EFFECTS OF INSTRUCTIONAL DESIGN INTEGRATED WITH ETHNOMATHEMATICS: ATTITUDES AND ACHIEVEMENT

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ABSTRACT

EFFECTS OF INSTRUCTIONAL DESIGN INTEGRATED WITH ETHNOMATHEMATICS: ATTITUDES AND ACHIEVEMENT

This study was designed for two major goals which are to develop an instruction integrated with ethnomathematics related to symmetry and patterns subject with examples from Topkapı Palace and to clarify the effects of this instruction in an experimental design.

In order to analyze the effectiveness of the instruction on mathematics achievement level and attitudes towards mathematics a quasi-experimental design was implemented in three schools (137 seventh grade students) in İstanbul, by obtaining quantitative data (*Scale for Attitudes Towards Mathematics, Mathematics Achievement Scale 1,*and *Mathematics Achievement Scale 2*) and qualitative data (*Open ended questionnaire for attitude towards mathematics, Evaluation sheet and Interview).*

Repeated measures ANOVA was used for analysis of data and results indicated that both regular instruction and the instruction integrated with ethnomathematics were effective in improving linear trend over the mean values between pre, post and retention level of mathematics achievements of the students in control and experimental groups of all three schools. There was a significant interaction effect of type of instruction and mathematics achievement levels between the experimental and control group of only one school. None of the instructions were effective in improving a significant linear trend over the mean values between pre and post levels of attitude towards mathematics of the students. There was a statistically significant interaction effect of type of instruction and attitude towards mathematics between the experimental and control group of only one school. The results obtained by qualitative data can be summarized as students in the experimental group had more positive attitudes towards mathematics than the students in control group.

ÖZET

ETNOMATEMATİĞİN ENTEGRE EDİLDİĞİ ÖĞRETİM TASARIMININ ETKİLERİ: TUTUM VE BAŞARI

Topkapı Sarayı'ndan örneklerle simetri ve örüntüler konusunda etnomatematik uygulamalı bir öğretim tasarımı gerçekleştirmek ve bunun etkilerini deneysel bir desen ile ortaya çıkarmak çalışmanın başlıca iki amacıdır.

Etnomatematiğin entegre edildiği öğretim uygulamasının matematik başarısı ve matematik tutumu üzerinde etkililiğini ölçmek için yarı deneysel araştırma deseni kullanılmış ve İstanbul ilinde üç ayrı okuldan 137 yedinci sınıf öğrencisi çalışmanın örneklemini oluşturmuştur.

Matematik Tutum Ölçeği, Matematik Başarı Ölçeği 1 ve *Matematik Başarı Ölçeği 2* olmak üzere üç araç ile deney ve kontrol grubu öğrencilerinin matematik başarı düzeylerinde ve matematiğe karşı tutumlarında oluşan değişim ölçülmüştür. İki yönlü tekrarlamalı varyans analizi sonuçları, her iki grubun öğrencilerinin ön test- son-test ve kalıcılık testlerine göre matematik başarı düzeylerinde doğrusal bir eğilim olduğunu, bir okulda ise deney ve kontrol grupları arasında öğrencilerin matematik başarı düzeylerindeki değişim açısından istatiksel olarak anlamlı bir fark olduğunu göstermiştir. Deney ve kontrol gruplarındaki öğrencilerin matematiğe karşı tutumlarında bir doğrusal gelişim olmadığını ve üç okuldan sadece birinde, deney ve kontrol grupları arasında öğrencilerin matematiğe karşı tutumlarındaki değişim açısından istatiksel olarak anlamlı bir fark olduğunu göstermiştir.

*Açık Uçlu Matematik Tutum Anketi, Değerlendirme Anketi ve Görüşme*den alınan nitel veriler, deney grubundaki öğrencilerin matematiğe olan tutumlarının kontrol grubundaki öğrencilere göre daha olumlu yönde geliştiğini göstermiştir.

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LIST OF SYMBOLS / ABBREVIATIONS

df	Degree of freedom
f	Frequency
M	Mean
n	Number
Sig.	Significance
Std. Deviation	Standard Deviation
MATT	Scale for Attitude Towards Mathematics
MAS1	Mathematics Achievement Scale 1
MAS2	Mathematics Achievement Scale 2
MATT-Q1	Open ended questionnaire for attitude towards mathematics
MATT-Q2	Evaluation sheet
MATT-I	Interview questions

1. INTRODUCTION

Mathematics helps people to think critically, to solve problems systematically and to actualize the mathematical activities such as counting, measuring quantities, designing buildings and works of art in their life. Mathematics and life are related with each other. When making mathematical activities, culture and those activities reciprocally affect each other. Mathematics is not a culture free discipline (Zaslavsky, 1998). Relating mathematics and daily life has become a crucial issue of math education in recent years (National Council of Teachers of Mathematics, 2000; Mathematics Curriculum of Primary Schools in Turkey, 2006). One of the problems of mathematics education is that students cannot easily relate what they learn with their lives, which results in learning problems of students, negative attitudes towards mathematics and low achievement levels.

The OECD Program for International Student Assessment 2003 (PISA) results showed that the performance of Turkish students who were in the 44^{th} rank among 49 countries on mathematical literacy. This kind of literacy ascertains students’ capacity to identify the role of mathematics in the world, to make judgments and to use mathematics in ways that meet the needs of that individual’s life (Retrieved from the official website of PISA). Results of international studies probably lied to the changes take place in curriculum of Primary Schools which is accomplished by the Ministry of National Education.

There is a tendency to a constructivist learning philosophy in the new national curriculum. The new mathematics curriculum emphasizes learning the core of mathematics. The philosophy of the new mathematics curriculum stated by the Ministry of National Education (Mathematics Curriculum of Primary Schools in Turkey, 2006) is based on the idea that every child can learn math by using math in the life physiologically and psychologically actively, by solving problems in teamwork as well as by discovering the aesthetic and entertaining characteristics of math. Eventually the curriculum assumes that students will have positive math attitude and self-concepts towards mathematics.

One of the aims of new mathematics curriculum of Turkey is to relate mathematics lessons to students' daily live. One way of integrating academic mathematics which is taught and learned in the school and practical mathematics is by using *ethnomathematics*, *"the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes."* (D'Ambrosio, 1997; p.16). Presmeg defines ethnomathematics as "the mathematics of cultural practice" (Presmeg, 1998; p.328). With the synthesis of mathematical concepts and ethnomathematical perspectives, students can realize real people in their real life context while developing mathematical ideas (Zaslavsky, 1998).

Tapia and Marsh (2000), Ma and Xu (2004) and Singh *et al.* (2002) showed that achievement level in math was reciprocally related with students' attitude towards math. Butty (2001) noted that students with better attitudes towards math had a significantly higher achievement scores than those with poorer attitudes toward mathematics. On the other hand, Schultes and Shannon (1997) found that many students gained greater appreciation for math after learning the subject matter from a cultural perspective since it made students more comfortable and confident about discussing mathematical concepts such as infinity with their peers (Arismendi-Pardi, 2001).

The aim of this study was to design an instruction integrated with ethnomathematics in the light of the goals of the new primary school mathematics curriculum to positively affect students' attitudes towards mathematics and increase their achievement level in mathematics. Specifically, this study investigates the effect of mathematics instruction integrated with ethnomathematics on the 7^{th} grade students' attitude towards mathematics and math achievement. The instruction was prepared for the chapter entitled as, *Mathematics in Our Life* which consists subjects of symmetry and patterns.

2. LITERATURE REVIEW

The literature review consists of four parts which can be listed as *(a) attitude towards mathematics, (b) an overview on definitions of ethnomathematics, (c) research on ethnomathematics* which will be guide for this study *(d) tilling and patterns in Turkish and Islamic ornaments* for the development of instructional design part which will be given in the next section.

In the first part, the construct *attitude towards mathematics* is defined by Ma and Kishor (1997); Aiken (1980); and Ercikan, McCreith and Lapointe (2005). In the second part, the definitions of ethnomathematics were discussed. The research review on ethnomathematics is based on the ethnomathematical applications of cultures and the integration in the educational area. Tilling and patterns in Turkish and Islamic ornaments part is summarized in order to guide the reader for seeing the geometrical shapes from the ethnomathematical perspective. The instruction will be based upon the deductions gained from related literature.

2.1. Attitude towards Mathematics

The literature review on attitude toward mathematics points out studies that mention what attitudes toward mathematics refer to and how it affects achievement in mathematics and participation to mathematics lessons.

Ma and Kishor (1997) stated that attitude toward mathematics refers to students' affective responses to whether they find mathematics easy/difficult or important/unimportant. Neale (1969) defined attitude toward mathematics “students' affective responses to a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics and a belief that mathematics is useful or useless" (Ma and Kishor, 1997; p. 43).

Aiken (1980) merged several definitions of attitude to assert that attitudes may be conceptualized as learned predispositions to respond positively or negatively to certain objects, situations, concepts, or persons. As such they possess cognitive (beliefs or knowledge), affective (emotional, motivational), and performance (behavior or action tendencies) dimensions.

Ercikan, McCreith and Lapointe (2005) noted that in Canada, Norway and USA, the strongest predictors of participation in advanced mathematics courses were students' attitudes towards mathematics.

2.2. An Overview on Definitions of Ethnomathematics

This part of the literature review is to present an overview on the definitions of ethnomathematics. Table 1.1 represents an overview on the definitions of the ethnomathematics stated in this part, from definition of D'Ambrosio (1985) to the definitions of Vithal and Skovsmose (1997).

Table 1.1. Definitions of Ethnomathematics

ORIGINAL YEAR OF PUBLICATION	AUTHOR	Date Cited (If Different From The Publication Date)
1985	D'Ambrosio	1997
1986	Ascher and Ascher	1996
1993	Gerdes	1997
1994	Pompeu	
1986	Presmeg	1998
1997	Vithal and Skovsmose	

In 1970's Brazilian mathematician, Ubiratan D'Ambrosio contributed the term **ethnomathematics** to the literature during his oral presentations. In 1980's, he used the term in an article named as *Ethnomathematics and its Place in the History and Pedagogy of Mathematics* published in *For the Learning of Mathematics* (D'Ambrosio, 1997).

D'Ambrosio (1997) who is also a pioneer in the philosophy of mathematics makes a historical overview about mathematics education and determines some periods throughout Western history according to major turns in the socio cultural compositions. According to him, mathematics had two distinct branches in the times of Plato and those branches are called as "scholarly" mathematics, which was incorporated in the ideal education of Greeks, and "practical" mathematics for buying, selling and such issues for laborers. He says that in the middle ages there was a convergence of that practical mathematics that began to use some ideas from scholarly mathematics in the field of geometry. This approximation was fostered with the translation from the Arabic of Euclid's Elements. He says also that Fibonacci was probably the first who began this mixing of the practical and theoretical aspects of arithmetic.

The next turn according to D'Ambrosio (1997) is the Renaissance with the changes in the architecture. The approximation is felt by scholars who start to use the vernacular for their scholarly works, writing in a non-technical language and in a style accessible to non-scholars. The approximation of practical mathematics to scholarly mathematics increases in the industrial era, because of necessity in dealing with increasingly complex machinery and instruction manuals, as well as social reasons and begins to enter the school system (D'Ambrosio, 1997). The last tread in the periods of the twentieth century was structured with the question of *what mathematics should be taught in mass educational systems*. The answer has been that it should be a mathematics that maintains the economic and social structure, reminiscent of that given to the aristocracy when a good training in mathematics was essential for preparing the elite and at the same time allows these elite to assume effective management of the productive sector (D'Ambrosio, 1997). The mathematics, which is taught and learned in the schools, is called as *academic mathematics*. On the other hand, "*ethnomathematics is the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes* (D'Ambrosio, 1997; p. 16). Its identity depends largely on focuses of interest, on motivation, and on certain codes and jargons, which do not belong to the realm of academic mathematics. Ethnomathematics is to include much of the mathematics, which is currently practiced by engineers, especially calculus. This is a very broad range of human activity throughout histories that remains alive in culturally identified groups and constitutes routines in their practices." Ethnomathematicians are concerned with the social history of mathematics, which aims at understanding the mutual influence of socio-cultural, economic and political factors in the developments of mathematics (D'Ambrosio, 1997).

Pompeu (1994)presented in the *International Study Group on Ethnomathematics* (ISGEm) (which is founded in 1985 and an affiliate of US. National Council of Teachers of Mathematics) *Newsletter* "ethnomathematics refers to any form of cultural knowledge or social activity characteristic of a social and/or cultural group." (p.3)

In NOVA (Science in the News journal), which published by the organization Australian Academy of Science, it is claimed that:

> Advocates of ethnomathematics say it is helping different cultures to understand each other. Mathematics is seen as integrated with Western civilization, which conquered and dominated the entire world. On the other hand, ethnomathematics recombines them in unusual discipline by melting science and social justice. Besides some scientists, see it as a legitimate discipline to offer the modern world.

Gilmer (1995) who was one of the founders of ISGEm (*The International Study Group on Ethnomathematics which was founded in 1985 by math educators Gloria Gilmer, Ubiratan D'Ambrosio, Gil Cuevas, and Rick Scott.)* defined ethnomathematics for a dictionary of multicultural education:

> Ethnomathematics is the study of the mathematical practices of specific cultural groups in the course of dealing with their environmental problems and activities. … It can be exemplified as the manner in professional basketball player who estimates angles and distances different from the manner used by truck drivers. Professional basketball players and truck drivers are from identifiable cultural groups that use mathematics in their daily work. They have their own language and specific ways of obtaining these estimates and Ethnomathematicians study their techniques. (p.19)

Ascher & Ascher (1986) defined ethnomathematics as "the study of mathematical ideas of a nonliterate culture". According to them mathematical ideas of nonliterate people must be drawn from ethnographic literature, in addition non-literate people, in other words primitive people do not have professional classes for mathematics, as a result their mathematical ideas are implicit in various areas or activities rather than being explicit.

Presmeg defines ethnomathematics as “the mathematics of cultural practice” (Presmeg, 1998; p.328).

D'Ambrosio (2001) states that:

> Ethnomathematics term requiring a dynamic interpretation is used to express the relationship between culture and mathematics. The concepts, which cannot be categorized in only neither ethno nor mathematics. The term ethno describes all of the ingredients that make up the cultural identity of a group: language, codes, values, jargon, beliefs, food and dress, habits, and physical traits. Mathematics expresses a broad view of mathematics which includes arithmetic, classifying, ordering, inferring, and modeling. (D'Ambrosio, 1987). Ethnomathematics reveals how mathematics continues to be culturally adapted and used by people throughout time. Since there is no relevance of culture constructed between content and instruction, teachers and students are not aware of the connection existing between mathematics and culture. They may assume that “mathematics is acultural, a discipline without cultural significance”. (p.22)

Zaslavsky (1998) also mentions about ethnomathematics and multicultural mathematics education:

> People in various cultures are engaged in doing ethnomathematics which is meeting of cultural anthropology with mathematics and education and ethnomathematics is not only ethnic mathematics; mathematics developed by different ethnic groups is included in it also. The relationship between multicultural mathematics education with ethnomathematics is the inclusion in the curriculum especially ethnomathematics of people’s ethnic and racial groups, men and women, the various classes in society and practices and problems of students’ own communities. (p.43)

According to Vithal and Skovsmose (1997), support in education has become an essential consequence of industrialization in the *Third World Countries* to which modernization was applied. Especially W*esternization in Education* became crucial. Ethnomathematics is a reaction to this cultural imperialism, which is built into modernization theory: “A main concern for ethnomathematics is to come to identify culturally embedded mathematical competences and instead of thinking in terms of importing curriculum to think in terms of self-development. A curriculum can be related to an already existing competency in mathematics” (Vithal and Skovsmose, 1997; p.132). They identify four strands of ethnomathematics. First is the traditional history of mathematics. Second is the analysis of the mathematics of the traditional cultures and of indigenous people. Those cultures are examined in terms of number systems, gestures and symbolisms, games and puzzles, geometry, space, shape, patterns, symmetry, art and architecture, time, money, networks, graphs, sand drawings, kin relations and artifacts, farmers, and carpenters. The other strand deals with the mathematics of different groups in everyday settings showing that mathematical knowledge is generated in a wide variety of contexts by both adults and children and developing strategies for solving mathematical problems in everyday situations. Lastly, the relationship between ethnomathematics and mathematics education is another focus point. It deals with the connection between mathematics found in everyday contexts and in the formal school system.

All of the definitions consider the points such as the culture in which mathematics arise, mathematics that is implicit in cultural in cultural practices, the use of anthropological principals to investigate mathematical practices, relation and implications for mathematics education. The definition of D’Ambrosio, which is *the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes* (D’Ambrosio, 1997; p.16) is used in this study as the main focus of the instruction integrated with ethnomathematics. In addition to this definition, instruction integrated with ethnomathematics of the study, as Zaslavsky (1998) stated, includes ethnomathematics of people’s ethnic and racial groups’, the various of classes in the society and practices of students’ own communities.

2.3. Research on Ethnomathematics

Ethnomathematics researchers study the cultural history of mathematics or mathematics inherent in cultural practices or artifacts and ethnomathematics in mathematics education. The first research was on mathematics inherent in cultural practices or artifacts. The latter ones are on ethnomathematics and mathematics education area.

Leonel Morales (1993) studied about the geometry found in the various aspects if the daily activities of the Maya. Some of the activities are the designing of the cities, the shape of buildings, ceramics and weavings and geometry in the Mayan language. He found out the following:

> The layout of Mayan cities has a relationship with the astronomy. Second is that Mayan calendar is calculated with the stages of corns. Third, buildings have geometric shapes that are supposed to be planned before their construction. In addition, paintings are also supposed like that because of the symmetry in the murals. Besides, ceramics have geometric shapes and a collection of curves and other geometric figures. For decorative curves in which human figures, animal and flower shapes are used. There are spiral curves. In their native language, a number of mathematical terms are used, which shows the high level of geometry in this civilization. The terms such as quadrilateral, cylindrical, measuring, playing dice, along side of etc. for the weavings in both personal and domestic designs of mosaics, having different interpretations can be found. Repeating triangles in rows and chains either horizontally and vertically or diagonally, broken lines, rotations, rhombuses and chains can be seen on those mosaics.

Barta, Abeyta, Gould, Galindo, Matt and Seaman (2001), mention about the mathematical ecology of the Shoshoni and implications for the elementary mathematics education and the young learner. Firstly, researchers try to find the culturally specific use of mathematics in Shoshoni traditional living places with qualitative research techniques. Bishop (1991) stated that some of the everyday activities of people involve a substantial amount of mathematical applications which are the six universal mathematical behaviors: counting, measuring, designing, locating, explaining and playing, can be seen in all cultures (as cited in Barta *et al.,* 2001). According to Barta *et al.,* (2001), mathematical connections to daily practices of any culture can be identified by using these mathematical behaviors. Barta and his colleagues based their analysis on the six universal mathematical behaviors as follows:

> Firstly, counting system of Shoshoni was based on the grouping of ten to quantify objects, people, and events of daily life. Values range from one to countless. The infinity is represented as "having no end" like "more of those than there are hairs on a horse". Secondly, mathematical operations are used according to their needs such as dividing the meat after hunting to equal parts. Thirdly counting is done with hand gestures. Measuring is actualized with parts of body such as arms, hands, paces. They classified the shapes as having corners or not having. Circles have a crucial place in their lives because they believe in that everything in the life is round and circles represent the life circles as they have no beginning and no end. Shapes also convey spiritual significance. Moreover, triangles represent mountains and individuals. When creating a tool patterns are used. For locating, they drew maps by using stars as clocks, rivers. For the display of wealth and prominence some ways were used such as clothing tools, weapons etc. the number of elk teeth, the kind of fur are some of the ways. Lastly there are games for men, women and children in the Shoshoni playing in which mathematics especially probability is embedded. (p.88)

Moyer (2001) reports that some contributions of diverse cultures foster understanding of mathematics. Knowing how one's own culture has contributed to mathematics and these contributions enhance our cultural environment supports the acquisition of mathematical power. According to her, teachers have two questions to cover mathematical programs with math: "*Where does culture fit into mathematics instruction?"* and *"How do I as a teacher, with limited experience with cultural diversity, reflect in my* *mathematics program."* The author suggests that teachers can integrate culture in small ways. According to Davidman and Davidman (1994) they will go on to examine deeper issues such as ensuring educational equity, empowering students, reducing prejudice, and promoting cultural pluralism (as cited in Moyer, 2001). The study of Moyer (2001) makes suggestions about the use of patterns as one starting point to integrate culture in math lessons and describes a mathematics experience that connects these ideas for students. The author claims that teachers will start to see culture as a part of their current mathematics instruction and may begin to integrate culture in their lessons in rich and meaningful ways such as investigating patterns and symmetry found in architecture, clothing, pottery, and baskets of many culture. Zaslavsky (1994) says that the cloths of Asante's people in Ghana are reflections of both cultural values and geometric skills and symmetry of designs can be found on mirror patterns on palace walls of an ancient Persian king many centuries ago, and there are tessellating patterns in Islamic culture in repeating designs that decorate mosques and palaces (Moyer, 2001). Moyer (2001) claims that exploring those geometric designs requires an understanding of the ways that shape tessellates and of their line or reflection and rotational symmetry and teachers can discuss objects that show repeating patterns and symmetry. She gives examples of Native American peoples' using rotational symmetry to produce intricate basket designs in which students can visualize the concepts of line and rotational symmetry. She suggests teachers to show students examples of tessellating patterns that have elements repeating and have the fact that no gaps or spaces appear between the repeating pieces and no piece overlap and to show them how to create tessellations using geometric shapes so that the arrangements fit together as a puzzle with no spaces between the blocks. The author also exemplifies lines of symmetry and transformational geometry including translations (slides), reflections (flips) and rotations (turns). Another class activity Moyer (2001) suggests students' working together to create a pattern quit with tessellations line and rotational symmetry and coloring their designs.

Moses (2005) implemented ethnomathematics and multicultural mathematics activities and tried to investigate to what extend that affected African American students' achievement. The role of culture is seen as prevalent in the learning of mathematics and there is a great interest in the use of multicultural activities in the mathematics classroom. African cultural activities related to geometry are used whether African American students' achievement in geometry and perceptions of mathematics in general. The factors affecting African American students achievement are determined as parents, who plan an integral role in child’s education, socioeconomic factors, teachers, especially their expectations, curriculum and course enrollment (Moses, 2005). For the curriculum factor, Suleiman and Moore determined an affective and conducive learning environment having the following characteristics:

i. Provide mathematics resources consistent with the social and educational demands of the global technological society
ii. Motivate all students to learn mathematics
iii. Adjust teaching to the unique learning styles if students of math
iv. Highlight contributions of all cultures in the areas of math and science
v. Prepare teachers of math to affectively respond to the cultural and linguistic variables affecting the acquisition of math. (Moses, 2005; p.88).

Moses (2005) gives reasons to include culture in mathematics as follows:

> “Multicultural activities should not be seen as separate from “regular mathematics” but should be discussed when relevant to study and learning. Culture should be included in the mathematics classroom because it improves students’ academic achievement (Banks, 1989), helps move classrooms towards and equitable learning environment (NCTM 1989, 2000), helps students to have positive beliefs about mathematics (Masingila& King, 1997), and integrates mathematics with other disciplines (Zaslavsky, 1989, 1998).” (p.45)

In the study of Moses (2005), the sample was constituted in two groups, which were math instruction with African culture and the other without African culture. Pre assessment instrument measured geometry concepts such as linear measurement polygons, circles, and solids. Matching the corresponding definitions, short constructed responses to solve problems and performance tasks to solve problems by explaining them were used. The post assessment was for the measure of mathematics achievement and how students’ mathematical knowledge developed over the course of their respective geometry units. With the study in the quasi experimental design, qualitative and quantitative data were collected. According to results, students’ achievement scores increased as they learn about African culture.

Another study which is similar to above mentioned study was conducted by Arismendi-Pardi (2001). Aim of the study is comparing the final grades of students in a college intermediate algebra course taught with and without ethnomathematical pedagogy. It is found that there was a statistical significant difference between mean scores in Intermediate Algebra course of students who were taught with ethnomathematical pedagogy and those who were taught without ethnomathematical pedagogy in favor of the first group. .

Presmeg (1998) argues that the ethnicity of students is a resource for mathematics teachers. He notes that beliefs about the nature of math are a factor in the implementation of ethnomathematical approach. D'Ambrosio (1985) said that mathematics is a cultural product, which needs to be acknowledged as such in the classroom, for both the purpose of meaningful learning of the subject in developing countries (Presmeg, 1998). For the use of cultural practices in learning school mathematics, a graduate course was designed in the development of mathematical activities and concepts from authentic cultural elements by students. It has two components which are theoretical and practical. In the practical component, each week the class participates in at least one cultural activity and explores mathematics of that activity and its potential for developing mathematical understanding. In the research component, participants are required to investigate a personally meaningful theoretical or pedagogical aspect of their choice, which relates to mathematics as a cultural product, to write a paper on their topic, and to organize classroom discussion or an activity relating to this topic. Some of the activities of the practical part are geometrical designs on Ndebele houses (South Africa), symmetric strip decorations (Inca, Maori) Traditional American quilting patterns (Presmeg, 1998). Two activities were explained in the study of Presmeg (1998). One of them is Traditional North Pacific navigation in which traditional methods are saturated with mathematical ideas. For example, non-linear system of astronomy is related with dividing a planned journey into segments according to rising positions of star constellations. The presenter of this activity dressed in traditional Micronesian costume, used a genuine bamboo stick chart and asked to students to navigate from one island to another. The second example was about mathematical elements in Korean flag and related with the mathematical dimensions and proportions. The meaning of the symbols and the patterns in those shapes are also explained those patterns are also related with the mathematical patterns. In conclusion, the authenticity of the projects, which were done by the students, students' ownership of their projects, the connection between mathematical ideas and lived experience of individual students, were emphasized.

Powell and Temple (2001) gives a board game example called as *Oware* and played in Africa as a math activity, which can be played at schools. With the literature review of the studies of ethnomathematicians, they reach that "Teachers in the United States who have seen how games played in other cultures can help children in our society one mathematical skills, thinking strategies and problem solving abilities and develop an awareness of their participation in a global community". Powell and Temple (2001) say that Oware game provides opportunities for all children to build and extend arithmetical ideas and strategic thinking and to explore important social behaviors. Besides, it can help children understand that humans encode their mathematical ideas in diverse cultural products, including architecture, art games, music, and written texts. They also assert that children who play Oware not only build mathematical ideas but also interact with aspects of African culture. Moreover, players of the game can learn to recognize interesting and important numerical patterns and acquire insights into useful and sophisticated mathematical ideas. In addition to mathematical characteristics of Oware, it offers connections with other curriculum areas (Powell and Temple, 2001). For an art project, the authors suggest to create students' their own Oware boards or traditional ones by using various materials such as empty egg cartoon.

