical Shapes used in Amulets and Evil Eye Beads

This figure, generally triangular, quadrangle and pentagon in shape, symbolizes that some people's looks have a kind of power and these looks may lead to misdeed, harm, unluckiness and even death.

The Geometrical Shapes used in Bird Figures

Bird motifs obtained with shapes like triangles, quadrangle, parallelogram and octagon in carpets and rugs have many diverse meanings. For instance while birds like owl and raven mean bad luck, dove, pigeon and nightingale are used to symbolize good luck.

Bird is the symbol of happiness, joy and love. It symbolizes strength and power. It is also the symbol of many civilizations settled in Anatolia, and empire. For example bird symbol can be seen in the flag of Ghaznavids (961-1187), (Picture 17).

Picture 17. The Flag of Ghaznavids

The Geometrical Shapes used in Hook and Latin Cross Figures

These motifs which are composed of geometrical shapes like triangle, parallelogram, pentagon, hexagon, circle and star are believed to protect people from danger.

The Geometrical Shapes used in Eagle Figures

Eagle figure which include different geometrical shapes like quadrangle, pentagon, hexagon and 17-gon, 20-gon (17-20 sides) symbolizes power, strength, amulet, dominance of government and items like spells used in old religious ceremonies.

Picture 18. An eagle figure from the wall of Ulu Cami.

The Geometrical Shapes used in Cleat Figures

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The figure of cleat which is weaved by using trapezoid, triangle, 29-gon, 7-gon and 14-gon represents productivity, heroism, strength and happiness.

The Geometrical Shapes Used in Fertility Figures

The figure which consists of equilateral quadrangles, triangles, hexagons and trapezoids symbolizes a family. This pattern is believed to protect the family from the evil eye.

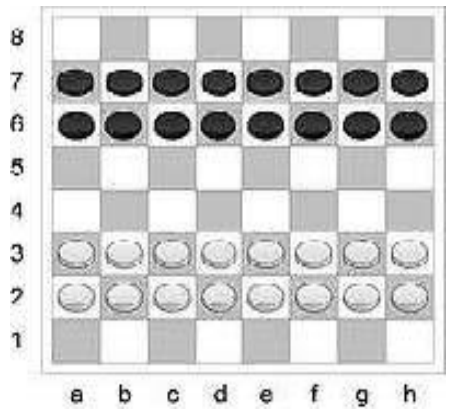
Picture 19. *Some hand weaved rugs from Anatolia*

ETHNOMATHEMATICS IN INTELLIGENCE GAMES

History of mathematics has always been in interaction with mathematical games. Gaming is a common language of individuals. Games are determined according to physical, cognitive and intellectual levels of individuals. These types of games are also encountered in Anatolia. The names and pictures of the games which had been played by almost everyone from 7 to 70 at everywhere once upon a time in Anatolia, yet they are almost disappeared nowadays. Some of these games are given below.

Turkish Checkers

Turkish Checkers is an enjoyable game which is played almost all regions of Anatolia. Picture 20.



Picture 20. Turkish Checkers.

Well (Mangala) Game

Mangala is a game which is played in different regions of Anatolia with different rules. It is played by putting small pebble stones to each well by five or six times. Wells might be done on stones, sand or grass (Picture 21, Picture 22).

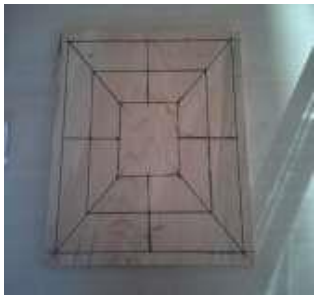
Picture 21. Mangala Rock at Gaziantep Castle museum

Picture 22. A thousand year old Mangala at Mersin, Kanlı Divane.

Nine Stone and Twelve Stone Games

These games are played with two players and each player should have 9 and/or 12 small stones for the game (Picture 23, Picture 24).

Picture 23. Nine Stone Game.



Picture 24. Twelve Stone Game.

Match Game

This game is played with 40 match sticks and it is another intelligence game in Anatolian culture, Picture 25.

Picture 25. Match Game.

CONCLUSIONS AND SUGGESTIONS

It has been observed that geometrical shapes are widely used in architectural works of art and hand-knotted carpets made in Anatolia in the 13th century. This makes us infer that 13th century people living in Anatolia were closely interested in geometry and they made use of geometrical shapes in almost all fields of life. Therefore, this study portrays that ethnomathematics has an important place in mathematics education in historical-cultural field. Anatolian culture is full of these treasures. It is possible to get the students to realize how societies do mathematics in their own cultures and their mathematical thoughts especially by developing an ethnomathematical curriculum model in educational programs. The mathematical idea which will be obtained by this way might be helpful for students to learn formal mathematics and to provide the skill of mathematization any kind of future situations. What is more, students who have negative attitudes to mathematics perceive that understanding this course is really hard and this course is quite boring. Therefore an ethnomathematics based educational program and mathematical problem solving activities might be helpful in both making the course more entertaining and creating a more positive attitude to the course with a better understanding.

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