Gerdes (1998) describes and reflects in his study some of the tensions, which exist in math teacher education in Mozambique where teacher education institutes classes consist of students from both urban and rural areas. The aim of the study is to develop an awareness of the social and cultural bases of mathematics, which contributes both to enhance self-confidence, capacity, readiness and openness to work in a multicultural environment among future math teachers. The descriptions, reflections and classroom dialogues were presented in the study. To integrate students especially from rural areas the author made a study in his course called as mathematical know-how of a teacher student from the North. He asked the student the applications of math in the daily life. The student teacher explained his thumb-arm rule, which was used to estimate distances to enemy positions, which requires similar triangle rules and trigonometry. Other students gave examples such as the construction of rectangular house bases. On the other hand, students who were from urban areas became surprised with those examples, which were full of mathematics. The students who gave those examples became more self-confident and attended to lessons eagerly the following lessons and discussions (Gerdes 1998). The second part of mathematical know how of teacher students, the author studied on didactic alternatives in axiomatic construction for Euclidean geometry in his geometry course. The abstractions from experiences reality with epistemological views similarity axioms were discussed (Gerdes, 1998). In the second decade of the liberation, the lecturers became more interested in socio-cultural aspects on math education and they had opportunity to generate new experiences in raising social and cultural mathematical awareness among future math teachers. In the course called as "Math in History", the first theme was "the counting and numerations systems" which provides students to analyze and compare various ways of counting and numerations they learned in their life. Besides, in the course "Ethnomathematics and the Teaching of Mathematics in Secondary School" the mathematical and educational exploration of basket weaving techniques, geometry of traditional African sand drawings, Lusona-geometrical recreations of Africa was centered (Gerdes 1998). In the symmetry and geometry theme, the weaving on the bags and baskets of Gitonga domain were discussed in terms of its pattern, periods, height, number of patterns, its cylindrical wall, the number possible combination of them. Besides students, prejudice as not having math in this weavings, the change in their thoughts were also stated (Gerdes 1998). Student teachers also analyzed the ethnomathematics of female art, craft of pot decoration, the tattoos, and the decoration of the clothes of people with "out of school" learning processes from individual learning by imitating and copying, trying and experimenting, learning through guidance from older family members or friends to collective learning environments among friends of the same age group (Gerdes, 1998).

As the result of his study, Gerdes (1998) reached some dimensions in developing awareness in the social and cultural bases of mathematics and mathematics education. The first dimension is becoming aware of mathematics as a universal activity, which is "pan-cultural", and "pan human" activity. The mathematical thinking and capable of learning more exist in an organized way in all cultures (D'Ambrosio, 1985a, 1985b as cited in Gerdes, 1998). The second dimension is becoming aware of multi-linear development of math, which means the learning of mathematical ideas, even in a homogenous cultural context may follow different paths. Third important dimension is developing an awareness of the influences of socio-cultural factors on teaching and learning mathematics especially by teachers. Teachers can make students see that in their activities, there are mathematics engaged in them, they already know math in their lives, therefore students can look from a different point of view to their perceptions such as lacking mathematical ability or fear of mathematics (Gerdes, 1998).

Lipka and his colleagues (2005), studied on math in a cultural context, which is based on two case studies of a successful culturally based math project. Math in a Cultural Context (MCC) was developed form the ethnographic work with Yup'ik elders and teachers of southwest Alaska with two case studies of novice teachers, one cultural insider and one outsider illustrate how each effectively taught MCC. Their research showed favorable results in implementing MCC a culturally based mathematics curriculum for both urban and rural (Yup'ik) students. The design of the research is both quantitative and qualitative/ethnographic methods. The definition of "culturally based math education" includes content knowledge (informed by both Western knowledge and Yup'ik elders), pedagogical knowledge (informed by school-based practices and community based ways of teaching, communicating and learning), contextual knowledge (ways of connecting schooling to students' prior knowledge and the everyday knowledge of the community). The authors designed MCC to create classroom and community interaction in which mathematical and pedagogical knowledge connect to both the school and community context and to include both Western reform oriented instructional practices and local ways of learning and knowing. In the conceptual framework of the study it is stated that students' prior knowledge helps student to make connections and inferences, draw conclusions and assimilate new ideas and hence to make curriculum more accessible.

In the curriculum designed by the authors, one of the activities, which connect everyday knowledge to school based knowledge, was building a rectangle fish rack. Students faced with perimeter held constant problems and challenged to optimization of the space. The curricular and pedagogical approach includes expert apprentice modeling in a context of problem solving and math as inquiry and communication. Thus "the curriculum includes a variety of cognitive processes, analytic, creative and practical tapping into different learning modalities (Sternberg *et al.*, 2001, as cited in Lipka *et al.*, 2005). The results of students' mathematics performance were in favor of MCC (Lipka *et al.*, 2005).

Stevens, Sharps, Nelson (2001), gave another example of using ethnomathematics in the literature. The example is about ratios and drums. Kieren (1998) created a model for describing a student's developing knowledge about ratio and numbers and the first level of the model is determined as ethnomathematics level in which a person's own life experiences are effective (as cited in Stevens *et al.,* 2001). Hence, students' unique world knowledge can be used to teach ratios. At the second level of Kieren's model, students develop their intuitive knowledge by combining thought, informal language, and image. At level three, students begin to use symbols through conventional language to mutation and algorithms. The African rhythms and drumming are embedded into the ratio lesson and it is implemented in four days of a class whose half of were African American (Stevens *et al.,* 2001). Firstly, the history of drumming was explained and it was exemplified with heartbeat and students are given a task to find heartbeat and pulse. The ratio of it was given as 1:1. The rhythms are comprised of mathematical patterns (Stevens *et al.,* 2001). The history of drummers and their education procedure were also explained. The second part of the lesson was rhythms. A musical rhythm is a special kind of pattern, so a natural pattern to blend music and mathematics is through analyzing patterns in various rhythms. In the African music, several rhythms are often played at the same time. Just as polygon is a generalization for all geometric shapes that are many sided, so is polyrhythmic a description of music that results from the simultaneous playing of many rhythms" (Stevens *et al.,* 2001). Three rhythms are discussed in the study. Playing techniques, symbols for the various hand movements and the number of beats are explained. With the combination of two rhythms the least common multiple (LCM) subject were explained by the calculation of the number of rhythms. After analysis of two rhythms, the drummer's awareness for using ratios is more understandable in terms of dancer's interaction with songs. During the lesson, students were asked to create their own rhythms and to find their rations. After playing the drum introduction, and the information and the history part, the teacher described ratio to help students describe the situations. At the end of the 4^{th} day of the instruction, students demonstrated an application of least common multiple.

The article of Gerdes (2001) presents an example of an educational mathematical activity from Africa that he has used with young students and offers suggestions for exploring the game. According to National Council of Teachers of Mathematics (NCTM)

2000, mathematics education is meant to introduce pupils to mathematical problem solving, communication, reasoning and connections (as cited in Gerdes, 2001). Gerdes suggests that teachers may look for suitable activities from diverse cultural contexts and analyze how these activities may be integrated into their teaching to create a truly simulating and enriching environment to help all students fully develop their potentials. Gerdes (2001) mentions about a mathematical educational game called *as Julirde* played by Fulbe Children in Cameroon:

> *Julirde* game is also named as the game of mosques, which is played by several boys. The game begins with one boy's drawing 9x9 points, which are equidistant on the sand. Concepts of symmetry including line and point, twofold and four-fold symmetry can be developed. (p.322)

Barkley and Cruz (2001) note that Native American beadwork incorporated in daily lives shows a high degree of sophistication in terms of specific symmetrical patterns which are used to symbolize the balance and communicate people's feeling of harmony with the natural world in which they lived. Elegant isosceles and equilateral triangles, stepped mountains, square and rectangle bundles were adapted from the quill design, which were rich in the use of transformational geometry. The math in the beadwork design was related with transformational geometry; rotations, slides and flips, lines of reflections, centers of rotations, and glide reflections and similarity of triangles and symmetry in the study. The authors say that the geometrical shapes of beadworks designs may not be interesting without a background although to study math in the use of context is one of the central goals of the NCTM's Principles and Standards for School Mathematics (2000) (as cited in Barkley and Cruz, 2001). "Students use geometric concepts, properties, and relationships in problem-solving situations and communicate the reasoning used in solving those problems" according to the Colorado Model Content Standards (1994). The standard for geometry also encourages children to (a) recognize two and three-dimensional shapes and their relationships (b) relate geometric ideas to measurement, patterns and number sense (c) solve problems using geometric relationships and spatial reasoning and (d) recognize geometry in real world applications. The geometry was studied in using the beadworks in a contextual basis. The course was based on Van Hiele's phases of learning geometry which are (1) inquiry/information by examining and observing the patterns with their informal terms such as slide, turn, and flip, (2) exploration by student's making their own symmetry patterns , (3) communication by students' exchanging and discussing each other patterns

(4) complex task by teachers' presenting a related but more complex task and students' discussion about triangles, their symmetry and the measurement of slides and designing their strip patterns, rhombuses, circles, triangles and squares and lastly (5) summary by students' integrating their thinking about the geometric figures and movement of them in planes and coding them mathematically (Barkley and Cruz, 2001). After exploring geometric shapes and patterns found in various cultures, students can select geometric shapes to create a design that tessellates or demonstrates line or rotational symmetry with pencils. Then students will identify the geometric characteristics in their design and discuss about being a cultural group (Barkley and Cruz, 2001).

The activities stated in the study of White (2001) are to communicate students' ideas to collect organize and represent data about themselves in the form of a quilt and to make connections between the mathematics that they learn in school and that they see in the world. White (2001) designed a lesson with math through fabrics having the following properties:

> First part is exploration of different geometric shapes, patterns, and spatial representations (horizontal and vertical lines), their appearance in the daily life, search for patterns and their utilities to show students how various cultures such as Africa, Europe, Asia and North America use mathematics in their fabric designs. In the second part of the activity, students made a patch in hexagons to tell something about her or him and collecting data in bar graph with group discussions. After determination one characteristic of a person, they added other ones from their patches. At the end of this activity, each child shared one shape such as ovals, squares, triangles, hexagons, diamonds, and rectangles found in fabrics, and explored various cultures and mathematical concepts. The activities included problem solving, geometry, analysis and representation. Questioning, communicating and reasoning skills were fostered. This activity can be rearranged according to age level and diversity of students. (p.355)

The study of Brenner (1998) involved culturally relevant instruction with a class of Native Hawaiian kindergarten students, Prior to this study, ethnographic fieldwork was used to identify relevant areas of mathematical practice for Native Hawaiian children. Researchers then tested and interviewed children to find out how culturally based practices influenced their knowledge of mathematics. Information from fieldwork, tests and interviews was used to develop classroom activities. With the reflection of those activities, games with mathematical content were offered. The instruction based upon those changes was implemented during one year. The achievement level of students in the experimental group which took the instruction was higher than the control group.

The research on ethnomathematics summarized above attempts to supplement the existing curriculum through the cultural practices and or/and examine the outcomes of integrating into classroom instruction. There are many studies that seek to supplement the curriculum and their focus is usually on indigenous cultures (e.g. Barta *et al.*, 2001; Gerdes 1988, Lipka *et al.*, 2005, Morales 1993). Studies that focused on outcomes did this through an examination of cultural practices and or artifacts, students' home/everyday experience or students' cultural practices. The studies that examined the effects of integrating ethnomathematics into mathematics classroom instruction, in general found that integrating ethnomathematics into mathematics instruction has positive effect on students performance (e.g. Arishmendi-Pardi, 2001; Lipka *et al.*, 2005; Brenner, 1998).

The literature review showed that people use the mathematical activities in their real life with cultural practices, artifacts (Morales, 1993). In everyday activities, people involve a substantial amount of mathematical applications, which are universal behaviors such as counting, measuring, designing, locating, explaining and playing as an example, when designing tools, patterns are used especially for clothing tools, weapons (Bishop, 1991 as cited in Barta *et al.*, 2001). Moreover Moses (2005) noted that students' achievement scores in mathematics increased as they learn about African culture. The grades of algebra course of students taught ethnomathematical pedagogy were higher than the students' who took without the ethnomathematical pedagogy (Arismendi-Pardi, 2001). The connection between mathematical ideas and lived experience of individual students, were emphasized in the study of Presmeg (1998) which argues that the ethnicity of students is a resource for mathematics. Powell and Temple (2001) say that Oware which is a board game played in Africa can help children understand that humans encode their mathematical ideas in diverse cultural products, including architecture, art games, music and written texts. Gerdes (1998) argued to develop an awareness of the social and cultural bases of mathematics, which contributes both to enhance self-confidence, capacity, readiness and openness to work in a multicultural environment among future math teachers. Barkley and Cruz (2001) noted that Native American beadwork incorporated in daily lives shows a high degree of sophistication in terms of specific symmetrical patterns which are used to symbolize the balance and communicate people's feeling of harmony with the natural world in which they lived. Gerdes (2001) suggested that teachers may look for suitable activities from diverse cultural contexts and analyze how these activities may be integrated into their teaching to create a truly simulating and enriching environment to help all students fully develop their potentials. Lipka and his colleagues (2005) found that the results of students' mathematics performance were in favor of the instruction which is math in a cultural context and based on two case studies of a successful culturally based math project.

2.4. Tilling and Patterns in Islamic Ornaments

In order to integrate cultural practices to math instruction, symmetry and patterns subjects which are included in the existing 7^{th} grade math curriculum were selected. This part of the literature review aims to provide mathematics inherent in cultural practices or artifacts on geometrical shapes on tilling and patterns.

Grünbaum and Stephard (1987) stated that "*pattern* that is designs repeating some motif in a more or less systematic manner-must have originated in a similar manner" has made use of by every known human society as in the example of Alhambra at Granada in Spain which has impressive tilling like Moslem religious buildings. They state that artifacts of all cultures abound with patterns, which are intricate and complex and some sort of decoration on fabrics carpets, baskets and utensils weapons, wall have patterns and tiles made of stone, ceramic or other materials with the aim to fit together without appreciable gaps to cover the plane or surface. Besides these have applications in modern engineering to manufacture in the most economical way (Grünbaum and Stephard, 1987).

Abas (2001) states that Islamic patterns, which are for decorations, show a great variety of geometrical structures and constraints of the Euclidean space and they can be educational aids for the teaching of many topics in mathematics, physics, chemistry, crystallography, computer science and design. He says that in addition to being valuable in the teaching of geometry to school children, they are also related with abstract notions of Group theory at the university level and those patterns occur on carpets, windows, doors, screens, railings, bows, furniture in mosques and on other surfaces. The author emphasizes that Islamic patterns provide a vast ready-made stock of material for the teaching of symmetry at all levels-from kindergarten to university. At the university level, they may be used to teach transformation geometry. The mathematical process involved in the creation of these patterns requires the application of symmetry transformations (rotations, reflections, translations, and glide reflections).

According to Abas and Salman (1995), Islamic patterns can be classified in three types. First, is the rectangular *Kufic* patterns that employ simple rectangles and squares to create calligraphic designs in a stylized form of the Arabic scripts. They are usually employed to add dignity and solemnity. The second pattern is the *arabesque,* which comprises curvilinear elements resembling leafed and floral forms in which spiral forms intertwine, undulate and coalesce continuously. The noticeable feelings of these patterns are periodicity and rhythm. The other pattern type is *space-filling patterns*, which employs complex polygons and regions bounded by circular arcs. The basic cell of the pattern repeats itself repeatedly. Abas and Salman (1995) states the characteristics of the space filling patterns:

> One of the recognizable characteristics of Islamic patterns is the prominence of symmetric shapes, which resemble stars and constellations. Second is that rectilinear elements forming the pattern are often interlaced, which can be seen in tent dwelling, carpet weaving, origins and experiences of the Arabs and the Turks. The flow and infiniteness are the other characteristics of the patterns. By copying the repeating cell, the pattern can be replicated infinitely to fill as much space as desired. There is no natural point of focus for the eye. As one looks at the expanse of the pattern, the eye flows continuously and following the lines and seeing a variety of intricate structures and relationships. (p.24)

Abas and Salman (1995) also state the reasons to use geometry especially symmetry and polygons and tessellations in the Islamic art:

> First reason is that in Islamic culture there should not be any sculpture or likeness of living creatures. The art consists of nonfigurative art. Only the rays of God are represented with rays. Besides, there are two main passions, which are “desire for abstractions” and “the search for unity”. The attraction of stars is deep rooted in the human psyche. Stars in the motifs as in the flags of countries, in the aim of constructing pyramids represent the desire “to reach for the stars”. The great attraction for star shapes in Islamic art reflects this primordial love and practical involvement with the heavens. . In addition, long experience of carpet weaving gave tent dwellers skill and passion for tessellations, interlaced patterns and all over covering of surfaces. (p.41)

The authors stated that the artists, artisans, architects, geometers, and designers who created and perpetuated Islamic patterns were secretive. They disclosed their methods and discoveries only to chosen people. The long established tradition is that the master reveals his jealously guarded notebooks only to his sons or to a few devoted apprentices. Many nineteenth century European artist, architects, and designers became fascinated by the brilliant colors and abstract geometric designs of Islamic art.

The authors show how the geometric structures of the bulk of Islamic patterns are based on the symmetric division of concentric circles placed on nets, the tight packing of space with polygons and replication. Besides the first basic strategy called as *Khatem Sulemani* stated in the book of Abas and Salman (1995) is making an 8-pointed star shape, by dividing the circle symmetrically or by self-super positioning of a polygon, which is a rectangle. When this pattern repeats or fills the space, tills, there can exist space filling pattern or other variations of Khatem Sulemani. According to them beautiful patterns have to be based on some form of inner logic of proportions. In a complex pattern as they give an example, the inner logic of the pattern is based on the packing of the space with tessellating polygons. The pattern relies on 16-fold divisions of circles placed at the center and at the vertices of a square repeat cell. The square itself has 8-fold symmetry and therefore it suffices to show the construction lines in one eight of the square. Another type of pattern is constructed by starting with a grid and allowing the cell to appear implicitly. The grids used most commonly are the isometric grids (made from equilateral triangles), the square grid, and the rectangular ones. Since six equilateral triangles combine to form a regular hexagon, the isometric grid can also be considered as being hexagonal (Abas and Salman, 1995). The authors also note that the human brain cannot stand the randomness and disordered events:

> The pattern which is defined as any regularity that can be recognized by the brain." can be seen everywhere, in the sky, sea, sand dunes, in thought, language poetry, music, social behavior peacock feathers, the singing of birds, the binomial theorem. The notion of patterns is the understanding because the brain is the recognizer of patterns. Computers are also versatile and adaptable because they use patterns especially to reduce information. Symmetry like pattern is omnipresent. It is used to refer harmony of proportions. Moreover, in science symmetry is associated with the one, which is beautiful, eye catching, and perfect. Human ornaments and artifacts from every culture and age are made with symmetric patterns. The patterns having high degree of symmetry are easier to grasp and remember. Beside symmetry gives the brainpower to predict. This power is used by especially modern physics. Furthermore, the atomic and molecular structures have the same characteristics with Islamic patterns, such as the same basic geometrical structures, replication. (p.79)

Abas and Salman (1995) make classification of Islamic patterns according to their shapes and the types of symmetries. Firstly, they determine the unit cell shapes, which are an oblique parallelogram with unequal adjacent sides, a rectangle, a rhombus with adjacent sides equal, and not containing a 60 degrees angle, a square and a rhombus with adjacent sides equal and containing 60 degrees angle. They determine the types of Islamic patterns by firstly placing a motif in the generator region, which is called as the template motif. Secondly, they apply suitable symmetry transformations from the symmetry group to generate the motif in the complete unit cell. This motif is called as the unit motif by them. The next step is identifying the pattern types by asking whether there is any rotational symmetry and the smallest rotation angle, the mirror reflection lines and glide reflection lines.

Necipoğlu (1995) noted that the term Arabesque is added by Ernst Herzfeld in 1913 as a fourth to three more common variants of it which are vegetal geometric and calligraphic. Herzfeld also stated that the ant naturalism and geometric abstraction of the arabesques, characterized by “countless repetitions” and “infinite correspondence” that gave rise to completely covered surfaces reflecting a typically Islamic horror vacui, psychological fear of empty spaces. (as cited in Necipoğlu, 1995; p.45). On the other hand, Burckhardt’s work on aesthetics discussed the metaphysical aesthetics of major world religions, including Islam. He stated two typical forms of Arabesque as follows. One is geometrical interlacing made up of a multitude of geometrical stars, the rays of which join into an intricate and endless pattern and conceives “unity in multiplicity and multiplicity in unity” (as cited in Necipoğlu, 1995; p.86). The second form of the Arabesque is composed of vegetable motifs, stylized to the point of losing all resemblance with nature and obeying only the laws of rhythms transposed into graphic mode, each undulating in complementary phases and each surface has its inverse counterpart. Necipoğlu (1995) states that the arabesques is both logical and rhythmical, both mathematical and melodious. It shows Islam’s equilibrium of love and intellectual sobriety. Moreover, the universal character of geometrical ornament is the fundamental elements of which are essentially the same whether they appear on a rug or in a refined urban decoration.

According to Arık and Sancak (2007), “the reason of using tilling tiles with geometric shapes in or daily lives in pavements and roads covered with parquet is not only that they are aesthetical but also that in the restoration they can preserve their shapes.” (p. 1). They state that to make tilling; rhombuses, parallelogram shapes or any type of geometrical shape can be used by repeating the shapes with the rule which is that there will both be any empty space and they will not fit snugly into. If the tilling repeats itself in any two directions, with constant distance, this tilling is called as "*periodical tilling"* although some tilling covers the surface infinitely without any periodicity (Arık and Sancak, 2007).

When a tiling is reflected according to a linear exist, if its shape does not change, it has a reflectional symmetry according to that axis. If a geometric shape or tiling remains unchanged when it is rotated 360/n (n is an integer) degrees angle, this shape or tiling has n-fold rotational symmetry. If a shape does not have reflectional symmetry, its mirror reflection cannot be obtained with rotational symmetry. The regular polygons with n sides have n reflectional symmetry and n fold rotational symmetry (Arık and Sancak, 2007).

Arık and Sancak also mention about the reasons why the geometric shapes in Islamic art are weighted. The reasons are that in Islamic art, the animated pictures and sculptures are forbidden and geometry is seen as an important science branch. In Islamic art, in palaces, mosques, small mosques, madrasah, and graves ornaments, there can be observed calligraphic and floral shapes and geometric shapes. Besides, in Selçuklu ornaments, periodic tilling with equilateral triangles, squares, regular hexagons with these sides corresponded each other and composed into a whole shape are used. In additions, stars and constellations and the shapes to connect those stars are used frequently in Selçuklu and Islamic art. Especially the shapes with n-fold symmetry such as 5-stars, 10-stars are used. In the examples of the book Arık and Sancak, they state all the basic shapes and their characteristics. Besides they also mention about the special door, windows shutter ornament of Ottoman culture in mosques and palaces. Arık and Sancak (2007) stated the general characteristics of these shapes as follows:

i. The number of tiles in every corner is limited with two or four. Hence, all tiles can be colored with two colors with the rule any two tiles with the same color will not be together. The other characteristics of those tiles, is every geometric shape has only one color in the whole shape.
ii. All tiles has the reflectional symmetry according to x and y-axis. Hence composing only quarter of the whole shape is the difficult part. Then reflecting it once results to compose its half. The second reflection composes the whole shape.

iii. All tiles in the sides of completely tilling are cut from their reflectional symmetry axis. Since all the shapes have reflectional symmetry, by repeating the whole shape in two directions, the plane can be tiled periodically. This also gives opportunity to cover three-dimensional shapes such as columns although it is not observed in the Ottoman art. (p.105)

Demiriz (2000) also state the rule of not drawing animated objects in the paintings of artists dealing with Islamic art. With this limited rule, they vary their works with floral and geometric patterns which give opportunity to change. In the first look, some works can be supposed as the same. However, when they examined the differences which needs high expertise can be observed. Demiriz (2000) found that the main principles of Islamic world are infiniteness, symmetry, anonymity:

> Firstly, the motifs cover on the plane indefinitely in two directions. The motifs such as cinctures or central motifs such as 7-pointed star, 9-pointed star, and 11-pointed stars are only one part of an infinite figure. In the branches of Islamic art, even in architecture symmetry is an obeyed rule. In some of the exceptional motifs, asymmetry cannot be seen in the first look… The artists even Mimar Sinan hides themselves, which is a common tradition…Wood is one of the most preferred and appropriate. In order to add decorative motifs to wall fabrics, bricks are mixed with stones. Stone especially marble is appropriate to all types of tilling. Colored stones are used in mosaics. (p.32)

In this part of the literature review the ethnomathematics of tilling and patterns is discussed. The mathematical characteristics of Turkish and at the same time Islamic patterns in addition to general characteristics are stated by Abas and Salman (1995), Abas (2001), Arık and Sancak (2007). Besides Grünbaum and Stephard (1987) mentioned about the general relationship between tilling and patterns with mathematical concepts although Necipoğlu (1995) emphasizes the meaning of those tilling in Turkish ornaments. According to those above mentioned studies, the instruction for symmetry and patterns was prepared by integrating ethnomathematics which is the mathematics practiced in tilling and patterns as well as with the reasons behind usages.

3. SIGNIFICANCE OF THE STUDY

The primary goal of the societies is to increase the level of their living standards with the individuals having scientific and mathematical literacy. Although people gain the mathematical literacy in their daily life, they cannot connect the mathematical issues they face in the real life with the academic mathematics. Mathematics education in Turkey has a major problem as not connecting the academic mathematics and the practical mathematics. Mathematics is seen as a separate issue from the culture. On the other hand, according to National Council of Teachers of Mathematics (2000), "...school mathematics experiences at all levels should include opportunities to learn about mathematics by working on problems arising in contexts outside of mathematics. These connections can be other subject areas and disciplines as well as to students' daily lives..." (p. 65)

This study will be conducted to develop an instructional design to connect mathematics with culture and daily life, and will be a guide for further studies of mathematics educators in terms of integration of ethnomathematics to mathematics lessons. The study also questions how students' attitudes towards mathematics and their math achievement change by taking the instruction that exemplifies the integration of ethnomathematis.

4. STATEMENT OF THE PROBLEM

The literature review showed that people use the mathematical activities in their real life with cultural practices, and artifacts (Morales, 1993). Presmeg (1998) argues that the ethnicity of students is a resource for mathematics. Gerdes (2001) suggests that teachers may look for suitable activities from diverse cultural contexts and analyze how these activities may be integrated into their teaching to create an enriching environment to help all students fully develop their potentials. The grades of algebra course of students taught ethnomathematical pedagogy were higher than the students' who took without the ethnomathematical pedagogy (Arismendi-Pardi, 2001). Lipka and his colleagues (2005) found that the results of students' mathematics performance were in favor of the math instruction in a cultural context. Within the light of the findings of the related literature, in order to create enriched environment to make students develop their potentials, giving them instruction integrated with ethnomathematics may be helpful. In some studies such as Arismendi-Pardi (2001) and Lipka *et al.*, (2005), mathematics performance of students who took instruction in a cultural context or with ethnomathematical pedagogy was higher than the ones who took the instruction without cultural context or ethnomathematical pedagogy. In the light of above mentioned research studies, this study has two major goals which are; first to develop an instruction integrated with ethnomathematics and second to probe the effects of instruction integrated with ethnomathematics on students' attitude towards mathematics and mathematics achievement levels. The problem statement of this study is "Is there any significant effects of instruction integrated with ethnomathematics on seventh grade students' mathematics achievement levels and attitude towards mathematics?"

4.1. Research Questions and Hypotheses

The following research questions and hypotheses are formed in order to enlighten above mentioned goals:

Research Question 1: Will there be any change in the achievement levels of 7th grade students after they receive different instructions (instruction integrated with ethnomathematics or regular instruction) on symmetry and patterns topic?

i. 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post measures (post test and retention test) compared to pre measure as assessed by *Mathematics Achievement Scale.*

ii. 7th grade students who received instruction integrated with ethnomathematics will show significantly higher learning gains (difference between post and pre measures on *Mathematics Achievement Scale*) as compared to those who received regular instruction on symmetry and patterns topic.

Research Question 2: Will there be any change in the attitude levels of 7th grade students after they receive different instructions (which are instruction integrated with ethnomathematics or regular instruction) on symmetry and patterns topic?

i. 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post test as compared to pre test on *Scale for Attitudes Towards Mathematics*.

ii. 7th grade students who received instruction integrated with ethnomathematics will show significantly higher gains (differences between post and pre means on *Scale for Attitudes Towards Mathematics*) as compared to those who received regular instruction on symmetry and patterns topic.

Research Question 3: How did students' attitudes towards mathematics change in comparison groups (which are instruction integrated with ethnomathematics and regular instruction) after the instructions of symmetry and patterns topic?

Research Question 4: What are the students' ideas on using mathematics in daily life?

Research Question 5: What are the attitudes of students' towards use of daily life examples in mathematics lessons?

4.2. Variables and Operational Definitions

4.2.1. Dependent variables

The dependent variables of the study are **students' mathematics achievement levels** and **attitudes towards mathematics.**

Students' **mathematics achievement levels** were measured with *Mathematics Achievement Scale* in two levels:

i. *Mathematics Achievement Scale 1 (MAS1)*, was used to measure mathematics achievement level of students in prerequisite knowledge related to topics of symmetry and patterns as pretest. The prerequisite topics of the symmetry and patterns topics are angle, line and plane using protractor, basic characteristics of polygons (see Appendix A).

ii. *Mathematics Achievement Scale 2 (MAS2)*, was used to assess mathematics achievement level of students in symmetry and patterns topic. It was used as a posttest and retention test (see Appendix B).

Students' **attitudes towards mathematics** were measured with four separate instruments:

i. *Scale for Attitude Towards Mathematics (MATT)* which was developed by Nazlıçiçek and Erktin (2002) was used with a pretest-posttest design to assess students' attitudes towards mathematics. This instrument is formed by three subscales which are mathematics achievement; the benefits of mathematics and interest toward math lessons as perceived by the students (see Appendix C).

ii. *Open Ended Questionnaire for Attitude Towards Mathematics (MATT-Q1)* was used in pretest in order to probe students' attitudes towards mathematics. It was included two open ended questions (see Appendix D).

iii. *Evaluation Sheet (MATT-Q2)* was used in the posttest to assess students' own learning in terms of their attitudes towards mathematics by personal declarations. The evaluation sheet consists of six open ended questions. Students were asked to write down their likes and dislikes about the things they faced during the treatment and usage of mathematics which are exemplified in the treatment, whether the usage of mathematics should be integrated to mathematics lessons and how this affected their learning (see Appendix E).

iv. *Interview (MATT-I)* which was conducted after the treatments is a semi structured one. Totally there were seven questions lasting around five minutes for each student (see Appendix F).

4.2.2. Independent variable

The independent variable of the study is **the type of instruction for the seventh grade the symmetry and patterns topics** namely *regular instruction* and *instruction integrated with ethnomathematics.*

Both of the instructions were developed according to the objectives of 7th grade mathematics curriculum of National Education of Turkey, as stated in Teacher Guide Book of 7th Grade (Aygün, S.Ç., Aynur, N., Çuha, S.S., Karaman, U., Özçelik, U., Ulubay, M., Ünsal, N. 2007). The subjects are reflection and rotational symmetry, patterns, and ornaments (see Appendix G). Details will be given in the "Treatments and Instructional Materials" part.

Regular instruction for the 7th grade the symmetry and pattern topic refer to the instruction which is stated and exemplifies in Teacher Guide Book (see Appendix H).

The instruction integrated with ethnomathematics was designed according to the definition of D'Ambrosio that is *the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes* (D'Ambrosio, 1985; as cited in 1997, p. 16). *Instruction integrated with ethnomathematics* for the 7th grade symmetry and patterns topics refer to the instruction which was designed according to mathematics of the tilling and patterns of the rooms called as Room of Murat III, The Flat of Valide Sultan (Mother of Sultan) in Topkapı Palace, practiced by the carpenters and tilling experts and the reasons behind the usage of the mathematics in those rooms by integrating to the instruction stated Teacher Guide Book (see Appendix I).

Main difference between the instruction integrated with ethnomathematics and the regular instruction is the shapes and examples used in the activities. The regular instruction activities, as stated below consist of the shapes in the geometry. On the other hand in the activities of the instruction integrated with ethnomathematics, the shapes are chosen from The Flat of Valide Sultan and Room of Murat III (see Appendix I for the Instruction Integrated with Ethnomathematics). They are also geometric shapes but having meaning behind them. The other difference is that students learn Turkish history and lifestyles of the people in the past centuries in the mathematics lesson. The worksheets were implemented for students' class activities during the instruction integrated with ethnomathematics. The worksheets are parallel to the students' practice and activity parts stated in the Teacher Guide Book of 7th Grade Chapter 5. However the shapes were selected from the patterns and ornaments of Room of Murat III and The Flat of Valide Sultan. In addition, they were prepared in the ethnomathematical perspective.

Furthermore, both of the instructions include the use of the symmetry and patterns in daily life with pictures. PowerPoint presentations were used in both of the instructions. In regular instruction (see Appendix H) with only examples, without any explanation or reason about the usage of them. The instruction integrated with ethnomathematics on the other hand includes the use of symmetry and patterns with reasons in a cultural context.

5. METHODOLOGY

5.1. Sample

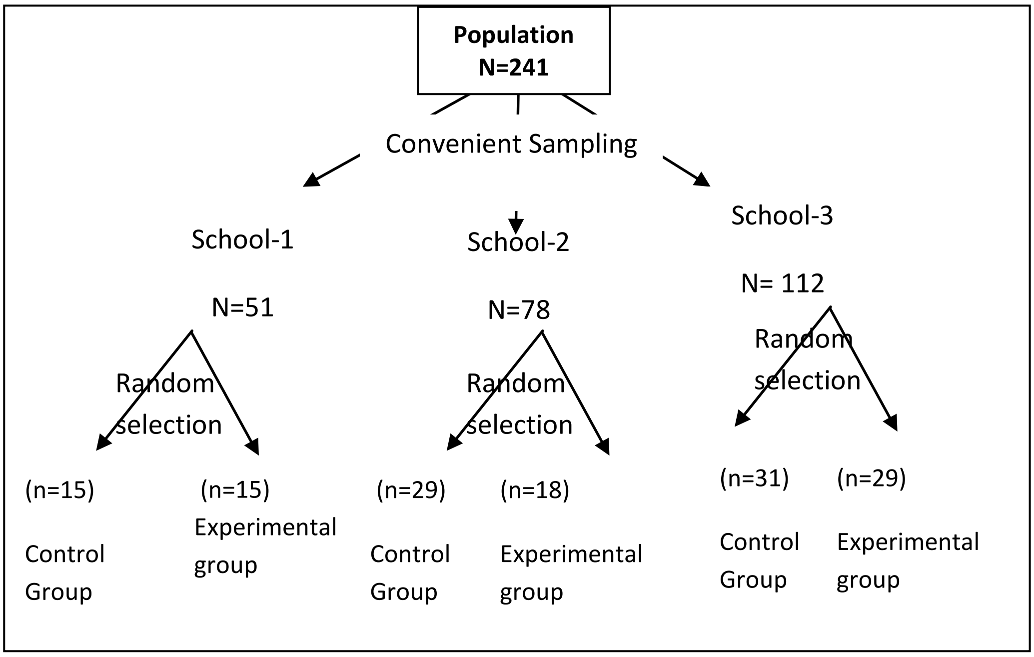


Figure 5.1. Process of sample selection

The sample of the study consists of the seventh grade students and determined by convenient sampling. The study was conducted in three primary schools named as Hattat İsmail Hakkı Primary School (School-1), Orgeneral Kami ve Saadet Güzey Primary School (School-2), and Sultantepe Primary School (School-3). School-2 is also one of the laboratory school of Boğaziçi University, Faculty of Education. All of the schools are state supported schools. The researcher took permission from Turkey Ministry of National Education in order to conduct the study in these schools (see Appendix J). The target population (N=241) was all the 7th grade students in above mentioned schools. School-1 and School-2 have only two seventh grade classes; on the other hand, School-3 has three seventh grade classes. The control and experimental groups were selected randomly for each school. As a result, there are six groups, three of them are control groups treated with the regular instruction and three of them were experimental groups, treated with the instruction integrated with ethnomathematics.

Totally 186 students received the treatments. Students who did not participate in pretest, posttest or retention test were omitted from the sample of the study. The sample of the study for the analysis of Research Question 1 and Research Question 2 is n=137 and for Research Question 3, Research Question 4 and Research Question 5 of the study the sample is n=152.

Seventh grade students were selected because there were enough ethnomathematical examples of symmetry and pattern topics of seventh grade of the primary school mathematics curriculum of in Turkish culture. The symmetry and pattern subject was included in the sixth, seventh and eighth grade curriculum. Symmetry and pattern topics of sixth grade are in the introduction level. The seventh grade includes more examples in the intermediate level. In the eighth grade level, symmetry in the analytical plane is the focus of the subject matter. So, the instruction integrated with ethnomathematics best fits the seventh grade curriculum in terms of examples and level of the content.

5.2. Design and Procedure

The aims of the study are first to develop an instruction integrated with ethnomathematics and to probe the effects of the treatment, instruction integrated with ethnomathematics on students' attitude towards mathematics and mathematics achievement levels.

The study is an example of quasi-experimental design with control and experiment groups (Gay, 2003). Since the participants were selected non-randomly for the study except the random assignment of intact groups to both experimental groups the design is called as non-equivalent control group design (Gay, 2003).

In each school, the control and experimental groups (classes) are selected by random sampling. One group received the regular instruction, which was called as *the control group*. *The experimental group* received the instruction integrated with ethnomathematics.

Before the treatment, in order to evaluate students' knowledge level for the prerequisites of the symmetry and patterns subject, Mathematics Achievement Scale 1 (MAS1) was administered as pretest to all control and experimental groups. Subjects involved in the instrument were; angle, line and plane using protractor, basic characteristics of polygons (triangles, rectangles, squares, parallelogram, pentagons and hexagons). Besides, Scale for Attitudes Towards Mathematics (MATT) which measures their attitudes towards mathematics was also administered as a pretest. After the treatment, students were administered the MATT as the posttest in order to see if there were any improvement in students' attitudes towards mathematic after the instructions, and Mathematics Achievement Scale 2 (MAS2) which measured students' mathematics achievement level in the subjects line symmetry, rotational symmetry and patterns included in the instructional designs at the end of the instruction. Also an interview was planned in order to get qualitative data for explaining the quantitative results in depth. A semi structured interview (MATT-I) was conducted with 50 students depending on the differences in their attitudes between pretest and posttest, for the purpose of triangulation of data obtained from other paper pencil instruments and getting more detailed answers from students. Lastly, MAS2 was administered also as retention test after nine months (MAS3).

Table 5.1 summarizes the design of the study:

Table 5.1. Design of the study

PRE-MEASUREMENT	TREATMENT	POST-MEASUREMENT	RETENTION MEASUREMENT
• Scale for Attitude towards mathematics (MATT) • Scale for the prerequisites of the symmetry and patterns (MAS1) • Open ended questionnaire for attitude towards mathematics as a pretest (MATT-Q1)	Control group: Regular instruction for the symmetry and patterns subject Experimental group: Instruction integrated with ethnomathematics for the symmetry and patterns subject	• Scale for Attitude towards mathematics (MATT) • • Scale for the symmetry and patterns (MAS2) • Evaluation sheet as a posttest (MATT-Q2) • Interviews with selected students (n=50) from control and experimental group (MATT-I)	• Scale for the symmetry and patterns (MAS3)

5.3. Instruments

The instruments utilized for evaluation of the constructs are as follows:

1. Scale for Attitudes Towards Mathematics (MATT)
2. Mathematics Achievement Scale 1 (MAS1)
3. Mathematics Achievement Scale 2 (MAS2)
4. Open Ended Questionnaire for Attitude Towards Mathematics (MATT-Q1)
5. Evaluation Sheet (MATT-Q2)
6. Interview (MATT-I)

The instruments are designed to assess students' attitudes towards mathematics and to evaluate mathematics achievement levels related with angle, line and plane using protractor, basic characteristics of polygons (triangles, rectangles, squares, parallelogram, pentagons and hexagons) and also line symmetry, rotational symmetry and patterns.

5.3.1. Scale for Attitude towards Mathematics (MATT)

In order to determine students' attitude towards mathematics at the beginning and at the end of the study, students were given Scale for Attitude Towards Mathematics (MATT) which was developed by Nazlıçiçek and Erktin (2002). It is a paper pencil test which constituted of 20 Likert-scale response items (see Appendix C). Items were scored on a 5-point scale ranging as **never, rarely, sometimes, usually, and always.** The scale included items such as;

- *Math lessons are enjoyable*
- *I get bored in math lessons.*
- *I deal with other things in mathematics lessons.*
- *I cannot understand the subjects in mathematics lessons.*
- *I am successful in the topics that require mathematical knowledge.*
- *Mathematics lessons are like fun time for me.*

The instrument is formed by three subscales which are mathematics achievement level perceived by the students, the benefits of mathematics perceived by the students and interest toward math lessons (Nazlıçiçek and Erktin, 2002).

<u>5.3.1.1. Validity and Reliability Analysis of the Instrument:</u> The content validity and reliability of the scale is stated by Nazlıçiçek and Erktin (2002). The reliability of MATT was calculated with the Cronbach Alpha Coefficient which is 0.84 for the sample 234 students from 6^{th}, 7^{th} and 8^{th} grades. For the content validity of the test, factorial analysis of variances was investigated and when the items are categorized in three subscales which are mathematics achievement level perceived by the students, the benefits of mathematics perceived by the students and interest toward math lessons, 52 percent of the variance is explained. As an evidence for validity of the scale, the correlation coefficient between

students' attitudes towards mathematics and their math achievement was found as .36 which is statistically meaningful for 0.01 significance level. According to Nazlıçiçek and Erktin (2002) this value was consistent with the previous studies Minato and Yanese, (1984); Ethington and Wolfle, (1986); Cheung (1988); Erktin, (1993).

5.3.2. Mathematics Achievement Scale 1 (MAS1)

In order to measure students' knowledge on the prerequisite topics for the symmetry and patterns, Mathematics Achievement Scale 1 (MAS1) was developed by the researcher (see Appendix A). The prerequisite subjects included in MAS1 are angle, line and plane using protractor to measure angles, basic characteristics of polygons (triangles, rectangles, squares, parallelogram, pentagons and hexagons). Those prerequisites were determined according to the prerequisites stated in the lesson plan of *Mathematics in Our Life* unit (Aygün *et al.*, 2007). The questions were taken from Student Text Book for Grade 6 prepared by the Ministry of National Education. Scale consists of 16 questions with several item types such as short answer, short explanations, with checkbox, filling the tables, drawing figures. Two mathematics teachers and also graduate students in mathematics education, as experts were asked to judge content validity of the instrument. The instrument was administered to the sample as a pretest lasting in 30 minutes. In the following lessons, subjects were exposed to the treatments.

In order to analyze the data gathered from the students who were administered this instrument researcher developed an answer key, and two judges evaluated the key. With the help of feedback provided by the judges, the researcher adapted the answer key to its final version and data obtained from MAS1 were analyzed according to this version of the answer key by the researcher.

5.3.2.1. Validity and Reliability Analysis of the Instrument: The validity analysis of the instrument was done qualitatively. One academician and two experiences mathematics teachers who are also graduate students in mathematics education examined the test for the content validity.

Reliability is also related to the consistence of scoring of a test. It is necessary for a test to be reliable, because there should be consistency in the scoring. If there is no consistency between the scores, this means that the scores obtained from one administration of a test would be very different with the scores when this test would be re-administered. Therefore, inter-rater reliability analysis was conducted in order to determine the consistency in scoring the items. In order to determine inter-rater reliability a mathematics teacher and who is also graduate student in mathematics education scored 31 randomly selected answer sheets. She scored the items according to the original answer key that the researcher had developed. Pearson-r correlation coefficient was calculated between researcher's scoring and the other rater's scoring. Statistical information about these analyses was given in Table 5.2. The Pearson-r Correlation Coefficient was calculated as r= 0.989 in terms of two raters' scores for the whole scale.

Table 5.2. Pearson r correlation coefficients of two raters' scores for MAS1

		Scorer1	Scorer2
Scorer1	Pearson Correlation	1	0.989**
	Sig. (2-tailed)		0.000
	N	31	31
**. Correlation is significant at the 0.01 level (2-tailed).			

5.3.3. Mathematics Achievement Scale 2 (MAS2)

Mathematics Achievement Scale 2 (MAS2) for the line symmetry, rotational symmetry and patterns topics was prepared by the researcher and used as a posttest. Student Study Book for Grade 7 (Aygün *et al.,* 2007) which was prepared by the Ministry of National Education was used as a resource for the items. In the scale, there are 17 items with several item types such as short answer, short explanations, with checkbox, filling the tables, drawing figures (see Appendix B). This instrument was administered to the sample at the end of the treatments.

In order to analyze the data gathered from the students who were administered this instrument researcher developed an answer key, and two judges evaluated the key. With the help of feedback provided by the judges, the researcher adapted the answer key to its final version and data obtained from MAS2 were analyzed according to this version of the answer key by the researcher.

5.3.3.1. Validity and Reliability Analysis of the Instrument: One academician and two experienced mathematics teachers who are also graduate students in mathematics education examined the test for the content validity.

Inter-rater reliability analysis was conducted in order to determine the consistency in scoring the items. In order to determine inter-rater reliability a mathematics teacher and who is also graduate student in mathematics education scored 41 randomly selected answer sheets. She scored the items according to the original answer key that the researcher had developed. Pearson-r correlation coefficient was calculated between researcher's scoring and the other rater's scoring. Statistical information about these analyses was given in Table 5.3. The Pearson-r Correlation Coefficient was calculated as r= 0.994 in terms of two raters' scores for the whole scale.

Table 5.3. Pearson r correlation coefficients of two raters' scores for MAS2

		Scorer1	Scorer2
Scorer1	Pearson Correlation	1	0.994**
	Sig. (2-tailed)		0.000
	N	41	41
**. Correlation is significant at the 0.01 level (2-tailed).			

5.3.4. Open ended questionnaire for attitude towards mathematics (MATT-Q1)

In order to probe students' attitudes towards mathematics, two open ended questions were administered (see Appendix D). The questions are as follows:

- *How can we use the subjects we learn in mathematics lessons in daily life? Explain your thoughts by giving examples.*
- *Which subjects do you find enjoying in mathematics lessons? Why?*

5.3.5. Evaluation sheet (MATT-Q2)

The evaluation sheet consists of six open ended questions. Students were asked to write down their likes and dislikes about the things they faced during the treatment and usage of mathematics which are exemplified in the treatment, whether the usage of mathematics should be integrated to mathematics lessons and how this affected their learning (see Appendix E).

5.3.6. Interview questions (MATT-I)

After the treatments, a semi structured interview was conducted with 50 students (see Appendix F). The interviews lasted around five minutes for each student. Students were selected according to the results of pretest and posttest of MATT scale. The criteria were as follows while determining the students:

i. Students who have top three and bottom three scores from pretest to posttest.
ii. Students whose scores are differed at least 8 points from pretest to posttest.
iii. Students who have top three and bottom three scores in pretest and posttest in questions numbered 1, 2, 5, 6, 7, 8 which can be directly answered according to lessons they were exposed to for the research.
iv. Students whose scores are differed at least five points from pretest to posttest in questions numbered 1, 2, 5, 6, 7, 8.

5.3.7. Treatments and Instructional Materials

This section includes the description of the treatments, which are instruction integrated with ethnomathematics and regular instruction in “Mathematics in Our Daily Life” chapter in the 7th grade mathematics curriculum. Both of the instructions lasted six-lesson hour, which disseminated to one and a half week (as stated in the Teachers Guide Book of Mathematics). The time schedule of the treatments is given in Appendix K. Both types of the instructions were practiced by the researcher in all of the groups. The lesson plans elaborated with the worksheets and activities are summarized in Appendix H and I.

Both of the instructions start with line and rotational symmetry and lasts three-lesson groups. The second part is patterns and ornaments. The symmetry subject is included all the grade levels from 6 to 8. In the 6th grade, the terms and their basic applications were given. For the 7th grades, advance symmetry activities were given. The symmetry in the coordinate axis is in the 8th grade curriculum. Hence 7th grade curriculum best fits the instruction integrated with ethnomathematics of Topkapı Palace.

The study was applied in Istanbul which is a metropolis full of historical places. Topkapı Palace was constructed after the conquest of Istanbul by Turks and selected as an example. According to Ethem (1931) architecture of Topkapı Palace is a mirror for the state structure of Ottoman Empire and relationships with other states. Besides, it differs from other west palaces with its architecture and ornaments. It shows that it is a palace of east. Unlike west palaces as Dolmabahçe Palace, it consists of several parts and it has not one body (Ethem, 1931). Since it shows such a unique feature, this palace is selected as the place to find examples for ethnomathematics in it. Moreover, the palace has several sections. The section for the household of the sultans of the Ottoman Empire, the Harem section is selected to show their daily lives. It is full of works of art made by ceramics experts and carpenters. The motifs and tilling especially in The Flat of Valide Sultan and Room of Murat III are examined mathematically by researcher in terms of the symmetrical patterns in their ornaments (Arık and Sancak, 2007; Necipoğlu, 1995). So those parts of the Harem were selected to examine. Furthermore, Room of Murat III was constructed by Mimar Sinan who was a great and famous architect of those times (Demiriz, 2001). Also to introduce students with a sample work of Mimar Sinan this room was selected. In addition, the experts dealing with ornaments and tilling suggested examining the ethnomathematics of Room of Murat III. The history of Topkapı Palace and *Room of Murat III* and *The Flat of Valide Sultan* are in the Appendix L.

<u>5.3.7.1. Instruction Integrated with Ethnomathematics:</u> The instruction integrated with ethnomathematics for the 7th grade symmetry and patterns topics aimed to supplement the existing curriculum with the cultural artifacts and ornaments. It was designed according to mathematics of the tilling and patterns of the rooms called as Room of Murat III, The Flat of Valide Sultan in Topkapı Palace, practiced by the carpenters and tilling experts and the reasons behind the usage of the mathematics in those rooms by integrating to the instruction stated in Teacher Guide Book of 7th Grade, prepared according to national mathematics curriculum (see Appendix I).

The instruction integrated with ethnomathematics was designed according to the definition of D'Ambrosio; *the mathematics, which is practiced among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes* (D'Ambrosio, 1985; as cited in 1997, p. 16). Also as Zaslavsky (1998) stated ethnomathematics includes mathematics of people's ethnic and racial group's, the several classes in the society and practices of students' own communities. This type of instruction was based on the second strand of ethnomathematics defined as the analysis of the mathematics of the traditional cultures and of indigenous people and the fourth strand which focuses the relationship of ethnomathematics with the formal education system (Vithal and Skovsmose, 1997). In the instruction integrated with ethnomathematics it was aimed that students will learn the mathematics used by the carpenters, ceramic workers, and ornament workers with the reasons of using such kinds of mathematics.

Partially, students' practice and activity parts were implemented as it is stated in the Teacher Guide Book of 7th Grade Chapter 5 (Aygün *et al.*, 2007). Some of the activities were prepared by the researcher in order to integrate ethnomathematics to mathematics lessons

Students were given the terms “reflection, symmetry, and translation” and eight pictures related with those terms. They discovered the differences between them by finding the terms explaining the pictures. In the next step, students discussed where the symmetry does exist in daily life and also exemplified also by the teacher. Students were distributed *Worksheet 1* (see Appendix I). The example was drawing a shape’s reflection in the mirror to the isometric paper. It was stated that “The shape was taken from an ornament in Topkapı Palace, Harem Section where the emperor of Ottoman Empire and his family lived.” Then the definition and basic characteristics of mirror symmetry (reflection) was given. Students solved the other two examples in their textbooks after discussing the steps of drawing reflections of shapes without a mirror.

Then the exercise for drawing symmetry axis to polygons was done together with children with animation in PowerPoint presentation (see Appendix I). They also discussed how many symmetry axes can be drawn for the regular polygons. Seven pictures of tilling taken from Topkapı Palace, Harem Section, The Flat of Valide Sultan and Room of Murat III are shown to the students and their symmetry axes are drawn (see Appendix I). Students made the exercise in *Worksheet 2* which is about drawing symmetry axes of three shapes taken from Room of Murat III. At the end of the lesson students were given poster preparation homework for symmetric shapes which can be seen in nature and also in The Flat of Valide Sultan, Room of Murat III.

In the next three lessons, the subject was rotational symmetry. Three activities in the text book which are for a Z letter, an arrow and a shoe about whether they are rotated or not were done firstly by the students and the teacher checked in their books and they are also showed in the PowerPoint presentation (see Appendix I). Students discussed whether the rotation movement is seen in nature and the teacher gave examples such as doors and fans. Students discussed rotating a shape with respect to a point according to a determined angle and they decided that a shape which is rotated does not change, only its position and place change. They also used the term rotation angle and the center of rotation. *Worksheet 3* was distributed to students. This worksheet was about a six-sided shape taken form the ornaments of Room of Murat III. They had two copies of the same shape and stick them together with a clip in their centers. They found how many times in a whole 360 degree rotation, two shapes were coincided. This determines the rotational symmetry of the shape and wrote the rotational symmetry angle. This exercise was about rotation by its own axis in other words rotating with respect to the center of the shape. Then students discussed when and how many times regular polygons such as square, triangle, rectangular, pentagon have their own shapes while rotation according to their centers. They discovered that for n-sided regular polygon has n times its own shape while it is rotated up to rotating 360 degrees. They also discovered also that this regular polygon has 360/n degree rotational symmetry. Students Then students did the exercise related with rotational symmetry in the textbook and *Worksheet 4* is distributed as a homework.

The subject of fifth and sixth lessons was tessellations with patterns. Firstly students made ornaments with tessellations by using quadrilaterals, triangles and hexagons in different colors on isometric paper. Secondly they made tessellations with trapezoid and parallelogram. Then they examined the tessellation examples in the book. They try to see the main motif of the patterns. The tessellations are included in the PowerPoint presentation (see Appendix I). Then in the as the instruction integrated with ethnomathematics part, students are shown tilling with motifs presentation. The presentation included the reasons why people used tessellation in their ornaments and the examples in the historical places. At the end students were asked why these tilling and patters are used, what was the aim of using them and which geometric figures are used in those ornaments? This discussion is related with Turkish ornaments and Topkapı Palace which has an important role in Turkish History and full of symmetric ornaments. Students were asked whether they know Topkapı Palace and they shared their knowledge that they gained from Turkish history lessons in the discussion about Topkapı Palace. Then a PowerPoint presentation about Topkapı Palace began. A video show with photographs was shown. After explaining its basic structure, the selected rooms in the Harem section, The Flat of Valide Sultan and Room of Murat III were examined with a simulation named as “360 degree” which makes use to see all the room within different perspectives. It was also stated that “Since those rooms are full of symmetric figures, they are selected.” The motifs and ornaments are examined one by one with their photographs in the presentation. Then social and architectural properties of Harem Section was explained to students. Some of the properties are as follows:

- This is the house of the Ottoman emperor where his family lives so reflects the family life of the emperor.
- It was forbidden to enter the foreigners to enter Harem Section.
- Harem section was dark and cold since there were very few windows because of its secrecy.
- There was a hierarchical placement in the rooms and the most important people rooms' ornaments had higher complexity that the less important ones.
- The ornaments do not include animated figures because of religious reasons.
- Geometrical figures and flowers are used in tilling, cushions and carpets.
- The pools and taps were to cool off in the summer, for hygienic reasons. Another usage was not to make others listen outside of the room. When somebody is talking, another person outside of the room cannot hear anything if the tap was opened.
- The basic living problems were secrecy, light and heating. To make the rooms hotter there were fireplaces. The walls were full of tilling with symmetrical figures to reflect the heat and to foreclose humidity. There were candle places in the walls and they were also full of those figures. The carpets on the ground and hang in front of doors and windows were also to avoid cold weather.

The characteristics of The Flat of Valide Sultan and Room of Murat III were also stated. There were three types of ornaments which are calligraphy, flower deigns and patterns with repeated polygons-tessellations. The third type was related with the instruction integrated with ethnomathematics. Their basic characteristics such as infinitely continued, symmetrical and n-sided stars are also stated.

In order to systematize tessellations with polygons, there was an activity, filling a table asking “measure of an inner angle of the polygon, the number of polygonal area in one side, the number of sides of polygon, tessellation code, whether it is possible to make tessellations with only that polygon and the sum of the angles in one corner. The aim of this activity is to see that the measure of the total angle in one corner, to see whether a polygon can make a pattern on its own, without using any other polygon, to write tessellation code.

For the next exercise, students draw the tessellations with more than one type of the polygon and try to find tessellation codes of the tessellation codes of drawn ones. Students made an activity to define pattern types in the ornaments of The Flat of Valide Sultan and Room of Murat III. The questions to define were:

- Does the shape have rotational symmetry?
- If yes, what is the minimum angle that we should rotate to have the shape in the same posisiton?
- Does the shape have reflectional symmetry?
- Does the shape have reflectional symmentry more than one axis?
- Is there any translation of the main motif?

Students made the related worksheet (*Worksheet 5*) according to the question above. The shapes in *Worksheet 5* also consisted of the ornaments in the selected rooms (see Appendix I).

5.3.7.2. Regular Instruction: The regular instruction for the 7th grade, the symmetry and pattern topic were prepared according to text-book and teacher book which is prepared by the Ministry of National Education (Aygün *et al.*, 2007) (see Appendix H). The instruction was based on the activities stated in the text-book. Students solved the problems of the practice parts of the book. In the isometric and grid papers students draw the symmetric shapes of the objects and patterns. The shapes selected for the activities in the text-book are the ordinary geometric or non geometric shapes. More details will be given in Appendix H.

The main difference between the instruction integrated with ethnomathematics and the regular instruction is the shapes used in the activities. The regular instruction activities, as stated below consist of the shapes and examples in the geometry. On the other hand in the activities of the instruction integrated with ethnomathematics, the shapes are chosen from The Flat of Valide Sultan and Room of Murat III (see Appendix I). The other difference is that students in the experimental treatment also learn about Turkish history and lifestyles of the people who were living in the palace in the past centuries. The worksheets which were implemented as class exercises during experimental treatment are parallel to the students' practice and activity parts stated in the Teacher Guide Book of 7th Grade Chapter 5. However the shapes were selected from the patterns and ornaments of Room of Murat III and The Flat of Valide Sultan. In addition, they were prepared in the ethnomathematical perspective.

Both of the instructions include the use of the symmetry and patterns in daily life. In regular instruction it is presented with only examples, without any explanation or reason about the usage of them. The instruction integrated with ethnomathematics on the other hand includes the use of symmetry and patterns with reasons in a cultural context.

6. DATA ANALYSIS AND RESULTS

In this section statistical analysis results of the first two research problems should be given separately whereas descriptive statistics for the other three research problems will be given later.

MATT (Scale for Attitudes Towards Mathematics) was administered to both of the groups as pretest and posttest. MAS1 (Mathematics Achievement Scale1) was administered at the beginning of the study and MAS2 (Mathematics Achievement Scale2) was administered at the end of the study. MAS2 was administered also as retention test after nine months (MAS3). The scores obtained from MATT, MAS1, MAS2, MAS3 were in ratio level.

As it was mentioned before, there were three schools where the study was conducted. In each school one class was determined as control group and one class was determined as experimental group. Hence, totally there were three control groups and three experimental groups. Since the schools were not selected randomly, or the students in each school were not matched with each other, data gathered from each school were evaluated separately.

In School-1, the number of subjects in both control and experimental group was 15. In School-2, the number of subjects in the control group was 29 and in the experimental group it was 18. In School-3, the number of subjects in the control group was 31 and in the experimental group, it was 29. Because in some of the groups, the number of the subjects was below thirty by using normality tests distribution of the groups were tested in terms of pretest and posttest scores.

The groups were determined as control group and experimental group from the pre-existed groups, so there may be initial differences between those groups. Since two different dependent variables are measured repeatedly for each group who were exposed to a different condition, Repeated Measures ANOVA was conducted in order to test whether there is any statistically significant effect of treatments on mathematics achievement levels and attitudes towards mathematics.

The results of the normality test applied to the pretest and posttest scores of the students in the control and experimental group will be given first. Then, statistical analysis for testing the hypothesis will be given in the following part for the first and second research questions.

In order to determine the distribution of the MATT as a pretest, MATT as a posttest, MAS1, MAS2 and MAS3 scores of the students in each group, Normality tests of Kolmogorov - Smirnov and Shapiro -Wilk were conducted. So as it is seen from the Table 6.1, the results of tests were given separately for each school. According to results the distribution of subjects' scores are not significantly different than the scores which have normal distributions except three measurements out of thirty measurements.

Table 6.1.Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
School-1 Control Group	MATT1	0.225	15	0.040	0.876	15	0.042
	MATT2	0.127	15	0.200*	0.958	15	0.655
	MAS1	0.188	15	0.163	0.955	15	0.606
	MAS2	0.130	15	0.200*	0.969	15	0.839
	MAS3	0.124	15	0.200*	0.965	15	0.778
School-1 Experimental Group	MATT1	0.199	15	0.112	0.902	15	0.103
	MATT2	0.127	15	0.200*	0.952	15	0.550
	MAS1	0.221	15	0.046	0.917	15	0.176
	MAS2	0.114	15	0.200*	0.942	15	0.414
	MAS3	0.154	15	0.200*	0.974	15	0.911
School-2 Control Group	MATT1	0.134	29	0.197	0.934	29	0.070
	MATT2	0.111	29	0.200*	0.977	29	0.769
	MAS1	0.099	29	0.200*	0.963	29	0.382

	MAS2	0.088	29	0.200*	0.952	29	0.204
	MAS3	0.126	29	0.200*	0.968	29	0.516
School-2 Experimental group	MATT1	0.179	18	0.133	0.920	18	0.127
	MATT2	0.221	18	0.020	0.899	18	0.054
	MAS1	0.125	18	0.200*	0.972	18	0.835
	MAS2	0.143	18	0.200*	0.970	18	0.803
	MAS3	0.173	18	0.164	0.904	18	0.067
School-3 Control Group	MATT1	0.119	31	0.200*	0.900	31	0.007
	MATT2	0.060	31	0.200*	0.993	31	0.998
	MAS1	0.124	31	0.200*	0.925	31	0.033
	MAS2	0.195	31	0.004	0.941	31	0.089
	MAS3	0.132	31	0.184	0.980	31	0.809
School-3 Experimental group	MATT	0.164	29	0.044	0.963	29	0.380
	MATT2	0.112	29	0.200*	0.940	29	0.103
	MAS1	0.121	29	0.200*	0.970	29	0.568
	MAS2	0.097	29	0.200*	0.975	29	0.707
	MAS3	0.140	29	0.156	0.942	29	0.113
	*. This is a lower bound of the true significance.						

Research Question 1: Will there be any change in the achievement levels of 7th grade students after they receive different instructions (instruction integrated with ethnomathematics or regular instruction) on symmetry and patterns topic?

As it was mentioned at part 3.1.1 because of convenient sampling, it seems that generalization of results is not possible, so each hypothesis will be tested separately for each school.

i. 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post measures (post test and retention test) compared to pre measure as assessed by *Mathematics Achievement Scale.*

ii. 7th grade students who received instruction integrated with ethnomathematics will show significantly higher learning gains (difference between post and pre measures on *Mathematics Achievement Scale*) as compared to those who received regular instruction on symmetry and patterns topic.

Repeated Measures ANOVA was used in order to test the hypotheses related to first research question for School-1. Table 6.2 shows mean and standard deviation of scores of students in each group and their scores in pretest, posttest and retention test. The mean of the scores in MAS1 (pretest) and MAS2 (posttest) and MAS3 (retention test) were calculated for each control and experimental group and it is found to be M=73.06; M=78; the school the means were M=77.8; M=84.6; M=66.38 respectively for MAS1, MAS2 and MAS3 measurements. The mean values of the groups indicate that the experimental group achievement level is higher than the control group for all measurement. There is an improvement in both control and experimental group in posttest in terms of MAS 1 and MAS 2 scores. On the contrary, there is a decline in MAS3 performances in retention level.

Table 6.2. Descriptive statistics of MAS scores - School-1

	Groups	Mean	Std. Deviation	n
MAS1	Experimental Group	77.8000	10.60458	15
	Control Group	73.0667	17.71386	15
	Total	75.4333	14.54525	30
MAS2	Experimental Group	84.6000	8.53397	15
	Control Group	78.0000	13.37909	15
	Total	81.3000	11.52553	30
MAS3	Experimental Group	60.0667	12.10942	15
	Control Group	50.1000	15.90620	15
	Total	55.0833	14.78588	30

The results obtained from repeated measures ANOVA indicates that there is a significant change that takes place from pre, post and retention measures of MAS when the scores of students in experimental and control groups of School-1 are analyzed as a whole group. As is can be followed from the first row of the Table 6.3 there is a statistically significant linear trend over the mean values between pre, post and retention level mathematics achievements of the students in two groups in terms of MAS scores, F(1.28)=79.852; p=0.00. Posttest scores are higher than the pretest scores but retention scores are not. This result supports the research hypothesis (1.i). Moreover, no significant interaction effect (between pre-post- retention of the control and experimental groups) was observed when the changes from pre, post and retention level were analyzed for two groups (MAS*Groups). Second row of the Table 6.3 shows that, the changes from pre to post and retention level is not significantly different for the experimental group and control group; which implies that there is no effect of the different treatments on achievement levels of the subjects, F(2.28)=0.44; p=0.836 for School-1. So this result does not support the research hypothesis (1.ii) or fail to reject null hypothesis.

Table 6.3. Repeated measures ANOVA results on MAS scores - School-1

Source	MAS	Type II Sum of Squares	Df	Mean Square	F	Sig.
MAS	Linear	6211.837	1	6211.837	46.356	0.000
	Quadratic	5146.701	1	5146.701	79.852	0.000
MAS * Groups	Linear	102.704	1	102.704	0.766	0.389
	Quadratic	2.812	1	2.812	0.044	0.836
Error(MAS)	Linear	3752.083	28	134.003		
	Quadratic	1804.694	28	64.453		

In order to test the hypotheses related to the first research question, same procedure was used for School-2. As means and standard deviation of scores of students in each group and their scores in pretest, posttest and retention test shown in Table 6.4 for School-2 the control group's means are M=66.31; M=64.03; M=39.91 respectively for MAS1, MAS2 and MAS3 whereas M=66.38; M=66.77; M=66.05 respectively for the experimental group. The mean values of the groups indicate that the experimental group's mathematics achievement level is almost equal in the pretest. Although no change can be observed in the MAS performances of the experimental group, there is a decline in MAS performances in pre, post, and retention level for control group.

Table 6.4. Descriptive statistics of MAS scores - School-2

	Groups	Mean	Std. Deviation	n
MAS1	Experimental group	66.3889	17.21196	18
	Control Group	66.3103	14.08166	29
	Total	66.3404	15.17188	47
MAS2	Experimental group	66.7778	13.83327	18
	Control Group	64.0345	13.82152	29
	Total	65.0851	13.74113	47
MAS3	Experimental group	63.0556	10.73873	18
	Control Group	39.9138	15.80860	29
	Total	48.7766	18.00115	47

The results obtained from repeated measures ANOVA test indicate there is a significant change from pre, post and retention measures of MAS when the experimental and control groups of School-2 are analyzed as a whole group. As it can be followed from the first row of the Table 6.5, there is a statistically significant linear trend over the mean values between pre, post and retention level mathematics achievements of the students in two groups in terms of MAS scores, $F(1.45)=30.43$; $p=0.00$. Moreover, there is a significant interaction effect (between pre-post- retention of the control and experimental groups) was observed when the changes from pre, post and retention level were analyzed for two groups (MAS*Groups) Second row of the Table 6.5 shows that, the changes from pre, post and retention level is significantly different for the experimental group and control group; which implies that there is a statistically significant effect of the different treatments on achievement levels of the subjects, $F(2.45) =9.98$; $p=0.03$ for School-2. Hence the results support the research hypotheses (1.i) and (1.ii).

Table 6.5. Repeated measures ANOVA results on MAS scores - School-2

Source	MAS	Type II Sum of Squares	df	Mean Square	F	Sig.
MAS	Linear	7249.471	1	7249.471	52.674	0.000
	Quadratic	1775.022	1	1775.022	30.436	0.000
MAS* Groups	Linear	2953.809	1	2953.809	21.462	0.000
	Quadratic	582.131	1	582.131	9.982	0.003
Error(MAS)	Linear	6193.345	45	137.630		
	Quadratic	2624.388	45	58.320		

In order to test the hypotheses related to the first research question, same procedure was carried out for School-3. Table 6.6 shows means and standard deviations of scores of students in each group and their scores in pretest, posttest and retention test. The mean scores of the control group of School-3 for MAS1, MAS2 and MAS3 were M=76.77; M=81.35; M=51.93 respectively whereas the mean scores of the experimental group were M=79.00; M=78.68; M=54.65. The mean values of the experimental group show that the experimental group achievement level is higher than the control group in MAS1. There is an improvement in control group in posttest in terms of MAS 1 and MAS 2 scores. On the contrary, there is a decline in MAS3 performances in retention level. Moreover, MAS1, MAS2 and MAS3 scores of experimental group was decreased gradually.

Table 6.6. Descriptive Statistics of MAS scores - School-3

	Groups	Mean	Std. Deviation	n
MAS1	Experimental group	79.0000	9.70272	29
	Control Group	76.7742	12.15651	31
	Total	77.8500	11.00358	60
MAS2	Experimental group	78.6897	11.29508	29
	Control Group	81.3548	9.85748	31
	Total	80.0667	10.57157	60
MAS3	Experimental group	54.6552	17.85262	29
	Control Group	51.9355	15.10780	31
	Total	53.2500	16.40703	60

The results obtained from repeated measures ANOVA indicates that there is a significant change from pre, post and retention measures of MAS when the experimental and control groups of School-3 are analyzed as a whole group. As it can be followed from the first row of the Table 6.7, there is a statistically significant linear trend over the mean values between pre, post and retention level mathematics achievements of the students in two groups in terms of MAS scores, $F(1.58)=93.511$; $p=0.00$ for School-3. This result does not support the research hypothesis (1.i). Moreover, no significant interaction effect (between pre-post- retention and the control and experimental groups) was observed when the changes from pre, post and retention level were analyzed for two groups (MAS*Groups). Second row of the Table 6.7 shows that the changes from pre to post and retention level is not significantly different for the experimental group and control group; which implies that there is no effect of the treatments on achievement levels of the subjects, $F(2.58) =2.925$; $p=0.093$ for School-3. So this result does not support the research hypothesis (1.ii).

Table 1 Table 6.7. Repeated measures ANOVA results on MAS scores - School-3

Source	MAS	Type II Sum of Squares	Df	Mean Square	F	Sig.
MAS	Linear	18154.800	1	18154.800	155.942	0.000
	Quadratic	8429.344	1	8429.344	93.511	0.000
MAS * Groups	Linear	1.827	1	1.827	0.016	0.901
	Quadratic	263.690	1	263.690	2.925	0.093
Error(MAS)	Linear	6752.373	58	116.420		
	Quadratic	5228.299	58	90.143		

Research Question 2: Will there be any change in the attitude levels of 7th grade students after they receive different instructions (which are instruction integrated with ethnomathematics or regular instruction) on symmetry and patterns topic?

i. 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post test as compared to pre test on *Scale for Attitudes Towards Mathematics*.

ii. 7th grade students who received instruction integrated with ethnomathematics will show significantly higher gains (differences between post and pre means on *Scale for Attitudes Towards Mathematics*) as compared to those who received regular instruction on symmetry and patterns topic.

As it was mentioned before, because of sampling technique, it seems that generalization of results is not possible, so each hypothesis will be tested separately for each school.

For School-1, Repeated Measures ANOVA was carried out on MATT scores in order to test the hypotheses related to second research question. Table 6.8 shows means and standard deviations of scores of students in each group and their scores in pretest and posttest. The mean of the scores in MATT 1 (pretest) and MATT2 (posttest) were calculated for each control and experimental group. It is found to be M(control)=52.4; M(experimental)=55.2 in pretest and M(control)=49.3 and M(experimental)=49.9 in posttest respectively for School-1. The mean values of the groups indicate that the experimental group's attitudes towards mathematics are higher than the control group at the beginning although the means of the groups are close in the posttest. There is a decline in both control and experimental group in posttest in terms of attitude scores.

Table 6.8. Descriptive Statistics of MATT scores - School-1

	Groups	Mean	Std. Deviation	n
MATT1	Experimental group	55.2000	22.87060	15
	Control group	52.4000	27.67103	15
	Total	53.8000	24.98365	30
MATT2	Experimental group	49.3000	18.52778	15
	Control group	49.9000	15.48294	15
	Total	49.6000	16.77919	30

When the experimental and control groups of School-1 are analyzed as a whole group, the results obtained from repeated measures ANOVA test indicate there is not a significant change from pre and post measures of MATT. As it can be followed from the first row of the Table 6.9, there is not a statistically significant linear trend over the mean values between pretest and posttest level attitudes towards mathematics of the students in two groups in terms of MATT scores, $F(1.28)=2.414$; $p=0.131$. Moreover, no significant effect (between pre-post of the control and experimental groups) was observed when the changes from pre and post level were analyzed for two groups (MATT*Groups). Second row of the Table 6.9 shows that, the changes from pretest to posttest level is not significantly different for the experimental group and control group; which implies that there is no effect of the different treatments on attitudes towards mathematics of the subjects, $F(2.28)=0.396$; $p=0.535$ for School-1. According to the results, research hypotheses (2.i) and (2.ii) were not supported.

Table 6.9. Repeated measures ANOVA results on MATT scores - School-1

	MATT	Type II Sum of Squares	df	Mean Square	F	Sig.
MATT	Linear	264.600	1	264.600	2.414	0.131
MATT * Groups	Linear	43.350	1	43.350	0.396	0.535
Error(MATT)	Linear	3068.800	28	109.600		

For School-2, Repeated Measures ANOVA was carried out on MATT scores in order to test the hypotheses related to second research question. Table 6.10 shows means and standard deviations of scores of students in each group and their scores in pretest and posttest, for School-2 the control group's means are M=41.72 and M=33.55; respectively for MATT1 and MATT2. For experimental group of the school the means of same measurements were M=55.0 M=58.11 respectively. The mean values of the groups indicate that the experimental group's attitude scores increased from pretest to posttest. On the other hand, there is a decline in the scores of control group in terms of attitude towards mathematics. Moreover, the initial math attitude of experimental group is higher than the control group.

Table 6.10. Descriptive statistics of MATT scores - School-2

	Groups	Mean	Std. Deviation	n
MATT1	Experimental group	55.0000	21.54066	18
	Control group	41.7241	12.84773	29
	Total	46.8085	17.73432	47
MATT2	Experimental group	58.1111	16.56765	18
	Control group	33.6552	10.35883	29
	Total	43.0213	17.63980	47

When the experimental and control groups of School-2 are analyzed as a whole group, the results obtained from repeated measures ANOVA test indicates that there is not a significant change from pre and post measures of MATT. As it can be followed from the first row of the Table 6.11, there is not a statistically significant linear trend over the mean values between pretest and posttest scores of the students in two groups in terms of MATT scores, F(1.45)=3.394; p=0.072. Also, there is a significant interaction effect (between pre-post test of the control and experimental groups) was observed when the changes from pre, and post level were analyzed for two groups (MATT*Groups). Second row of the Table 6.11 shows that the changes that take place from pretest to posttest is significantly different for the experimental group and control group; which implies that there is an effect of the different treatments on attitude scores of the subjects, F(2.45)=6.99; p=0.011 for School-2. According to the results, research hypothesis (2.ii) was supported whereas hypothesis (2.i) was not supported.

Table 6.11. Repeated measures ANOVA results on MATT scores – School-2

Source	MATT	Type II Sum of Squares	Df	Mean Square	F	Sig.
MATT	Linear	337.064	1	337.064	3.394	0.072
MATT*Groups	Linear	694.116	1	694.116	6.990	0.011
Error(MATT)	Linear	4468.570	45	99.302		

For School-3, Repeated Measures ANOVA was used in order to test the hypotheses related to second research question. .As means and standard deviations of scores of students in each group and their scores in pretest and posttest for School-3 are shown in Table 6.12 the control group's means are M=42.77 and M=49.2 respectively for MATT1 and MATT2. For experimental group of the school the means were M=54.41, M=54.91 respectively measurements. The mean values of the groups indicate that the experimental group's attitude towards mathematics remained the same through pretest to posttest. On the other hand, there is an improvement in the scores of control group in terms of math attitude.

Table 6.12. Descriptive Statistics of MATT scores - School-3

	Groups	Mean	Std. Deviation	n
MATT1	Experimental group	54.4138	22.28311	29
	Control group	42.7742	18.94151	31
	Total	48.4000	21.27161	60
MATT2	Experimental group	54.9138	22.12871	29
	Control group	49.2419	16.18944	31
	Total	51.9833	19.33469	60

When the scores of experimental and control groups of School-3 are analyzed as a whole group, the results obtained from repeated measures ANOVA test indicate there is not a significant change from pre and post measures of MATT. As it can be followed from the first row of the Table 6.13, there is not a statistically significant linear trend over the mean values between pretest and posttest level attitudes towards mathematics of the students in two groups in terms of MATT scores, MATT, $F(1.58)=2.79$; $p=0.100$. Besides, there is not any significant interaction effect (between pre-post, of the control and experimental groups) when the changes from pre, and post level were analyzed for two groups (MATT*Groups). Second row of the Table 6.13 shows that, the changes from pretest to posttest level is not significantly different for the experimental group and control groups; which implies that there is no effect of the different treatments on attitudes towards mathematics of the subjects, $F(2.58)=1.932$; $p=0.170$ for School-3. So it was failed to reject null hypothesis and there is no support for research hypotheses (2.i) and (2.ii) for School-3.

Table 6.13. Repeated measures ANOVA results on MATT scores of - School-3

Source	MATT	Type II Sum of Squares	df	Mean Square	F	Sig.
MATT	Linear	385.208	1	385.208	2.790	0.100
MATT * Groups	Linear	266.808	1	266.808	1.932	0.170
Error(MATT)	Linear	8008.484	58	138.077		

Research Question 3: How did students' attitudes towards mathematics change in comparison groups (which are instruction integrated with ethnomathematics and regular instruction) after the instructions of symmetry and patterns topic?

Research Question 4: What are the students' ideas on using mathematics in daily life?

Research Question 5: What are the attitudes of students' towards use of daily life examples in mathematics lessons?

As it is mentioned before, apart from the MATT and MAS, there were three more questionnaires which are Open Ended Questionnaire for Attitude Towards Mathematics (MATT-Q1), Evaluation Sheet (MATT-Q2) and Interview (MATT-I) including questions about use of mathematics in daily life, participants' perception about mathematics and learning change, whether daily life usage of mathematics should be integrated to mathematics lessons. The paper pencil instruments conducted at the beginning or at the end of the instructions and responses to the interview were used to provide more detailed information on the findings. The research questions are answered below together, according to results of MATT-Q1, MATT-Q2 and MATT-I. Related to the qualitative data gathered through these instruments some descriptive statistics and examples to subjects' responses for each item will be given. Analyses were based on the descriptive statistics, and then the frequencies of the answers in control and experimental groups were calculated and compared with each other. In order to provide considerable saturation of data, multiple data collection strategies which were open ended questionnaires and interviews were used. After the treatments, 50 students were interviewed according to pre established criteria which were mentioned in the instrument part (see section 6.3.6).

After all data were gathered by MATT-Q1, MATT-Q2 and MATT-I, they were transcribed and the data were read carefully three times. While reading, a preliminary list of possible coding categories, notes, lists of ideas and diagrams that sketch out the relationships notices were determined. The data were searched through for categories and patterns. Words and phrases which represent these categories and patterns were written down. The similar items were grouped. These patterns are coded as means of sorting the descriptive data. The preliminary list of coding categories was shaped by assigning them as abbreviations to the units of data. They are modified by reading the whole data again.

One way of producing believable, credible and trustworthy work is using triangulation. To reduce the potential bias that comes from single researcher doing all the data collection, in order to look more than one perspective, and to assess more directly multiple analysts were used to review findings. Two different scorers other than the researcher, who are graduate students in mathematics education independently, analyzed the same qualitative data set. As a result of comparison, the codes were similar in all three coding lists. However the researcher's coding categories were longer because of the sub-codes under the major codes. After developing the coding categories, an abbreviation was used for each category. This procedure was made for each question of MATT-Q1, MATT-Q2 and MATT-I. Then all the data was marked with appropriate coding category.

In the analysis of data obtained from MATT-Q1, MATT-Q2 and MATT-I, the frequencies of the categories for each question were found. 84 respondents out of 152 students who were administered MATT-Q1 and MATT-Q2 were in the control group and the rest 64 were in the experimental group. Since some of the students did not answer all the questions, the percentages of frequencies were calculated according to the number of the students who answered to the question. All the percentages were calculated separately as two groups which are the control group and experimental group. The categories with greater than 5 % were reported in this part. However some of the categories which are lower were also reported for some answers for comparison purposes. The categories and their percentages in terms of frequencies were given for each question. The control and experimental groups will be compared in the conclusion part in terms of the percentages of the categories.

Also in the analysis of the data obtained from interview, the same data analysis procedure was followed. First categories were determined by qualitative data analysis. The number of the interviewees in the control group was 22 and in the experimental group, 28. Since some of the students did not answer all the questions the percentages of frequencies were calculated according to the number of the students who answered to the question. The frequencies of the categories for each question were found. All the percentages were calculated separately for control group and experimental group. The categories which were greater than 5 % were tabulated. However some of the categories which were lower than 5 % were also reported for some answers for comparison reasons. The categories and their percentages in terms of frequencies were given for each question. The control and experimental groups will be compared in the conclusion part in terms of the percentages of the categories.

In the first question of MATT-Q1, students were asked the question “*How can we use the knowledge that we have learned in mathematics lessons, in our daily life? Write down your thoughts with examples. (Matematik derslerinde gördüğümüz bilgiler günlük hayatta ne işimize yarar? Bu konudaki düsüncelerinizi örnekler vererek yazınız.)”* The same question was asked to students also in the posttest and similar categories were found in addition to new categories such as “designing and tessellations” “shapes in historical places and such as palace and mosques and museum”, “parquets, floors, bath tiling and pavements”, “decoration: Ceiling, door and cupboard ornaments” which are related to the subject matter of the instruction. The frequency percentages of categories are given in Table 6.14. The most frequent answer to the application of learning in daily life was “shopping, banking and accounting”. The second most frequent answer in the pretest for both control and experimental group was “everywhere, life cannot be without mathematics*”* although its frequency percentage decreased in the posttest. “several jobs” answer had higher frequency percentage in control group than the experimental group. The percentage of students answering “we do not make use of it” decreases in both control and experimental group after the instruction. The frequency of “engineering and architecture” had an outstanding increase for the posttest of the treatment when compared pretest. The number of students who think that “mathematics makes improvement in cognitive skills” increased for both of treatment groups in the posttest. Category of “medicine” occurred in the answers of posttest of the treatment with a higher percentage, 11.3 % in experimental group.

Table 6.14. Frequency table for the first question of MATT-Q1 and MATT-Q2

	MATT-Q1 (%)		MATT-Q2 (%)	
	Control Group n=76	Experimental Group n=63	Control Group n=69	Experimental Group n=62
Shopping, banking and accounting	60.7	67.6	66.7	38.7
Everywhere, life cannot be without mathematics	31.0	27.9	19.0	22.6
Several jobs	22.6	17.6	17.9	9.7
We do not make use of it	8.3	8.8	2.4	3.2
Measurement, cooking	7.1	22.1	14.3	11.3
Engineering and architecture	7.1	7.4	6.0	16.1
Plays, predictions	4.8	2.9	7.1	1.6
Cartography, navigations	4.8	11.8	3.6	4.8
Teaching	3.6	4.4	7.1	1.6
Thinking logically, improving intelligence skills	2.4	2.9	9.5	8.1
Medicine	1.2	0.0	0.0	11.3
Designing and tessellations			11.9	30.6
The shapes in historical places and such as palace and mosques and museum.			1.2	29.0
Parquets, floors , bath tiling and pavements			0.0	17.7
Decoration: Ceiling, door and cupboard ornaments			0.0	27.4

The second question of the pretest is "*Which subjects are enjoyable for you in mathematics lessons? Why? (Matematik derslerinde hangi matematik konuları sizin için eğlenceli geçiyor? Neden?)"* Students answered the question firstly by giving several topic names and they said the reasons behind why they found those subjects enjoyable. Table 6.15 shows the answers with frequency percentage for control and experimental groups. The categories occurred were the same with similar frequencies in control and experimental groups. The most frequent category was that if they liked the subject. The second frequent answer for control group was that "the subjects are enjoyable". However for experimental group, the second most frequent answer was "achievement levels on those subjects". Another reason found in the answers was related to the competencies of the teacher in the subject. Furthermore 7.1 % of the control group and 1.5 % of the experimental group think that none of the subjects are enjoyable.

Table 6.15. Frequency table for the second question of MATT-Q1

	Control Group n=64 (%)	Experimental Group n=53 (%)
I like the subject	46.4	45.6
They are enjoyable	33.3	32.4
To achieve those subjects	32.1	38.2
I do not like any of the subjects	7.1	1.5
The teacher is good at that subject	4.8	4.4

In Table 6.16, the categories for the second and third question of MATT-Q2 are given. Since those two questions are asking the same question in different ways they are analyzed together as one question. The questions are "*What are the characteristics of the symmetry and pattern lessons that you like or you do not like? Explain" and "What is the general impression that you have from the lessons we studied together which you did not state in the second question? ("Simetri ve süslemeler" ile ilgili işlediğimiz derslerin beğendiğiniz ve beğenmediğiniz yönlerini nedenleri ile birlikte açıklayınız.), (İkinci soruda belirtmediğiniz, birlikte işlediğimiz dersler hakkında genel izlenimleriniz nelerdir?)"* 73 % of the experimental group and 69 % of the control group found the lessons enjoyable. In addition the second most frequent category was about students' understanding the subject matter for both groups. Around 30 % of both groups liked the subject matter. 28.6 % of the experimental group stated that they learned historical and cultural examples while learning mathematics. Such a category could not be observed in the control group supposedly. The percentage of students who liked the examples given during the instruction for the control group was lower than the experimental group as well as the frequency percentage of the following categories "slides", "worksheet and assignments", "we learned how math is used in daily life", and "increased love and interest to math". On the other hand, the frequency percentages of "improvement in handwork" and "the instruction" of the control group were higher than the experimental group.

Also the answer categories which reflect negative attitudes occurred as “lessons are boring”, “I had difficulties in understanding”, “I had difficulties in drawing” and “I do not like it at all”. The results occurred to their frequency percentage are shown in Table 6.16.

Table 6.16. Frequency table for the second and third question of MATT-Q2

	Control Group n= 76 (%)	Experimental Group n=63 (%)
Enjoyable	69.0	73.0
I understood the subjects better and they will be retained	34.5	44.4
I liked the subject	32.1	36.5
We learned historical and cultural examples while learning mathematics and why they are used	0.0	28.6
I liked everything in the lessons	27.4	25.4
The examples: visual	9.5	22.2
Slides	7.1	17.5
Worksheets and assignments	3.6	11.1
We learned how mathematics is used in daily life	6.0	9.5
The instruction	14.3	9.5
Improvement in handworks	13.1	6.3
Love and interest to math increased	1.2	6.3
Improving intelligence skills	6.0	3.2
Negatives:		
Boring (the subject, ornaments etc.)	13.1	20.6
I have difficulties in understanding	11.9	12.7
I had difficulties in drawing	10.7	4.8
I do not like at all	4.8	3.2

In the fourth question of the posttest, students were asked the question *“Which areas that mathematics is used are exemplified in our lessons? (Derslerimizde örneklenen matematiğin kullanım alanları nelerdir?)*. The frequency percentage graph of the answers of both control and experimental group are given in the Figure 6.1. Control and experimental group frequency distributions differed especially in the categories “designing and tessellations" and "shapes in historical places such as palace, mosques, and museums". Meanwhile "everywhere, life cannot be without mathematics." category occurred in both of the groups but in the experimental group the frequency percentage was 18.2 although it is 11.2 % in control group (n-control=63, n-experimental=55).

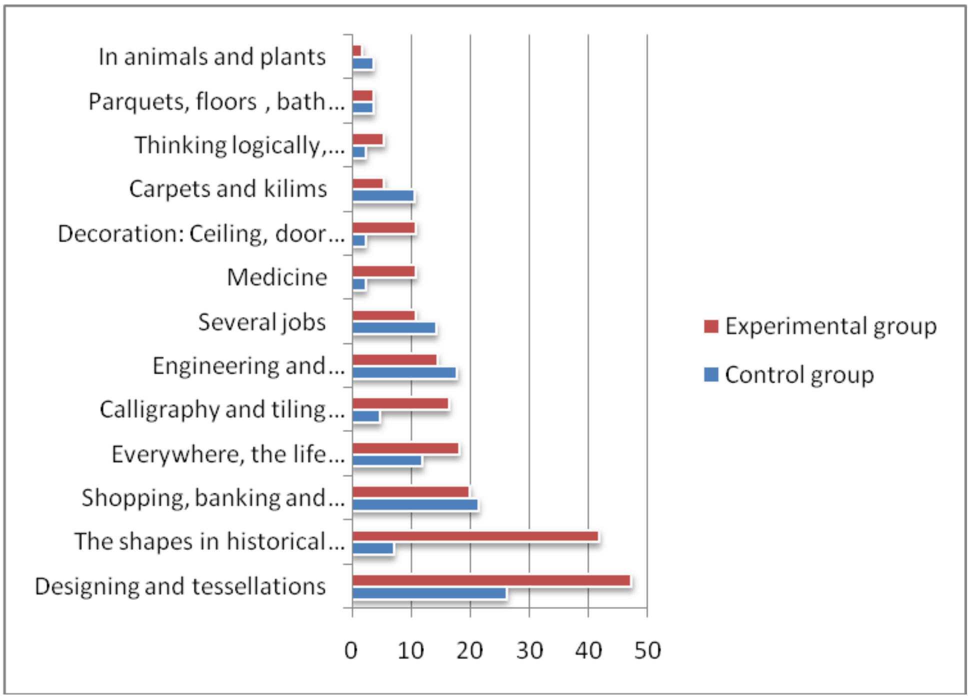


Figure 6.1. Histogram for the fourth question of MATT-Q2

The next question asked to students was *"How was your learning affected with the explanations about the uses of math in different disciplines? (Derslerimizde çeşitli alanlardaki matematik kullanımlarının anlatılması öğrenmeni nasıl etkiledi?)"* The most frequent category of the answers (n-control=63, n-experimental=54) observed for both control and experimental group was that they learned better and easier. However the frequent percentage of the experimental group, 83.3 % is crucially higher than the control group 51.2 % (see Figure 6.2). In the second most frequent category student stated that they learned enjoyable. Also in this category, the frequency percentage of the experimental group is higher than the control group. 22.2% of the experimental group answered the question as "I began to love math. My curiosity to math increased. I understood that it is an important subject. I understood the importance of math. I loved the subject." although 9.5 % of the control group gave such answers. This category is entitled as "improving math attitude" in the Figure 6.3. The answer "I learned much more about the subject matter and how to design different motifs." is shown as the column "to learn more on subject" again the control group's frequency is lower than the experimental group. Math and history column represents the answer "I learned mathematics and history, culture together". 16.7 % of the treatment group and 3.6 of control group responded in this way whereas 13.1 % of the control group, 3.7 % of the experimental group reported that no change took place. Lastly 3.7 of the control group and 1.9 % of the experimental group said that their learning was negatively affected during the treatments.

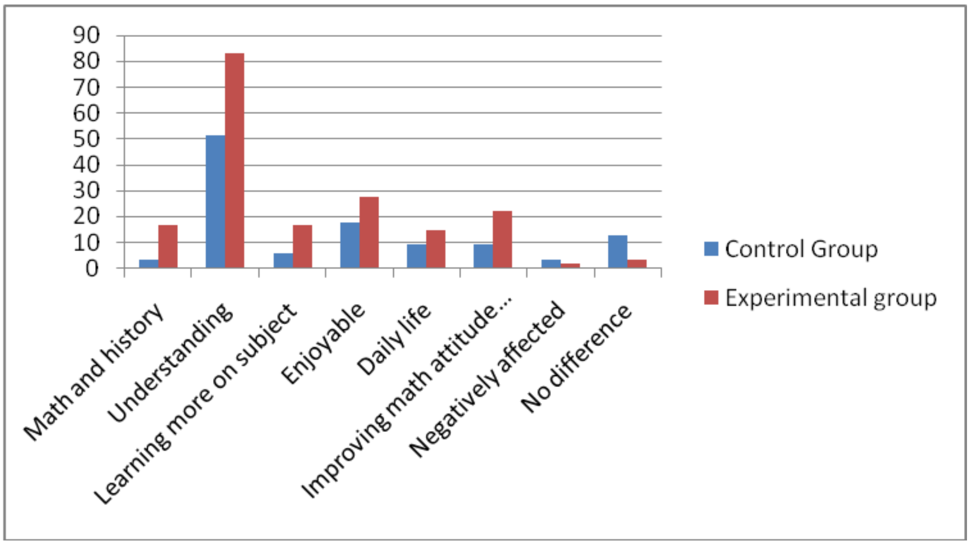


Figure 6.2. Histogram for the fifth question of MATT-Q2

Last question of MATT-Q2 (n-control=66, n-experimental=52), students answered the question *"In your opinion, should the topics such as uses of mathematics in daily life and mathematics in the history be included in mathematics lessons? Why? (Sence matematik derslerinde günlük yaşamda ve tarihte matematiğin kullanımına ilişkin kısımlar kullanılmalı mı?Neden?)"*. 1.2 % of the control group and 3.8 % of the experimental group said "no" to this question by reasoning "it is waste of time or confusing" (see Figure 6.3). 4.8 % of the control group and 3.85 of the experimental group stated that they had no idea about the question. On the other hand, 19.2% of experimental group and 4.8 % of the control group said only "yes, it should". The students endorsing that topics should be included in math lessons and gave reasons such as "there is math in daily life and history", "for better understanding and retention", "it is a source of cultural knowledge". The frequency percentage of students for each item did not differ in terms of control and experimental group.

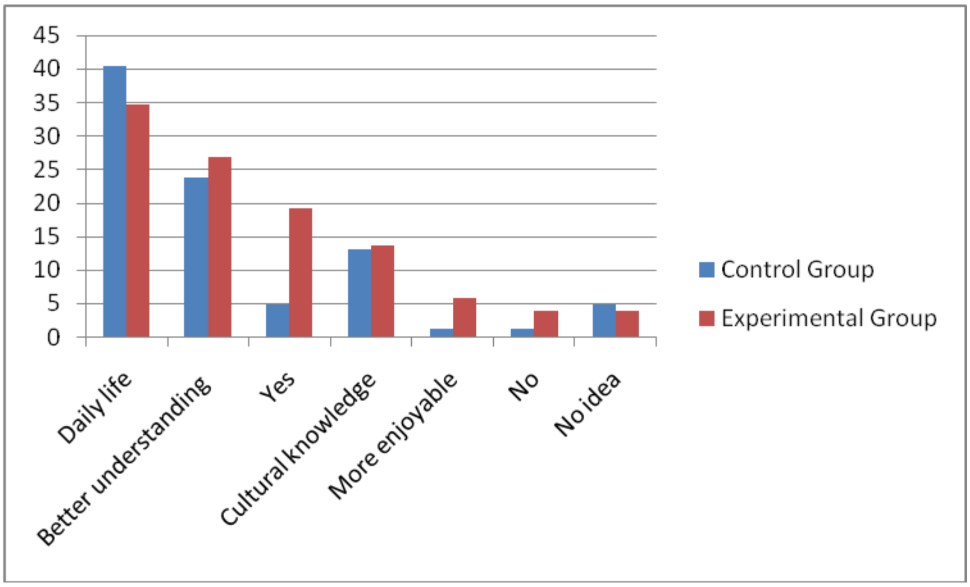


Figure 6.3. Histogram for sixth question of MATT-Q2

MATT-I (n-control=22, n -experimental=28)

In the first question of MATT-I which is a type of semi structured interview instrument, students were required to answer the question *"What do you remember about the lessons on symmetry and patterns? (Birlikte işlediğimiz simetri ve motifle kaplama dersi hakkında neler hatırlıyorsun?)"* Student answered this question by giving titles and subtitles of the subject matter, like "rotational symmetry". Although all students in the experimental group could remember the general characteristics of the lessons; 86.4% of the control group could remember. Moreover, 71.4 % of the experimental group could remember the examples about the usage of symmetry in historical places and mosques. 28.6 % of the experimental group, 4.5 % of the experimental group could remember daily life examples given in the lessons whereas these percentages are lower in the control group (see Figure 6.4).

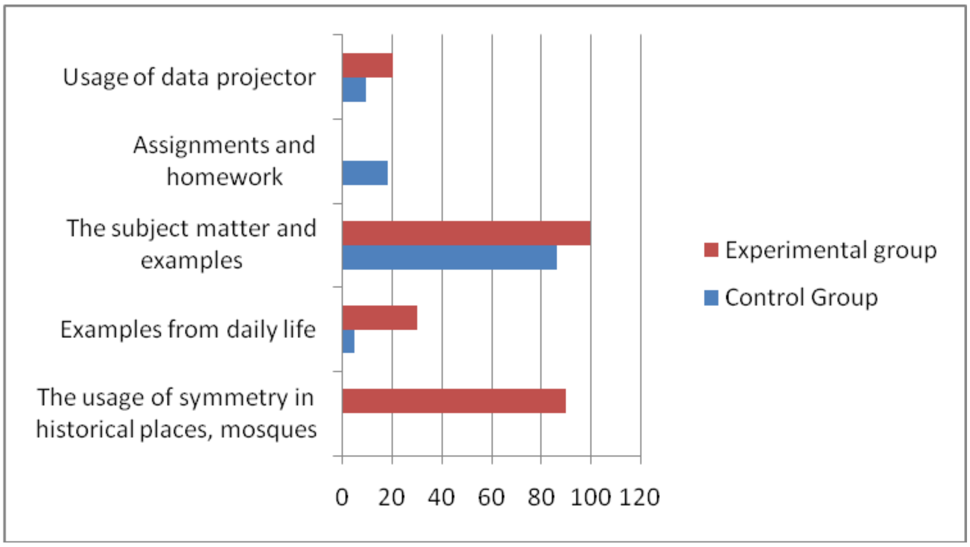


Figure 6.4. Histogram for the first question of MATT-I

The second question was about the differences between the treatments and regular math lessons *"What are the differences between our lessons and regular math lessons? (Bu derslerde normal matematik derslerinden farklı olarak neler vardı?)"* 46.4% of the experimental group declared the differences as examples form historical places and 28.6 of the group also declared examples from daily life (see Table 6.17). Those two categories did not occur in the control group. Furthermore, the categories the lesson was "visual", "more enjoyable", and more understandable" have been stated with low frequency percentages in both groups. There were also answers such as "much more positive attitude towards math", "instruction was better than our regular math instruction", "the subject was easier", "the subject was interesting"

Table 6.17. Frequency table for the second question of MATT-I

	CONTROL GROUP (%)	EXPERIMENTAL GROUP (%)
Examples from historical places	0.0	46.4
Visual	31.8	42.9
Examples from daily life	0.0	28.6
More enjoyable	27.3	25
More understandable	27.3	25
Assignments- worksheets and homework	9.1	20
No difference	22.7	10.7
Much more positive attitude towards math: I understood the importance of math. my curiosity increased towards math	4.5	10.7
Active participation to lessons increased	9.1	3.6
The subject was easier	36.4	3.6
The teacher's instruction was better than our mathematics teacher.	9.1	0
The subject was interesting.	9.1	0

The third question was "What are the usages of symmetry in daily life? What were the examples given in our lessons? *(Simetrinin günlük yaşamda kullanım alanları neler? Derslerimizde verdiğimiz örnekler neler idi?)*" According to frequency distribution, percentage of students' answers, "in palaces, historical places, tiling, carpets and ornaments especially in Harem section", "in houses, tiling of bathrooms, wood cupboards, wall and ceiling ornaments" had highest frequencies in the experimental group (see Table 6.18). The third most frequent answer of the experimental group was "motifs and ornaments" while the frequency percentage of the control group was 4.5. Moreover, 50 % of the control group and 17.9 % of the experimental group gave the answers "in nature, animals and plants".

Table 6.18. Frequency table for the third question of MATT-I

	CONTROL GROUP (%)	EXPERIMENTAL GROUP (%)
In palaces, historical places, tiling, carpets and ornaments especially in Harem section	9.1	82.1
In houses, tiling of bathrooms, wood cupboards, wall and ceiling ornaments	9.1	80
Motifs and ornaments	4.5	35.7
In nature, animals and plants	50.0	17.9
In pavement tiling	4.5	14.3
Examples in the books such as clover	0.0	7.1

The fourth question was *“How did the examples affected your own thoughts about mathematics?* (*Bu tür örnekler senin matematik hakkındaki düşüncelerini nasıl etkiledi?”)* Students from both groups declared that the lessons became more enjoyable, they understood better and they loved math much more. On the other hand, the categories “I learned that math is also used in historical places and items”, “my interest towards math increased” and “my interest towards the mathematics of motifs and ornaments increased” occurred in the experimental group with 26.6 %, 17.9% and 7.1 % while there is no such category occurred in the control group (see Table 6.19). On the other hand, “no difference” answer has 27.2 % in control group although it is 3.6 in the experimental group.

Table 6.19. Frequency table for the fourth question of MATT-I

	CONTROL GROUP (%)	EXPERIMENTAL GROUP (%)
It may be more enjoyable	40.9	60.7
I understood better	59.1	42.9
I loved mathematics much more	31.8	32.1
I learned that math is also used in historical places and items	0.0	28.6
My interest towards math has increased	0.0	17.9
I realized the importance and need of mathematics	13.6	14.3
I learned that math is used also in daily life	13.6	10.7
My interest towards the mathematics of motifs and ornaments increased	0.0	7.1
We learned much more information	13.6	7.1
No difference	27.3	3.6
Positively affected	13.6	0

In the fifth question students were asked *"How was your own learning and understanding of symmetry were affected with the examples? (Örnekler sayesinde simetri ve motifle kaplama konusunu anlaman ve öğrenmen nasıl etkilendi? Daha kolay, daha karmaşık, severek, sevmeyerek?)"* The frequency of the answer "I learned easier" was highest in both groups (see Table 6.20). On the other hand, the frequencies of "I could easily remember" and "I learned enjoyably" were considerably higher for the experimental group than the control group.

Table 6.20. Frequency table for the fifth question of MATT-I

	CONTROL GROUP (%)	EXPERIMENTAL GROUP (%)
I learned easier	72.7	89.3
I could easily remember	4.5	39.3
I learned enjoyably	36.4	67.9

The sixth question was *"How did integrating the examples to math instruction affected math lessons? (Bu konuların da matematik derslerine eklenmesi matematik derslerini daha zor/daha kolay, sıkıcı/eğlenceli hale getirdi mi?)"* "Math lessons became easier" and "more enjoyable" are the categories having around the similar frequency percentage in both groups. The answers "we learned the areas used symmetry", "my cultural knowledge increased" and "my thoughts about math changed positively" are the answer categories occurred only in the experimental group (see Table6.21).

Table 6.21. Frequency table for the sixth question of MATT-I

	CONTROL GROUP (%)	EXPERIMENTAL GROUP (%)
Math lessons became easier	50.0	57.1
More enjoyable	36.4	57.1
We learned the areas used symmetry	0.0	32.1
My general culture knowledge increased	4.5	28.6
My thoughts about math changed positively	0.0	25.0

The last question of the interview is *"Do you think that mathematics should be taught with daily life examples? (Matematiği bu tür günlük yaşam konuları içinde öğretilmeli mi? Niçin?)"* The students in control and experimental groups who answered as "yes" gave explanations such as "because it is necessary and math is in everywhere". The frequency percentage of students in experimental group, giving the answer "because people should see and learn that math is also used in historical places and artifacts" was 50 % although none of the students in control group gave such an answer (see Table 6.22). Moreover, "because we can learn easier" answer was given as an answer by 4.5 % of the students in the control group although this was 39 % in the experimental group. On the other hand 50 % of the control group reported that "there is no need to teach with daily life examples.

Table 6.22. Frequency table for the seventh question of MATT-I

	Control Group (%)	Experimental Group (%)
Yes, because people should see and learn that math is also used in historical places and artifacts	0.0	50
Yes, because we can learn easier	4.5	39.3
Yes	31.8	35.7
Yes, because It may be more enjoyable	4.5	25.0
Our quantitative abilities may increase	13.6	3.6
No need	50.0	0
No, because math is not used in daily life	4.5	0

7. DISCUSSION AND CONCLUSION

This study was designed for two major goals. The first goal is to develop an instruction integrated with ethnomathematics related to symmetry and patterns subject with examples from Topkapı Palace. Therefore the instruction integrated with ethnomathematics was developed after careful considerations with the examples of instructions raised in the literature and under the guidance of national mathematics curriculum. The second major goal of the study is to clarify the effects of instruction integrated with ethnomathematics through the implementation of the instruction in an experimental design. Effects of instruction were measured by examining mathematics achievement level and attitudes towards mathematics of the seventh grade students who received instruction integrated with ethnomathematics and regular instruction. Mathematics achievement levels of the groups were compared in terms of their level of achievement in prerequisite topics of the symmetry and patterns topics which are angle, line and plane using protractor, basic characteristics of polygons (triangles, rectangles, squares, parallelogram, pentagons and hexagons) and line symmetry, rotational symmetry and patterns topics. Attitudes towards mathematics of the students were compared in terms of their total scores of MATT scale. In the study, quantitative as well as qualitative data obtained from 137 seventh grade students who were attending three different public primary schools in İstanbul.

The effectiveness of instruction integrated with ethnomathematics was analyzed in three schools separately with quasi experimental design. In all three schools one class was selected as control group and one class as experimental group. Because of convenient sampling, it seems that generalization of results is not possible, so each hypothesis were tested separately for each school. MATT, MAS1 and MATT-Q1 were administered at the beginning of the study. After the treatments MATT, MAS2 and MATT-Q2 were administered as posttest. Also interviews were conducted with 50 selected students according to their scores in MATT. Nine months later MAS2 was administered second time as a retention test. Quantitative data analysis was conducted separately for each school. Qualitative analysis was conducted by considering all control and experimental groups of three schools together.

To test Hypothesis (1.i), repeated measures ANOVA was used in order to examine whether 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post measures (post test and retention test) compared to pre measure as assessed by Mathematics Achievement Scale. The results of the analysis in all three schools showed that there is a statistically significant linear trend over the mean values between pre, post and retention level mathematics achievements of the students in control and experimental groups of each school in terms of MAS scores, The results of School-1, School-2 and School-3 implied that both of the treatments which are regular instruction and instruction integrated with ethnomathematics were effective in improving linear trend over the mean values between pre, post and retention level mathematics achievements of the students in control and experimental groups, $F(1.28)=79.852$; $p=0.00$ for School-1, $F(1.45)=30.43$; $p=0.00$ for School-2 and $F(1.58)=93.511$; $p=0.00$ for School-3.

To test Hypothesis (1.ii), repeated measures ANOVA was used in order to examine whether 7th grade students who received instruction integrated with ethnomathematics will show significantly higher learning gains (difference between post and pre measures on Mathematics Achievement Scale) as compared to those who received regular instruction on symmetry and patterns topic. The results of the School-2 supported the research hypothesis since it was found that there is a significant interaction effect of type of instruction and mathematics achievement levels of seventh grade students who receive instruction integrated with ethnomathematics and regular instruction for School-2. This result implied that the instruction integrated with ethnomathematics was effective in improving mathematics achievement level of the students, $F(2.45) =9.98$; $p=0.03$. On the other hand the results of the School-1 and the School-3 did not support the hypothesis. It was found that there is not significant interaction effect between the experimental and control group of School-1 and School-3. The results implied that the treatment instruction integrated with ethnomathematics was not effective in improving mathematics achievement level of the students, $F(2.28)=0.44$; $p=0.83$ for School-1 and $F(2.58)=2.925$; $p=0.093$ for School-3 . The reason behind the results for School-1 may depend on sample size. There were 15 students in each group although the number of the class size is 27 in each group. Since some of the students could not attend to posttest or retention test so the number of subjects decreased for the study. The same situation occurred in all three schools but the size of the sample for School-1 became smallest. Meanwhile, the second school was a laboratory school of Boğaziçi University, Faculty of Education. Therefore, students in those schools may have attended to some research studies before this study. Hence students in both control and experimental group are accustomed to researchers who are unfamiliar persons in the classroom. However in the first and third schools, lessons with a new teacher and in a different format are new for all students in control and experimental groups. So the adaptation process for new experience may affect their comprehension level. Hence there is not a significant difference on mathematics achievement levels of the students.

This finding of the study contradicted with the report of Moses (2005) that African-American students' achievement scores in mathematics increased as they learn about African culture. Also the grades of algebra course of students taught by ethnomathematical pedagogy were higher than the students' who receive instruction without the ethnomathematical pedagogy (Arishmendi-Pardi, 2001). Moreover, many researchers reported the superiority of integrating ethnomathematics into mathematics instruction on students' mathematics performance (e.g. Arishmendi-Pardi, 2001; Lipka *et al.*, 2005; Brenner, 1998,). Another contradiction was found with findings of Lipka and his colleagues (2005); according to students' mathematics performance were in favor of the instruction which is math in a cultural context which was based on two case studies of a successful culturally based math project. Hence results of the current study about achievement levels may be questioned in terms of the time/length of the treatments or/and about the differentiation of the treatments.

To test Hypothesis (2.i), repeated measures ANOVA was used in order to examine whether 7th grade students who receive instruction integrated with ethnomathematics or regular instruction on symmetry and pattern topic will score higher for post test as compared to pre test on Scale for Attitudes Towards Mathematics. The results of the School-1, School-2 and School-3, did not support the research hypothesis since it was found that there is not a statistically significant linear trend over the mean values between pre and posttest levels of attitude towards mathematics of the students in control and experimental groups of each school in terms of MATT scores. The results of School-1, School-2 and School-3 implied that both of the treatments -regular instruction and instruction integrated with ethnomathematics- were not effective in improving a significant linear trend over the mean values between pre and post levels of attitude towards mathematics of the students $F(1.28)=2.414$; $p=0.131$ for School-1, $F(1.45)=3.394$; $p=0.072$ for School-2 and $F(1.58)=2.79$; $p=0.100$ for School-3.

To test Hypothesis (2.ii), repeated measures ANOVA was used in order to examine whether 7th grade students who received instruction integrated with ethnomathematics will show significantly higher gains (differences between pre and post means) in their attitude scores on Scale for Attitudes Towards Mathematics as compared to those who received regular instruction on symmetry and patterns topic. The results of the School-2 supported the research hypothesis since it was found that there is a statistically significant interaction effect between the experimental and control group of the School-2. The results of School-2 implied that the instruction integrated with ethnomathematics was effective in improving attitude towards mathematics levels of the students, $F(2.45)=6.99$; $p=0.011$. However the results of School-1 and School-3 showed no significant interaction effect, $F(2.28)=0.396$; $p=0.535$ and $F(2.58)=1.932$; $p=0.170$ School-1 and School-3 respectively. The reason behind this result may depend several factors. The number of students involved in the study and in timing of administration schedule again may be listed as the reasons for this result. The total number of students in School-1 is 60 and in School-3, 83 although the total sample size is 28 and 58 respectively in those schools. As it was mentioned previously, because the study was implemented at the end of the term, the students were not willing to work on the scales. Majority of students did not submit their project homework related with the examples of symmetry in the daily life. Especially the students in the third group did not involve the exercises and activities in the class. So motivation levels of students may be another reason for not observing any significant difference in attitude levels. The last exam of the term was over before the study since their grades would not be affected according to their performance in the study some student did not pay attention to the study. For example, some of the students ignored to give answers to the questions of MATT-Q2.

One of the school’s finding for the study showed that instructional practices which was enriched by ethnomathematical examples effected students’ attitudes towards mathematics positively in experimental group. The findings suggested that, integrating ethnomathematics is an effective strategy to promote students' attitudes towards mathematics in the school where the study is conducted. In order to enhance self-confidence, capacity, readiness and openness to work in a multicultural environment among future math teachers, Gerdes (1998) argued to develop an awareness of the social and cultural bases of mathematics.

In addition to mathematics achievement level and attitudes towards mathematics, students' ideas and perceptions about how we use mathematics in daily life and how participants' perception to mathematics and learning change, whether we should integrate usage of mathematics in daily life and in history to mathematics lessons were probed with other instruments. Students' answers to MATT-Q1, MATT-Q2 and MATT-I were examined. The questions were open ended questions that are asked about students' ideas and understandings. Notable results were obtained at the end of analyses. First of all, in the first question of the pretest and posttest students were asked daily life usage of the subjects which they learn in math lessons. As it is seen in Table 6.14 in the posttest students in the experimental group gave answers in new categories such as "designing and tessellations" , "shapes in historical places and such as palace and mosques and museum", "parquets, floors , bath tiling and pavements", "decoration: Ceiling, door and cupboard ornaments" with higher frequency than the control group. As it can be inferred from the categories students in experimental group reported much more usages of symmetry and patterns topic than the control group. The results can be interpreted by comparing frequencies such that when students see the examples ethnomathematical perspective they believe that mathematics is used in daily life.

In the second question, students were asked which mathematics subjects are enjoyable for them and the reasons. Student answers were interpreted in terms of the reasons they gave. In both groups students declared that they found a topic enjoyable if they like the subject or if they are successful in that subject. In addition to properties of the subject matter the way of instruction is also showed as a reason to find a lesson enjoyable.

In the second and third question students were asked about the characteristics of the treatments to both control and experimental group. In comparison to control group, more students in the experimental group stated that they could easily understand the subject and liked the examples. Meanwhile 28.6 % of the students in experimental group declared that they have learned historical and cultural examples while learning mathematics and why they are used. Another category which occurred in experimental group answers is students' love and interest towards math increased. Worksheets and assignments of the instruction were other characteristics of the lessons, which students like. On the other hand, some of the students in both groups found the lessons boring and had difficulties in understanding. The instruction and activities of the lessons should be improved so that the lessons will be more enjoyable and clear. The students in both of the treatment groups also stated that they learned details related to the usage of mathematics in daily life.

In the fourth question, students described areas in which mathematics is used and which are exemplified during the treatments. The majority of the students in the experimental group could describe the areas such as "designing and tessellations", "shapes in historical places such as palace, mosques, museums", "decoration: Ceiling, door and cupboard ornaments", "calligraphy and tiling ceramics" exemplified in our lessons with higher percentages than the control group. Meanwhile, some students in both groups said "Everywhere, life cannot be without mathematics", but with a higher percentage in the experimental group.

Students in both groups stated that their learning was affected in a positive way. More students in the experimental group declared that they learned better, easier and enjoyably. Furthermore 22.2% of the experimental group answered the question as "I began to love math. My curiosity to math increased. I understood that it is an important subject. I understood the importance of math. I loved the subject." although 9.5 % of the control group gave similar answers. The number of students stating that they learned much more about the subject matter and how to design different motifs was higher in the experimental group than the control group. Experimental group students also stated that they learned mathematics and history, culture together". The number of students stating no change in their learning occurred or negatively affected is critically low in the experimental group.

Use of data projector during treatments seemed to effect students' comprehension levels although it was used in all groups, visualization of the subject matter and use of data projector attracted students' attention. 17.5 % of the experimental group students and 7.1 % of the control group students stated that using slides is one of the properties of the lessons they liked. This result may be accepted as an indicator for the importance of using visualizations during instructions.

When students were asked whether the topics such as usage of mathematics in daily life and mathematics in the history should be included in mathematics lessons only few students said "no" as an answer to this question with reasoning "it is waste of time or confusing". The majority of students endorsing that they should be included in math lessons, gave reasons such as "there is math in daily life and history", "for better understanding and retention", "it is a source of cultural knowledge".

According to the findings of the interview which was conducted after the treatments, students in the 71.4 % of the experimental group could remember the examples about the usage of symmetry in historical places and mosques. 28.6 % of the experimental group, 4.5 % of the control group could remember daily life examples during the lessons.

Students perceived the instruction integrated with ethnomathematics different than their regular math lessons in terms of examples form historical places and examples from daily life. Furthermore students in both groups' declared that the lesson was "visual", "more enjoyable", and more untreatable" with similar frequency. The answers "much more positive attitude towards math" was seen more frequently in the experimental group.

More than 80 % of the experimental group students could remember the examples, the daily life usage of symmetry and pattern subject as In palaces, historical places, tiling, carpets and ornaments especially in Harem section, in houses, tiling of bathrooms, wood cupboards, wall and ceiling ornaments. On the other hand the frequency percentage of the answer "in nature, animals and plants" was higher in the control group, 50 %. The control group was shown only the examples of the daily life. This result showed that students are attracted by the examples from daily life. Although the number of daily life examples was almost the same in both group, the experimental group showed always higher frequency.

This may be an important effect of the instruction integrated with ethnomathematics, showing the direct use of mathematics in cultural contexts. According to students who were interviewed, examples related to the use of mathematics in daily life positively affected their attitudes towards mathematics; they began to love mathematics, and find mathematics more enjoyable. Some students only in the experimental group stated that "I learned that math is also used in historical places and items", "my interest towards math increased" and "my interest towards the mathematics of motifs and ornaments increased. On the other hand, the answer of "no difference" has 27.2 % in control group although it is 3.6 in the experimental group. This means that the examples were much more effective in the experimental group than the control group. The examples also affected students learning and understanding in terms of easiness in both groups. Students in the experimental group declared that they could easily remember the subject matter with the examples. Students also declare that the examples made math lessons easier and more enjoyable. The subjects of the experimental group also stated that they learned the areas used symmetry, my general culture knowledge increased. Besides that according to them their thoughts about mathematics changed in a positive way. More than half of the students in both groups thought that mathematics should be taught with daily life examples by giving reasons such as math is necessary and in everywhere. Students who were taught the subject matter in a cultural context stated reasons such as "people should see and learn that math is also used in historical places and artifacts "we can learn easier". Another important result was that half of the control group students stated there is no need of to teach with daily life examples. This result may be related with that students may think that there will be no advantage of learning daily life examples in mathematics lessons. Hence their learning will not be affected with those examples. Since students in control group did not receive daily life examples in a cultural context, they may not see them as advantageous in their learnings.

7.1. Limitations

It is not possible to generalize the results of the study to 7th grade students other than the students of three schools in the study. The sample size of the study is small and sampling technique is not appropriate for drawing generalizations. Since the schools were not selected by using randomization techniques, the data obtained from each school was analyzed separately. Hence the number of subjects in control and experimental group were below thirty, the distributions of the scores were determined with normality tests of Kolmogorov-Smirnov and Shapiro–Wilk. The results of these tests show that five measurements' scores are significantly different than the scores which have normal distributions. Furthermore, the numbers of the participants in control and experimental groups for each school were not equal. For example for School 2 there were 19 students in the control group although there were 29 students in the control group. Although during the instruction the class sizes of each school were similar some students could not take place during test administration sessions, eventually the sample sizes of groups decreased.

The researcher's dual role may be stated as a limitation of the study although the researcher taught both the control and experimental group. The researcher acted as a teacher for only six lesson hours for only a unit of subject matter and also covered the materials of the instruction and as a researcher and administered the questionnaires for collecting data.

Another limitation is about the schedule of the implementation. The study was implemented at the end of the term in three schools. In two schools all math exams were over, therefore, students were not willing to listen, have a task or participate in activity moreover answer questionnaires. Furthermore, since some of the students did not come to school at the end of the term, 30 students could not attend to posttest. 140 out of 180 students could be the sample of the study. So the number of the students in control and experimental groups of each school decreased. Meanwhile as it is stated above, students who participated in measurements had lower motivation.

To summarize the main limitations, it can be said that time of implementation, students' lower motivation to take questionnaires and exam, the researchers' dual role are the limitations of the study.

7.2. Recommendations for Further Research and Implications

This study was conducted in order to develop instruction integrated with ethnomathematics and measure its effectiveness in terms of students' mathematics achievement levels and attitudes towards mathematics, students' declarations bout their own learning. Although the results did not support the effectiveness of instruction integrated with ethnomathematics in two of the schools, further research with a better implementation schedule may change the effectiveness of the instruction, and provide necessary feedback to make revisions in the instruction. Also the instruction integrated with ethnomathematics developed for this study can be used as a model for developing similar instructions in different content areas and for different grade levels. Moreover, in general a potential trend showing the higher mathematics performance was observed in other research studies which are investigating the effects of instruction integrated with ethnomathematics. On the other hand, majority of the results obtained from MATT-Q1, MATT-Q2 and MATT-I which are instruments for gathering a qualitative date indicated that instruction integrated with ethnomathematics is effective in terms of students' attitudes towards mathematics and their perceptions related to the use of mathematics in daily life. This seems an interesting trend deserving further research.

In order to get generalizable results, a similar study may be carried out with a representative seventh grade sample and also the math teachers of the sample should be integrated into the study. Results may differ if students receive similar instructions during their real classroom settings from their math teachers.

For further research, mathematics teachers' attitudes towards integrating ethnomathematical examples to their lessons can be studied. Additionally, this study provides helpful findings on integrating ethnomathematics to mathematics lessons within a mathematics learning setting. The connection between mathematical ideas and daily life experiences of students, were emphasized in the study of Presmeg (1998) who argues that the ethnicity of students is also a resource for mathematics. As Gerdes (2001) suggested teachers may look for suitable activities to create a truly simulating and enriching environment to help all students fully develop their potentials.

In order to increase students' motivation levels towards completing the questionnaires and worksheets, they should be given some credits for their mathematics grades. Meanwhile, instruction integrated with ethnomathematics can be adapted to project based learning and its effectiveness also can be investigated. To increase the effectiveness of the instruction, field trips to informal learning centers or the historical places in which ethnomathematical examples related to subject matter exist may be planned.

The ornaments in Topkapı Palace prompted students to look at the colors, shapes, and patterns in the culture and reinforced the idea that ornaments can be a means of expressing one's cultural heritage, living style, psychology and status. The exploration of different ornaments, ethnomathematical practices, tilling and patterns may allow students to see how cultures express themselves and realize the mathematics that they use in school may be connected with things that they see in the real world. This kind of presentation offers a few ideas for using ornaments to help students explore various cultures and mathematical concepts. These activities can be modified with students in several grades. As students arrange and learn the characteristics of the shapes to form the tilling, they can explore the importance of the number of sides, angles, and so forth. Teachers might also modify their math lessons by searching other ethnomathematical practices.

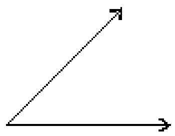
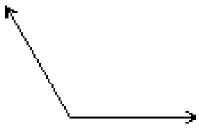
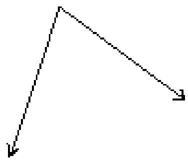
APPENDIX A: MATHEMATICS ACHIEVEMENT SCALE 1 (MAS1)

Ad Soyad:

Sınıf:

Okul:

1. Aşağıdaki açıları ölçünüz, çeşitlerini yazınız.

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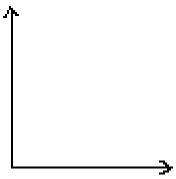
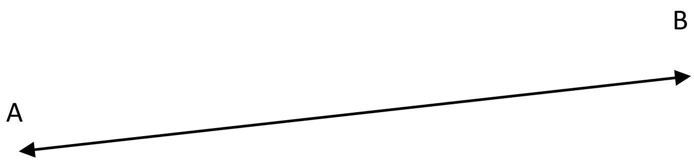



....

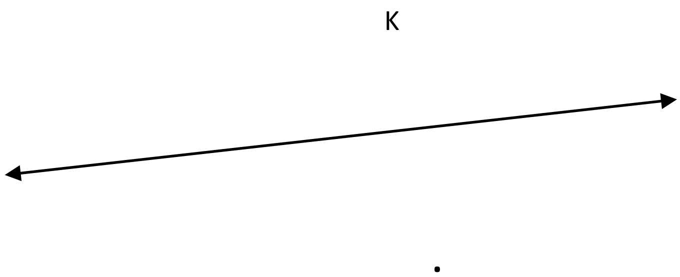
2. Aşağıda ölçüleri verilen açıları açıölçer yardımı ile çiziniz.

a) $s(AOB) = 30^\circ$ b) $s(KLM) = 75^\circ$ c) $s(PRS) = 90^\circ$

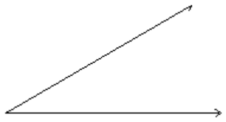
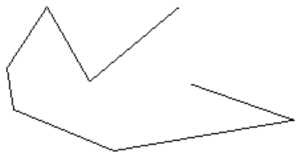
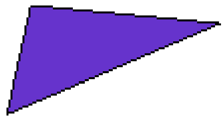
3. Aşağıdaki AB doğrusuna parelel bir doğru çiziniz.



4. Aşağıdaki m doğrusuna K ve L noktalarından dikme indiriniz.



5. Aşağıdaki şekillerden çokgen olanları işaretleyiniz ve türlerini yazınız.

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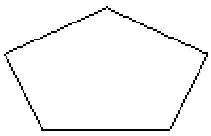
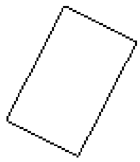
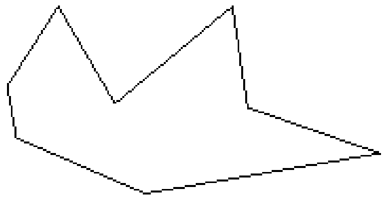

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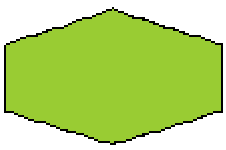
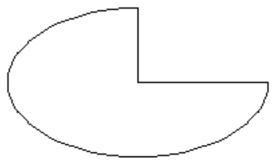
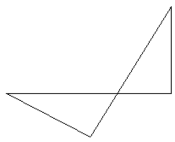

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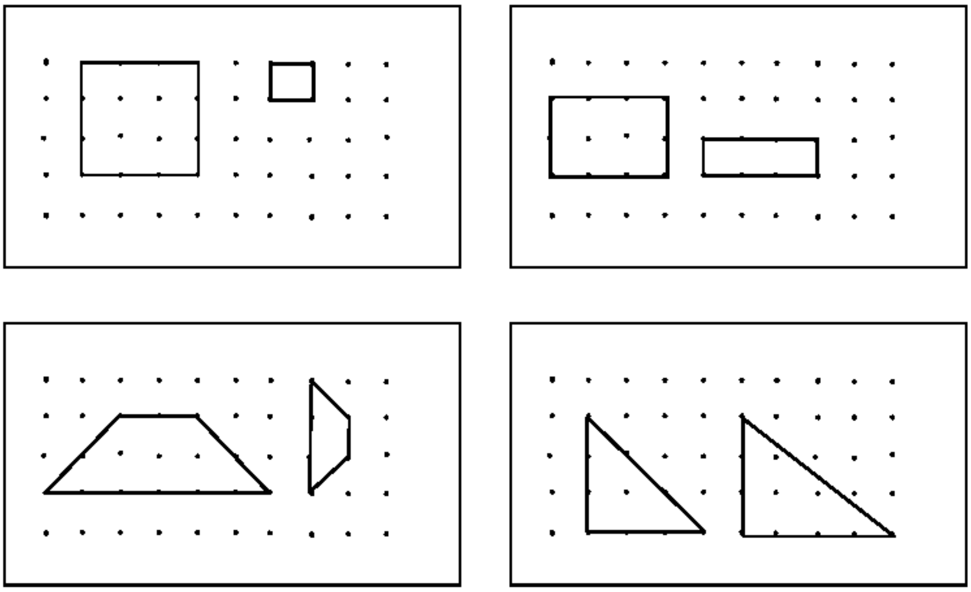
6. Aşağıda belirtilen çokgenlerin kenar, sayilarını, iç açılar toplamını ve dış açılar toplamını yazınız. Şekillerini çiziniz.

Çokgenin ismi	Kenar sayısı	İç açılar toplamı	Dış açılar Toplamı	Düzgün çokgen için Bir iç açısının ölçüsü	Şekil
Üçgen					
Dikdörtgen					
Beşgen					
Altıgen					
Sekizgen					

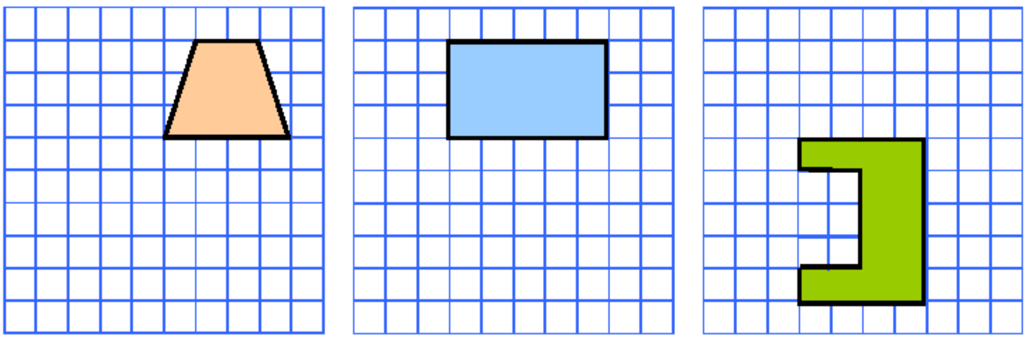
İpucu: Çokgen açılarını hesaplamak için: (n-2)x180

7. Çokgenlerin eşlik ve benzerlik durumunu birer cümleyle açıklayınız.

8. Aşağıdaki çokgenlerden hangileri benzerdir? Açıklayınız.

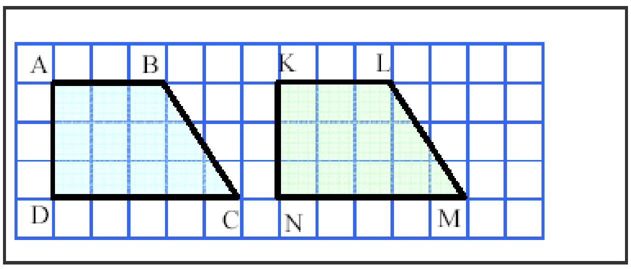


9. Aşagýdaki şekillerin belirtilen yön ve birimlerde öteleme altýndaki görüntülerini çiziniz.

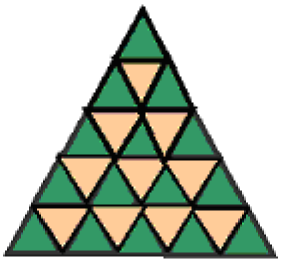


2 birim sola, 1 birim aşağıya 2 birim aşağıya,1 birim sağa 1 birim sağa, 3 birim yukarıya

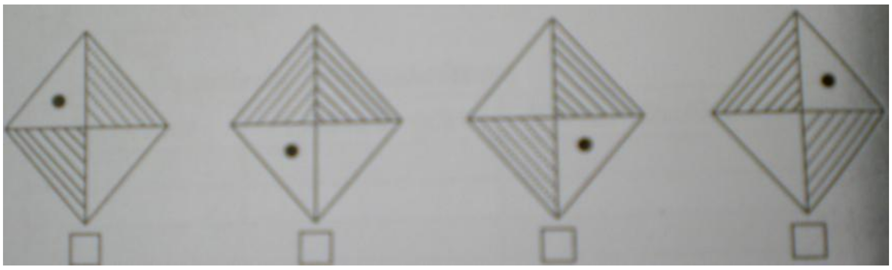
10. Aşağıda verilen şekil kaç birim ve hangi yöne ötelenmiştir?



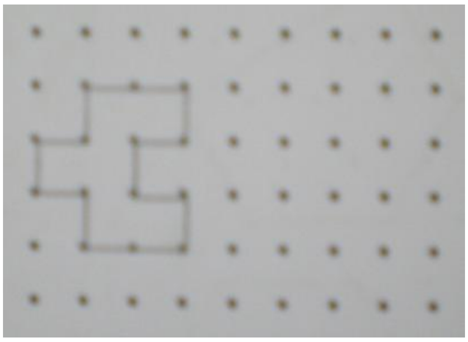
11. Aşağıdaki süsleme devam ettirilirse 15. sırada kaç tane üçgen olur?



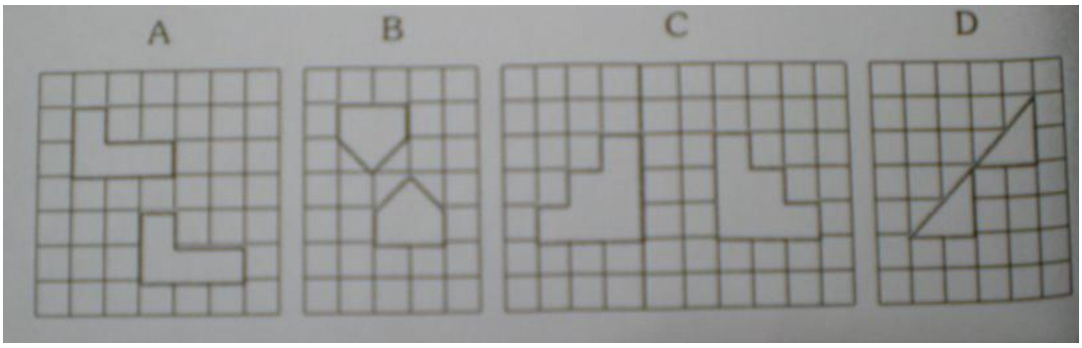
12. Aşağıdaki eş şekilleri belirleyiniz.



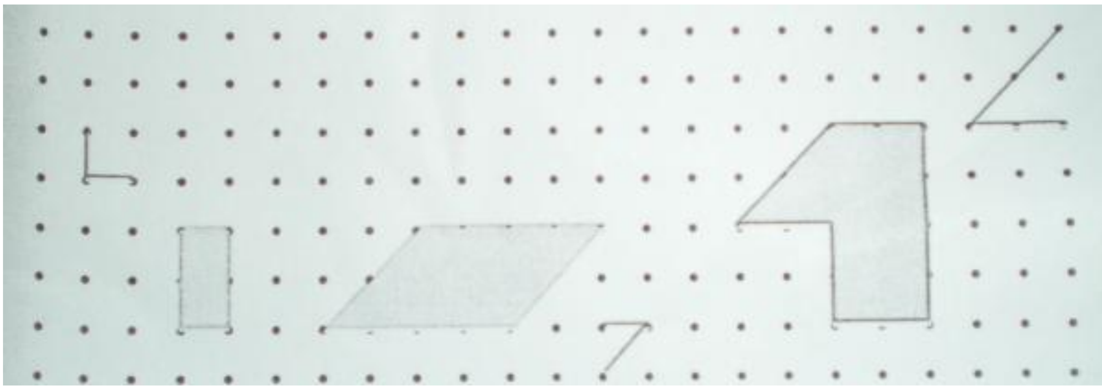
13. Aşağıdaki şekli 2 birim sağa öteleyerek noktalı kağıdınızda süsleme yapınız.



14. Aşağıdaki gruplardan hangilerinde şekil ve öteleme altındaki görüntüsü verildiğini belirleyerek öteleme kuralını yazınız.



15. Aşağıdaki şekillerin öteleme altındaki görüntüsün bir kısmı çizilmiştir. Eksik kısımları tamamlayınız ve ötelem kuralını yazınız.



16. Düzgün beşgen, düzgün altıgen ve düzgün sekizgen çiziniz.

Kaynakça

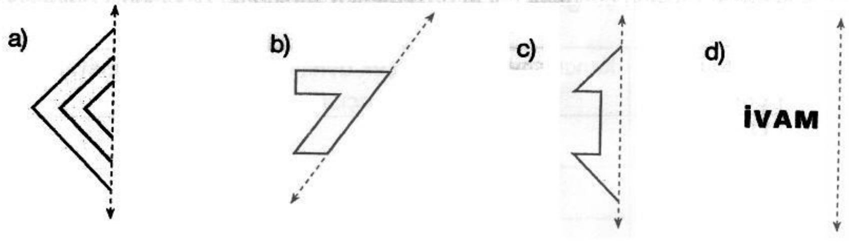
Göğün, Y. (2007). *Matematik Altıncı Sınıf Ders Kitabı.* Ankara: Güneş Basın Yayın Pazarlama Ltd. Ş. ,
Talim Terbiye Kurulu Örnek Proje Çalışması. Retrieved in March 14, 2008 from; http://talimterbiye.mebnet.net/e-ders/proje-grupcalismasi/matematik6.sinif-1.pdf .

APPENDIX B: MATHEMATICS ACHIEVEMENT SCALE 2 (MAS2)

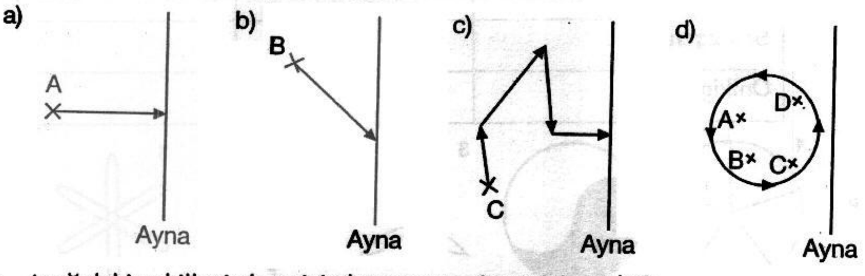
İsim:
Sınıf:
Okul:

MAS 2

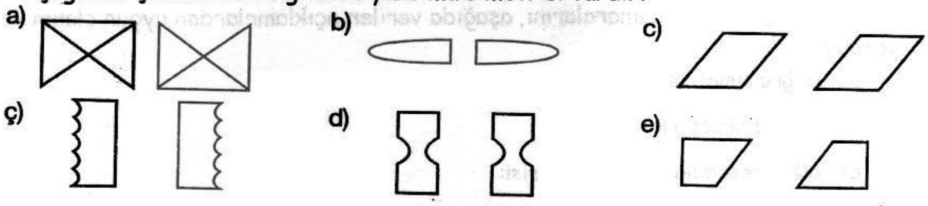
1. Aşağıdaki şekillerin yansımalarını belirtilen simetri eksenlerine göre çiziniz.

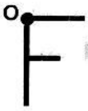


2. Aşağıdaki şekillerin aynadaki görüntülerini çiziniz.

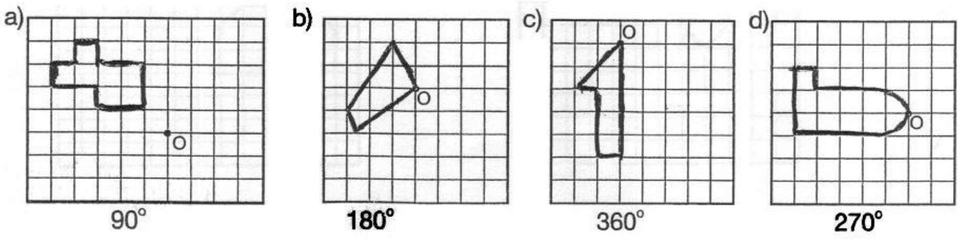


3. Aşağıdaki şekillerin hangisinde yansıma simetrisi vardır?



4. Aşağıda verilen a, b, c, ç'deki figürler,  **figürünün O noktası etrafında saat yönünde kaç derece döndürülmüş halidir?**

5. Aşağıdaki figürlerin, O noktasının etrafında verilen açıya göre, saat yönünde çevrilmiş hallerini çiziniz.



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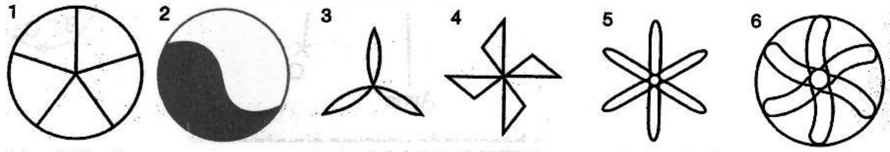
1
1

6. Bir şeklin en küçük dönme simetri açısı 30 derece ise diğer dönme simetri açıları ne olur?

7. Aşağıdaki düzgün çokgenler için düzenlenen tablodaki boşlukları doldurunuz.

Düzgün Çokgenler	Kenar sayısı	En küçük dönme simetri açısı	Dönme simetri sayısı
Üçgen			
Kare			
Beşgen			
Altıgen			
Sekizgen			
Onikigen			

8.



Yukarıdaki şekillerin numaralarını aşağıda verilen açıklamalardan uygun olanın karşısına yazınız.

a) **Doğru simetrisi:**

b) **Dönme simetrisi:**

c) **60 derecedeki dönme simetrisi:**

d) **120 derecedeki dönme simetrisi:**

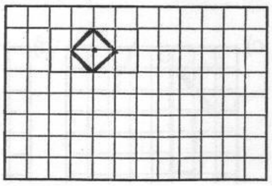
e) **72 derecedeki dönme simetrisi:**

f) **90 derecedeki dönme simetrisi:**

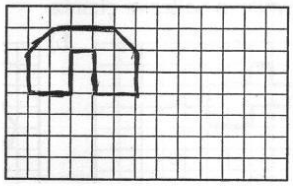
g) **180 derecedeki dönme simetrisi:**

9. Aşağıdaki figürleri kareli kağıda çizerek verilen yönlerde öteleme ve dönme hareketlerini yapınız.

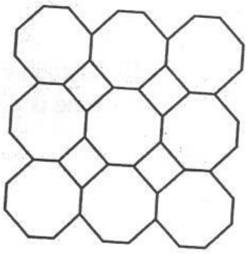
a) 2 sağa, 3 aşağı, 90° saat yönü



b) 1 aşağı, 5 sağa, 180° saatin yönünün tersi

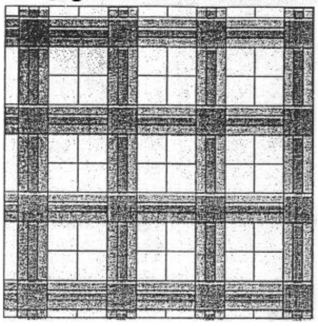


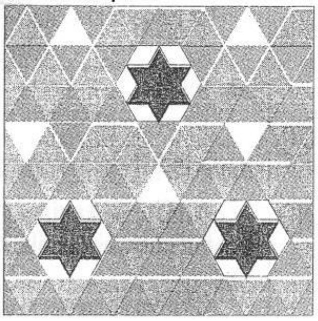
10. Yandaki süslemede;
a) Kodlamayı bulunuz.
b) Düzgün çokgenleri bulunuz.
c) Düzgün çokgenlerin her birinin iç açısını bulunuz.
d) Her köşedeki açıların ölçüleri toplamını bulunuz.



11. Kodu (4;6;3;4) olan bir model yapılabilir mi? Yapılabiliyor ise bu modeli kullanarak bir süsleme yapınız.

12. Aşağıdaki süslemelerde hangi hareketlerin yapıldığını altlarına yazınız.





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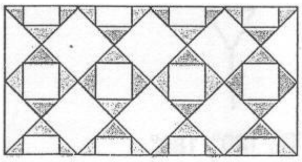

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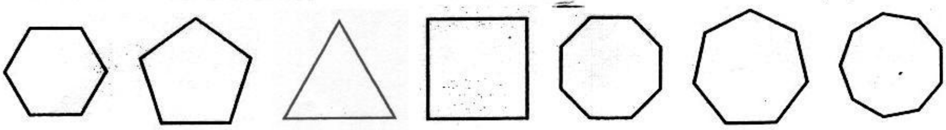
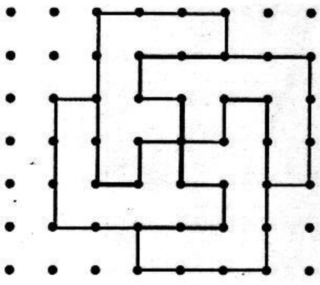
13. Aşağıda verilen düzgün çokgenlerin kaç tanesi ile tek başına süsleme yapılabilir?

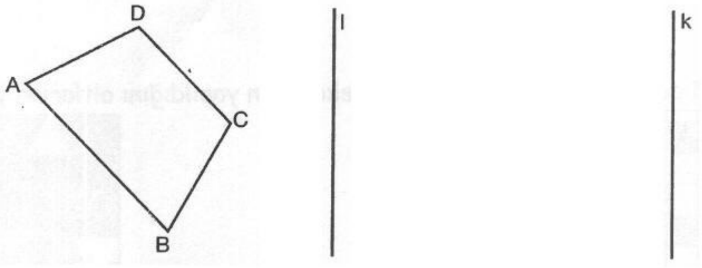


14. Aşağıdaki model kullanılarak yapılan süslemede hangi hareketler uygulanmıştır?



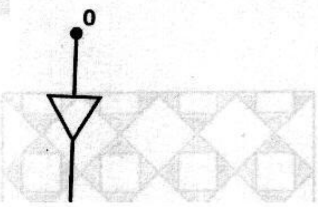
15. Düzgün altıgen ve eşkenar üçgen kullanılarak yapılan her süslemede köşe için kaç tane üçgene ihtiyaç duyulur?

16. Aşağıdaki yamuğun önce l doğrusuna göre, sonra k doğrusuna göre yansımasını çiziniz.



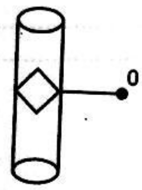
17. Aşağıdaki şekillerin, altlarında verilen açılara ve O noktasına göre dönme hareketini çiziniz.

a)



60°, 120°, 180°

b)



90°, 270°

APPENDIX C: SCALE FOR ATTITUDE TOWARDS MATHEMATICS (MATT)

MATEMATİKLE İLGİLİ DÜŞÜNCELERİNİZ

Ad Soyad :	**Yaş :**
Okul :	**Sınıf :**
Cinsiyet :	

AÇIKLAMA : Aşağıdaki maddeleri dikkatlice okuyunuz. Her madde sizin matematikle ilgili görüşünüzü almaya yöneliktir. Lütfen bu maddelerdeki durumların sizin için ne kadar geçerli olduğunu belirtiniz.

		Asla	Nadiren	Bazen	Sık Sık	Her Zaman
1	Matematik dersleri zevkli geçer.					
2	Matematik dersinde canım sıkılıyor.					
3	Matematiğim kuvvetlidir.					
4	İleride matematik öğretmeni olmak istiyorum.					
5	Matematik dersinde başka şeylerle ilgilenirim.					
6	Matematik dersinde konuları anlayamıyorum.					
7	Matematik bilgisi gerektiren konularda başarılıyımdır.					
8	Matematik dersi benim için keyifli bir oyun saati gibidir.					
9	Matematik dersi yerine ilgilendiğim başka bir derse girmeyi tercih ederim.					
10	Matematik bilmek ileride işime yarayacak.					
11	Belli temel bilgilerin dışında matematik bilmek gereksizdir.					
12	Matematik ödevlerinden nefret ederim.					
13	Matematik başarılı olduğum bir derstir.					
14	İleride matematikle ilgili bir alanda çalışırsam başarılı olabilirim.					
15	Matematiği neden okumak zorunda olduğumuzu anlayamıyorum.					
16	Matematik insanı daha iyi düşünmeye zorlar.					
17	Matematik dersi beni bunaltıyor.					
18	Matematik bilgisi iyi olan bir kişi diğer bilimleri rahatça anlar.					
19	Çalışırsam matematikten iyi notlar alabilirim.					
20	Matematik öğretmenleri çalışkandır.					

APPENDIX D: OPEN ENDED QUESTIONNAIRE FOR ATTITUDE TOWARDS MATHEMATICS (MATT-Q1)

Two open ended questions were added to MATT1. The questions are;

1. How can we use the knowledge that we have learned in mathematics lessons, in our daily life? Write down your thoughts with examples.

(Matematik derslerinde gördüğümüz bilgiler günlük hayatta ne işimize yarar? Bu konudaki düsüncelerinizi örnekler vererek yazınız.)

2. Which subjects are enjoyable for you in mathematics lessons? Why?

(Matematik derslerinde hangi matematik konuları sizin için eğlenceli geçiyor? Neden?)

APPENDIX E: EVALUATION SHEET (MATT-Q2)

The questionnaire has the questions as follows:

1. How can we use the knowledge that we have learned in mathematics lessons, in our daily file? Write down your thoughts with examples.
(*Matematik derslerinde gördüğümüz bilgiler günlük hayatta ne işimize yarar? Bu konudaki düşüncelerinizi örnekler vererek yazınız.)*

2. What are the characteristics of the symmetry and pattern lessons that you like or you do not like? Explain by reasoning.
("Simetri ve süslemeler" ile ilgili işlediğimiz derslerin beğendiğiniz ve beğenmediğiniz yönlerini nedenleri ile birlikte açıklayınız. Beğendiğiniz yönleri:Beğenmediğiniz yönleri:)

3. What are the general impressions that you have from the lessons we studies together?
(İkinci soruda belirtmediğiniz, birlikte işlediğimiz dersler hakkında genel izlenimleriniz nelerdir?

4. Which areas that use of mathematics are exemplified in our lessons?
(Derslerimizde örneklenen matematiğin kullanım alanları nelerdir?)

5. How was your learning affected with the explanation of the areas which mathematics is used in our lessons?
(*Derslerimizde çeşitli alanlardaki matematik kullanımlarının anlatılması öğrenmeni nasıl etkiledi?)*

6. In your opinion, should the topics such as usage of mathematics in daily life and mathematics in the history be included in mathematics lessons? Why?
(Sence matematik derslerinde günlük yaşamda ve tarihte matematiğin kullanımına ilişkin kısımlar kullanılmalı mı?Neden?)

APPENDIX F: INTERVIEW QUESTIONS (MATT-I)

1. What do you remember about the lessons on symmetry and patterns?
   (Birlikte işlediğimiz simetri ve motifle kaplama dersi hakkında neler hatırlıyorsun?)

2. What are the differences between our lessons and regular math lessons?
   (Bu derslerde normal matematik derslerinden farklı olarak neler vardı?)

3. What are the usages of symmetry in daily life? What were the examples given in our lessons?
   (Simetrinin günlük yaşamda kullanım alanları neler? Derslerimizde verdiğimiz örnekler neler idi?)

4. How did the examples affected your own thoughts about math lessons?
   (Bu tür örnekler senin matematik hakkındaki düşüncelerini nasıl etkiledi?)

5. How was your own learning and understanding of symmetry were affected with the examples?
   (Örnekler sayesinde simetri ve motifle kaplama konusunu anlaman ve öğrenmen nasıl etkilendi? Daha kolay, daha karmaşık, severek, sevmeyerek?)

6. How did integrating the examples to math instruction affected math lessons?
   (Bu konuların da matematik derslerine eklenmesi matematik derslerini daha zor/daha kolay, sıkıcı/eğlenceli hale getirdi mi?)

7. Do you think that mathematics should be taught with daily life examples?
   (Matematiği bu tür günlük yaşam konuları içinde öğretilmeli mi? Niçin?)

APPENDIX G: THE OBJECTIVES OF THE SYMMETRY AND PATTERNS CHAPTER OF 7TH GRADE NATIONAL MATHEMATICS CURRICULUM

Students will

- define the *reflection*
- define the *rotation*
- will draw the pictures of the shapes which are rotated according to a center point with an angle
- make ornaments by tilling a plane with polygonal shapes
- will define the codes of the ornaments developed with the polygonal shapes and will make ornaments according to the codes given
- make ornaments with reflection, rotation and transformation movements

Öğrencilerin,

1. yansımayı açıklaması
2. dönme hareketini açıklaması
3. düzlemde belirli bir nokta etrafında ve belirtilen bir açıya göre şekilleri döndürerek çizimini yapması
4. çokgensel bölge modelleriyle bir bölgeyi döşeyerek süsleme yapması
5. düzgün çokgensel bölge modelleriyle oluşturulan süslemelerdeki kodları belirlemesi, verilen kodlara uygun süslemeler yapması
6. Yansıma, öteleme dönme hareketleri ile süslemeler yapması

beklenir.

Kaynakça

Aygün, S.Ç., Aynur, N., Çuha, S.S., Karaman, U., Özçelik, U., Ulubay, M., Ünsal, N. (2007). *Öğretmen Kılavuz Kitabı Matematik 7.*İstanbul: Feza Gazetecelik A.Ş. MEB Devlet Kitapları

APPENDIX H: REGULAR INSTRUCTION FOR THE 7TH GRADE SYMMETRY AND PATTERNS SUBJECTS

In the regular instruction, students' practice and activity parts were implemented as stated in the Teacher Guide Book of 7th Grade Chapter 5 (Aygün, S.Ç., Aynur, N., Çuha, S.S., Karaman, U., Özçelik, U., Ulubay, M., Ünsal, N. 2007).

Students were given the terms "reflection, symmetry, and translation" examples in PowerPoint presentations. They discovered the differences between them by finding the terms explaining the pictures. In the next step, students discussed where the symmetry does exist in daily life and this exemplified also by the teacher. It is also stated that "science aims to find the symmetry in nature, and our brain tries to find the symmetry to find an order in life and does not like the chaos". Students did the examples related with the subject matter in the textbook (p.180). The example was drawing a shape's reflection in the mirror. Then the definition and basic characteristics of mirror symmetry (reflection) was given. Students solved the other two examples in their textbooks after discussing the steps of drawing reflections of shapes without a mirror (p.181). Then the exercise for drawing symmetry axis to polygons was done together with children with animation in PowerPoint presentation. They also discussed how many symmetry axes can be drawn for the regular polygons. At the end of the lesson students were given poster preparation homework for symmetric shapes which can be seen in nature.

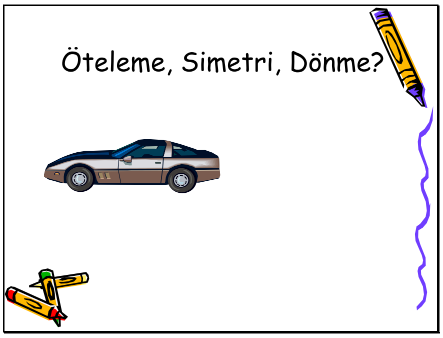
In the next three lessons, the subject was rotational symmetry. Three activities in the text book which are for a Z letter, an arrow and a shoe about whether they are rotated or not were done firstly by the students and the teacher checked in their books and they are also showed in the PowerPoint presentation. Students discussed whether the rotation movement is seen in nature and the teacher gave examples such as doors and fans. Students discussed rotating a shape with respect to a point according to a determined angle and they decided that a shape which is rotated does not change, only its position and place change. They also used the term rotation angle and the center of rotation. They did the exercise in the textbook called as the clover's movement. This exercise was about rotation by its own axis in other words rotating with respect to the center of the shape. Then students discussed when and how many times regular polygons such as square, triangle, rectangular, pentagon have their own shapes while rotation according to their centers. They discovered that for n-sided regular polygon has n times its own shape while it is rotated up to rotating 360 degrees. Also they discovered that this regular polygon has 360/n degree rotational symmetry. Then they made the exercise related with rotational symmetry in the textbook.

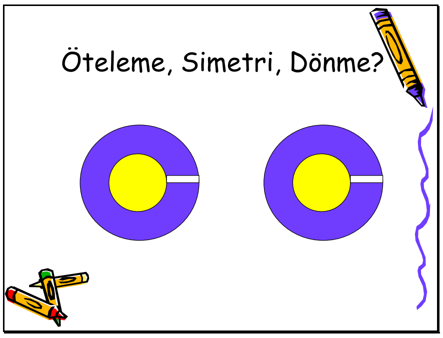
The fifth and sixth lesson subject is tessellations with patterns. Firstly students make ornaments with tessellations by using quadrilaterals, triangles and hexagons in different colors on isometric paper. Secondly they make tessellations with trapezoid and parallelogram. Then they examine the tessellation examples in the book. They try to see the main motif of the patterns. The tessellations are included in the PowerPoint presentation. In order to systematize tessellations with polygons, students fill the table below. The aim of this activity is to see that the measure of the total angle in one corner, to see whether a polygon can make a pattern on its own, without using any other polygon, to write tessellation code.

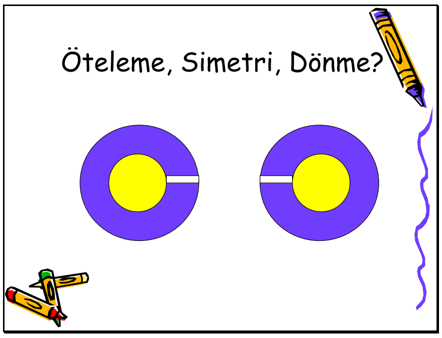
Polygon	Measure of an inner angle	The number of polygonal area in one corner	The number of sides of polygon	Tessellation code	Is it possible to make tessellations with only this polygon?	The sum of angles in one corner
Equilateral triangle	60	6	3	3;3;3;3;3;3	Yes	60x6=360
Square						
Regular hexagon						

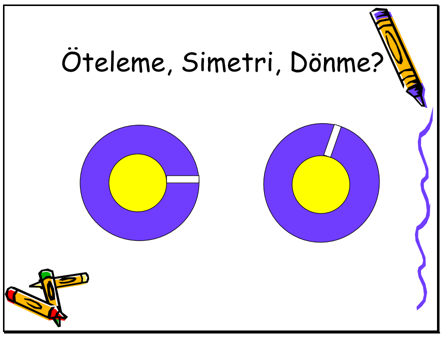
For the next exercise, students draw the tessellations with more than one type of the polygon and try to find tessellation codes of the tessellation codes of drawn ones. At the end, they make related exercise in their books.

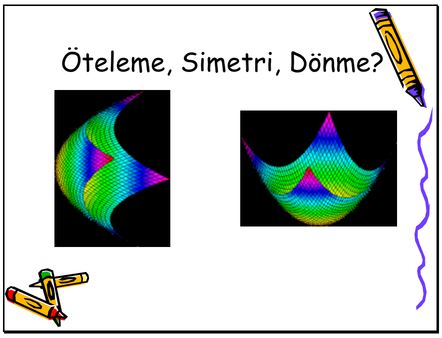
PRESENTATION FOR THE REGULAR INSTRUCTION

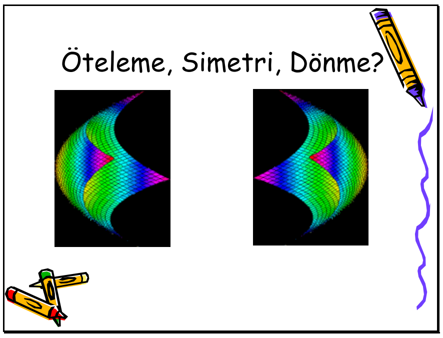


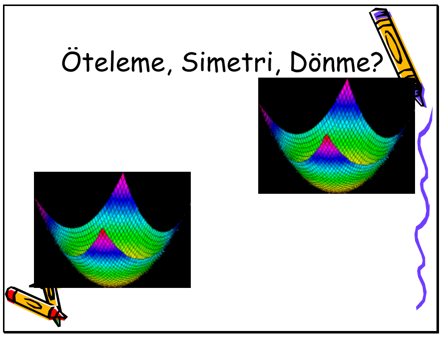


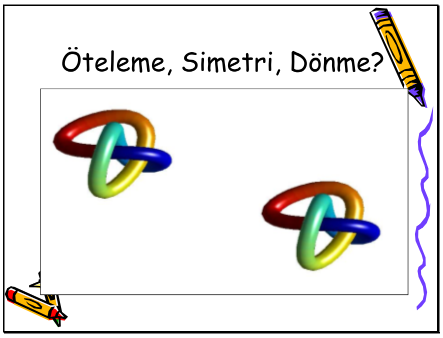

Öteleme, Simetri, Dönme?

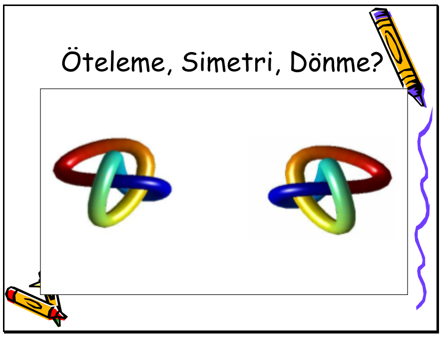

Öteleme, Simetri, Dönme?

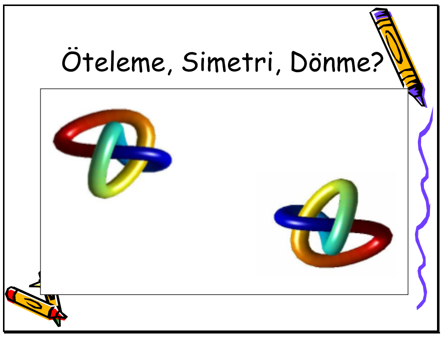

Öteleme, Simetri, Dönme?

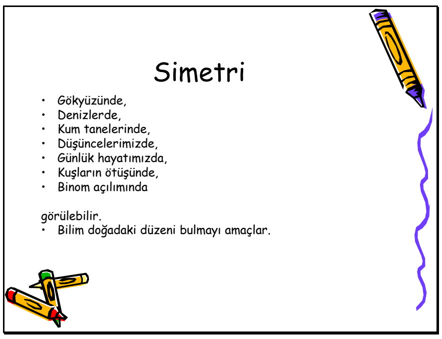

Öteleme, Simetri, Dönme?


Öteleme, Simetri, Dönme?


Öteleme, Simetri, Dönme?


Öteleme, Simetri, Dönme?


Öteleme, Simetri, Dönme?


Simetri
• Gökyüzünde,
• Denizlerde,
• Kum tanelerinde,
• Düşüncelerimizde,
• Günlük hayatımızda,
• Kuşların ötüşünde,
• Binom açılımında
görülebilir.
• Bilim doğadaki düzeni bulmayı amaçlar.

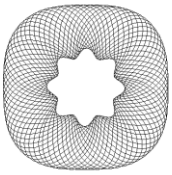

İnsan beyni
düzensizlikten hoşlanmaz.

Simetri ve Örüntü

- Simetri ve örüntüler anlamayı kolaylaştırır.
- Beynimiz düzenli şeyleri daha kolay tanır ve hatırlar.

- DNA örüntüleri yaşamın ve bizim gerçeklerimizi ortaya çıkarmıştır.

- Bilgisayarlar da adapte olabilen örüntüler sayesinde bilgiyi küçültüp saklayabilirler.



Simetrik şekil örnekleri

- Dişi zebraların desenlerinde erkek zebralara göre daha fazla simetrik desen bulunmaktadır.
- İnsan süslemeleri
- Simetrik çiçekler

- Simetrileri daha kolay farkederiz.
- Simetrinin olması bizi psikolojik olarak rahatlatır.
- İnsan vücudundaki asimetriler bazı hastalıkların farkedilmesini sağlayabilir.

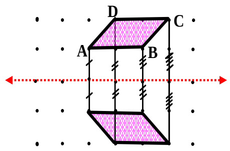
Aynısını Bulalım

- Şekli kareli kağıda çizelim.
- Simetri aynasını kesik çizgilerle belirtilen doğru boyunca yerleştirelim.
- Şekil ve simetri aynasındaki görüntüsünün biçim ve boyutu arasındaki ilişkiyi değerlendiriniz.
- Şeklin simetri aynasındaki görüntüsünü kırmızı kalemle çiziniz.

Ders Kitabı Sayfa 180

Ayna simetrisi

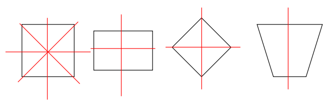
- Bir şeklin simetriği oluşturulurken şeklin üzerindeki her noktadan simetri eksenine dik inilip uzatılır.
- Eksenin diğer tarafında bu noktanın eksene eşit olan uzaklığındaki nokta işaretlenerek simetrik şekil bulunur.



- Gösterilen simetri doğrularına göre simetriklerini çizerek şekil tamamlama
- Düzlemsel şekillerin yansıma altındaki görüntülerini noktalı, izometrik veya kareli kâğıtlara çiziniz.

Sayfa 180-181

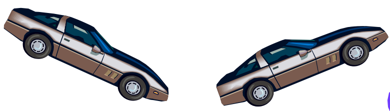
Etkinlik: Simetri Doğrusunun Çizilmesi



Ödev: Afiş Çalışması

- Çevrenizdeki şekillerden, doğruya göre simetri (masa üzerinde tam açılmış bir kitabın sayfaları gibi) oluşturanları araştırıp, şekillerin fotoğraflarını çekerek veya resimlerini yaparak bir afiş hazırlayınız.

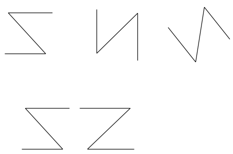
DÖNME SİMETRİSİ



Dönme Simetrisi

- Ders kitabında yer alan hangileri ters Z şeklinin döndürülmüş hali olduğunu bulma etkinliği,
- "Ok neyi gösteriyor?" : Kareli Kağıt
- Ayakkabı şeklinin belli açılara göre topuğunun etrafında döndürülmesi etkinlikleri

Sayfa 182-Z harfi
Ok neyi gösteriyo



- Dönme hareketi
- Belli açılarla bir nokta etrafında döndürme sonucu ortaya çıkan şekiller arasındaki ilişkiyi açıklayınız.

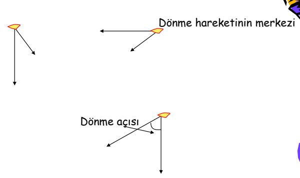
Dönme Hareketi

- Saatin yelkovanı
- Rüzgâr gülü
- Salıncak
- Yelpaze,
- Pervane,
- Kapı ve pencere kolundaki hareketler

- Döndürülen şeklin biçim ve boyutu değişmez.
- Şeklin duruşu ve yeri değişir.

- Saatin akrep ve yelkovanının bağlı olduğu pimin, rüzgâr gülündeki pimin, salıncakta oturağı taşıyan iplerin veya zincirlerin bağlandığı yerin dönme hareketinin merkezidir.
- Yelkovanın ilk durumu ile son durumunun oluşturduğu açıya "dönme açısı" denir.

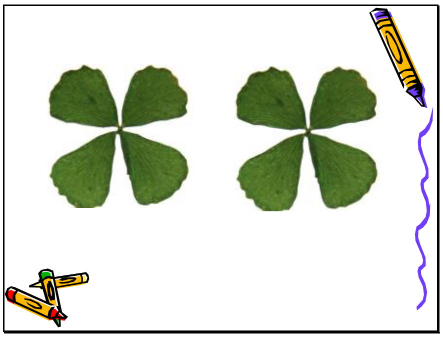
- Bir şekil, bir nokta etrafında döndürüldüğünde , o nokta dönme hareketinin **merkezi** olur.
- Çeyrek dönmenin 90° lik dönme, yarım dönmenin 180° lik dönmedir.
- 180'lik dönme (yarım dönme), merkezi dönme olarak adlandırılır.

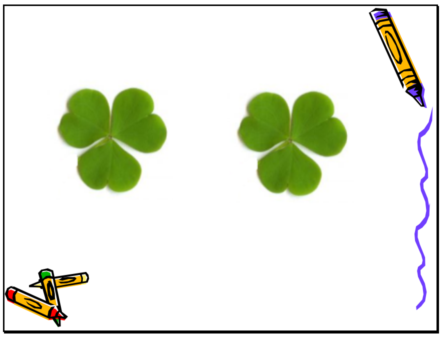


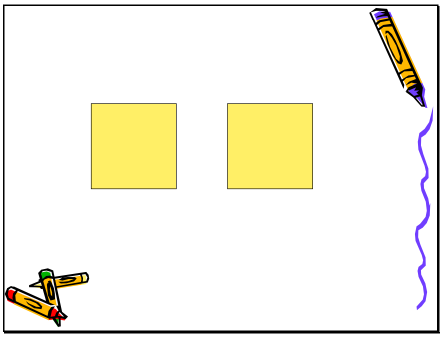
Yoncanın Hareketi

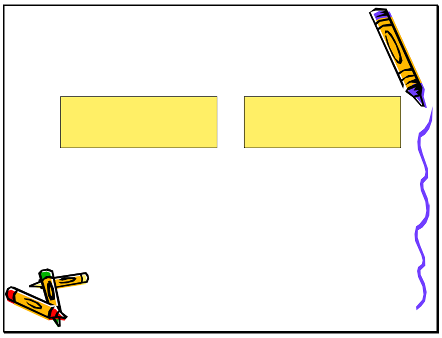
- Kartona 2 eş şekil çizelim.
- Kartondaki şekil ile kestiğimizşekli üst üste getirip raptiye ile tutturalım.
- Kestiğimiz şekli döndürerek hangi açılarda kartondaki ile çakıştığını not edelim.
- Not edilen açıların ölçülerini 360 ile kıyaslayalım.

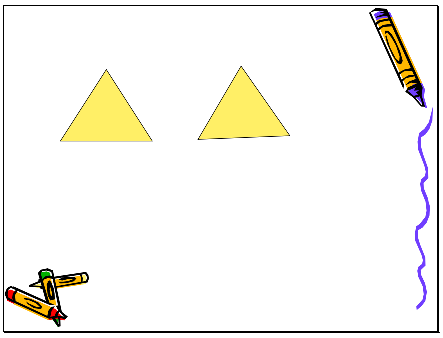
Sayfa 183

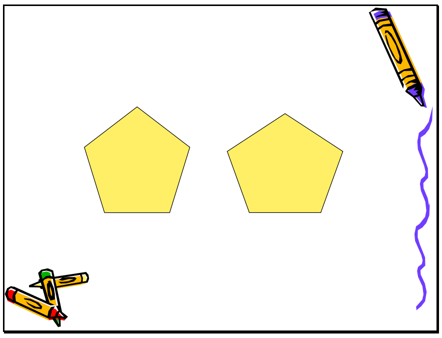


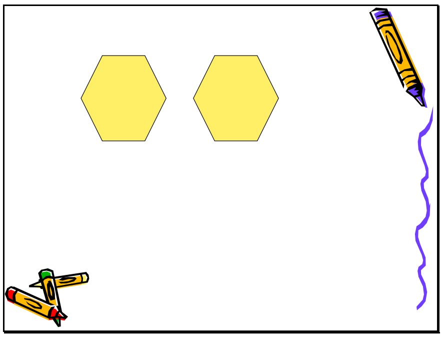


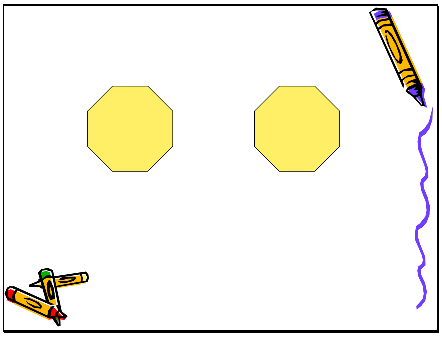












- Bir şekil kendi merkezi etrafında döndürüldüğünde 360° den küçük açılı dönmelerde en az bir defa kendisi ile çakışıyorsa bu şekil *dönme simetrisi*ne sahiptir.

Aşağıdaki şekiller hangi dönme açılarında dönme simetrisine sahiptir?

- Kare
- Dikdörtgen,
- Eşkenar üçgen,
- Düzgün beşgen
- Düzgün altıgenin

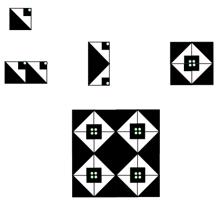
- **Çarkın dönme açıları**
- **Çalışma Kağıdı 5-Uygulama Sayfa 183**

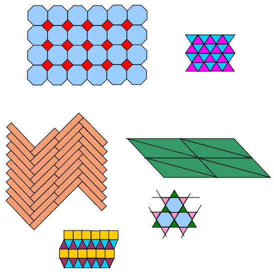
MOTİFLE KAPLAMA

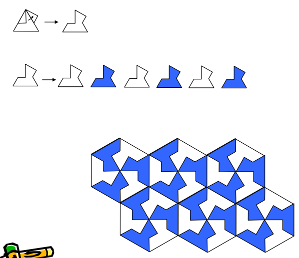
Motifle Kaplama

- **Süsleyelim Etkinliği**
- İzometrik kağıt üstünde üçgen, dörtgen veya altıgen kullanarak süsleme yapma ve farklı renklere boyama
- Yamuk ve parelelkenar kullanarak süsleme etkinliği

Sayfa 185







- **Çokgenlerle süsleme:**
- Bir eşkenar ücgende herbir iç açının ölçüsü kaç derecedir?
- Süslemenin içinde oluşan her bir köşenin etrafında kaç tane eşkenar üçgen vardır?
- Kare ve dikdörtgen kullanarak oluşturduğumuz örüntü blokları ile aynı adımları uygulayalım.
- Aşağıdaki gibi bir tablo yapalım ve uyguladığımız adımlara göre tabloyu örnekteki gibi dolduralım:

Çokgen	Bir iç açısının ölçüsü	Bir köşedeki çokgensel bölge sayısı	Bir köşedeki herbir çokgenin kenar sayıları	Süslemenin kodu	Süsleme yapılabilir mi?	Bir köşede oluşan toplam açı ölçüsü
Eşkenar üçgen	60	6	3	3;3;3;3;3;3	Evet	60x6=360
Kare						
Düzgün altıgen						

- Tabloya göre, süsleme yapılabilmesi için bir köşede oluşan açıların ölçüleri toplamı kaç derece olmalıdır?
- Süsleme kodu oluştururken hangi bilgilerden yararlanırız?
- 3;6;3;6 süsleme kodunun anlamını tartışınız.

- **Tablo:** Bir köşede oluşan açıların toplam ölçüsü
- **Oluşan toplam açı ölçüsü**
- **Eşkenar üçgen** $6 \times 60° = 360°$
- **Kare**: $4 \times 90° = 360°$
- **Altıgen** $3 \times 120° = 360°$

- Süsleme yapılabilmesi için, her bir köşede oluşan açıların ölçülerinin toplamı 360'tır.
- Her köşedeki düzgün çokgensel bölgelerin sayısı ile bunların kenar sayıları "süslemenin kodu" dur.

- Süsleme kodu örnekleri
- (3;3;3;3;3;3): Bir köşede birleşen 6 adet eşkenar üçgensel bölge
- (4;4;4;4): Bir köşede birleşen 4 adet karesel bölge
- (6;6;6): Bir köşede birleşen 3 adet düzgün altıgensel bölge

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- Birden fazla düzgün çokgensel bölge kullanılarak yapılan süslemelere ait tablo, benzer şekilde düzenletilerek süsleme kodları belirlenir.
- Ayrıca kodu verilen süslemeler de yaptırılır.

Küçük Modelle Büyük Süsleme

- Sayfa 187
- Etkinlik
- Örnek

Motifle Kaplama

- Yüzeylerin kaplanması ve daha güzel görünmesi için, geometrik desenlerle süslenmesi yüzyıllardır süregelen bir gelenektir.
- İnsanoğlu evlerini inşa ederken yerleri ve duvarları kaplamak için taşlar kullanmaya başladı.
- Güzel görünümlü dizaynlar için taşların şekillerinde ve renklerinde seçici davranmayı öğrendi.

"Örüntü" adı verilen ve birbirini tekrar eden sistemli tasarımlar ortaya çıkmaya başladı.

- Şimdiye kadar her toplum döşeme ve örüntüleri bazı kavramları sembolize etmek için kullanmıştır.
- Örneğin, Romalılar ve Akdeniz ülkeleri insanları insan ve doğa resimlerini mozaiklerde işlemişlerdir.

- Araplar bazi figür ve renkleri sadece birkaç şekil içinde gösterrek çok karışık geometrik desenler elde etmişleridir.
- Bunun en ünlü örnekleri İspanyada Elhamra sarayı ve İslami eserlerde bulunabilir.

- Dünyada kaplamaların yapısı, sanatı ve teknolojisi halen araştırılmaktadır.
- Amaç yüzeyi hiç boşluk bırakmadan en ekonomik şekilde en az malzeme ile süslü bir şekilde kaplayabilmektir.

- Günlük hayatımızda kaldırımlarda, yollarda hatta parkelerde kaplamalara rastlamak mümkündür.
- Kaplamaların kullanılmasında estetik nedenin yanı sıra bozulduklarında tamirinin kolay olması da etkilidir.
- Bu parçalar asla üstüste gelmeyecek şekilde yanyana dizilir. Arada boşluk kalmaz.
- Rasgele olmadan birbirlerini tekrar edebiliecek şekilde hazırlanmışlardır.

Sorular

- Kaplamaların günlük hayatta kullanım alanlarına örnek veriniz.
- Kaplamaları yaparken dikkat edilecek en önemli unsur nedir?
- Gördüğünüz kaplamalarda hangi tür geometrik şekiller kullanılmış?

Örnekler

- Halılar üzerindeki desenler
- Sepetler
- Seramik ve taşlardan oluşan kaplamalar

Kaynakça

Aygün, S.Ç., Aynur, N., Çuha, S.S., Karaman, U., Özçelik, U., Ulubay, M., Ünsal, N. (2007). *Öğretmen Kılavuz Kitabı Matematik 7.*İstanbul: Feza Gazetecelik A.Ş. MEB Devlet Kitapları

APPENDIX I: INSTRUCTION INTEGRATED WITH ETHNOMATHEMATICS FOR THE 7TH GRADE SYMMETRY AND PATTERNS SUBJECTS

1. **Ders**

Ünite Girişi
Ünitenin genel amaçlarından söz edilir. Anahtar kavramlardan bir önceki yıl görülen Yansıma ve öteleme simetrisi, örüntü konuları soru-cevap yöntemiyle hatırlatılır.

Hazırlanan görsel sunum doğrultusunda aşağıdaki alt başlıklar hakkinda sınıfta tartışma yapılır.

- Simetri nedir?
- Simetrinin kullanımı neleri ifade eder?
- Doğadaki simetrik şekil örnekleri
- Simetrinin insan beyni üzerindeki yararları

Simetri

- *Simetri de örüntüler gibi heryerde bulunurlar.*
- *Simetri günlük dilde dengeyi ve büyüklük ve şekil bakımından tam karşılığını bulabilmek demektir.*
- *Bilimde de güzellik ve mükemmelliği gösterir.*

Düzen ve Simetri

- *İnsan beyni düzensizlikten hoşlanmaz.*
- *Düzen ve örüntüler gökyüzünde, denizlerde, kum tanelerinde, düşüncelerimizde, günlük hayatımızda, kuşların ötüşünde, binom açılımında görülebiliri.*
- *Düzen ve örüntüler anlamayı kolaylaştırır. Beynimiz düzenli şeyleri daha kolay tanır ve hatırlar.*
- *Bilim de doğadaki düzeni bulmayı amaçlar.*
- *Örüntü "beyin tarafından algılanan düzenli sıralamalardır".*
- *DNA örüntüleri yaşamın ve bizim gerçeklerimizi ortaya çıkarmıştır.*
- *Periyodik cetvel de kimyasal elementlerdeki düzeni bulmaya yöneliktir.*
- *Bilgisayarlar da adapte olabilen örüntüler sayesinde bilgiyi küçültüp saklayabilirler.*
- *Tüm canlılarda kuşlar, böcekler, bitkilerde simetrik düzen bulmak mümkündür.*
- *Yerçekimi kanundaki etki-tepki yasası*
- *Dünya üzerindeki manyetik alan*
- *Sabun köpüğü*
- *Mikroskopik süt damlaları*

Simetrik şekil örnekleri

- *Dişi zebralarin desenlerinde erkek zebralara göre daha fazla simetrik desen bulunmaktadır.*
- *İnsan süslemeleri*
- *Ying-Yang sembolu düzenin filozofik anlamını anlatmak için simetrik yapıdadır.*
- *Simetrik çiçekler, simetrik olmayanlara göre daha çok öz salgılarlar.*
- *Bilimsel deneylere göre, göz beyin ilişkisi simetrileri farketmek için programlanmıştır.*
- *Simetrinin olması bizi psikolojik olarak rahatlatır.*

- *İnsan vücudundaki asimetriler bazı hastalıkların farkedilmesini sağlayabilir.*
- *İçinde çok simetri olan desenleri kolayca hatırlanabilir.*

TOPKAPI SARAYI

Noktaya ve doğruya göre simetri konusunu işlerken Topkapı Sarayı'ndan bahsedilir. Osmanlı İmparatorluğu'nun saraylarından biri olan Topkapı Sarayı hakkında öğrencilerin bilgilerini geri çağırması beklenir.

- Sorgulama tekniği ile öğrencilerden gönüllüler saray hakkındaki bilgilerinden bahsederler.
- Bu konuda Sosyal Bilgiler dersindeki "Türk Tarihine Yolucluk" konusundaki bilgileri geri çağırmaları beklenir.
- Saray hakkindaki kısa tanıtım filmi izlettirilir.
- Sarayın ve çeşitli süslemelerle donanmış olan Harem bölümünün ünitemiz ile ilgili ne tür bağlantıları beyin fırtınası yolu ile gösterilen fotoğraflar aracılığıyla keşfetmeleri sağlanır.
- Harem bölümü süslemelerinin ünitemizde göreceğimiz simetri konularının örneklerinin olduğu farkettirilir.

TOPKAPI SARAYI

Osmanlı İmparatorluğu'nun padişahlarının yaşadığı ve ülkeyi yönettikleri yer Topkapı Sarayı idi. Batı imparatorluğu saraylarından en önemli farkı: Örneğin Dolmabahçe Sarayı da Avrupa daki sarayları örnek alarak hazırlanmıştır.

Topkapı Sarayı diğer ülkelerdeki saraylar gibi tek parça binadan oluşmaz, bir takım daireler ve köşklerden oluşur.

HAREM DAİRESİ

- *Topkapı Sarayı'nın "Harem" kısmı ise padişahın annesi eşleri ve onların yardımcılarının kaldığı kısımdır.*
- *Harem, padişahların aile hayatını yansıtır.*
- *Harem dairesine dışardan insanların girmesi yasaktır.*
- *Satıcılar ve doktorlar dışında buraya kimse alınmamıştır.*
- *Padişahın özel dairesi olan Harem dairesi bir takım aralık yollar ve kemerli koridorlar ile birbirine bağlanmıştır.*
- *Harem dairesi, sarayın diğer bölümlerine oranla dar, yer yer üç dört katlı, karmaşık ve çok sayıda oda, sofa, taşlık, daire, koğuş içerir.*
- *Topkapı Sarayı'nın açık, bol ışıklı, çinilerle bezeli mekanlarına karşılık karanlık ve ışık problemi vardır.*
- *İçeride bayanlar yaşadığından dolayı pencereler ahşap ya da tuğla perdelerle kapatılmıştır.*
- *İçindeki havuz ve çeşmeler göz estetiğinin yanı sıra temizlik için de kullanılmaktadır.*

Harem odalarının tasarımları

- *Harem, yaşam düzeylerine ve görevlerine göre sıralı bir yerleşim sistemine sahipti.*
- *Örneğin harem ağaları ile yardımcıların yaşadıkları bölümler birer koğuş düzeni verirken padişaha ve ailesine ayrılan daireler özenli ve zengin dekorasyonlu tasarımlardır.*

Harem dairesi kapsamındaki süitler

- *Tahsis edilenin unvanıyla anılır.*

- *Haremde her padişahla yeni bir yaşam düzenine geçilirdi ve önlenemeyen yangınlar, tahrip edici depremler, ısınma aydınlanma gereksinimleri, eskimeler, çini, ahşap, taş malzeme tercihleri, padişah ailesinin durumu bir takım tadilat ve yenilikler gerektiriyordu.*
- *Harem için Türk çinilerinin yanı sıra, İtalya'dan, İspanya'dan, Viyana'dan çiniler, mermerler; döşemeler için Sivas dolaylarından taşlar getirtilmiştir.*
- *Haremde kullanılan çiniler, taşlar, vitraylar, dizaynlar rasgele değil, saray seramonisine ve kapalı bir ortamda ömür geçirenlerin gereksinimlerine uygundur.*
- *Duvarlar çiçek desenleri ile bezelidir.*
- *Hayvan ve insan figürleri görünmez. Yerlerde ise halılar serilidir.*
- *Duvarlara, sedirlere, pencerelere en kıymetli kumaşlardan örtüler örtülmüş, işlemeli yastıklar ve minderler yerleştirilmiştir. Öd ve sandal ağaçlarından yapılan yastıklar fildişi ve iri mercanlarla işlenmiştir.*
- *Dış dünyaya demirden ve tunçtan üst üste kapılarla kapanan Haremde; dışarıdakilerin hayal ettiği renklilikte olmasa bile bir cennet köşesi yaratılmaya çalışıldığı hissedilir.*
- *Boğazın ve Marmara'nın martıları, İstanbul'un güvercinleri, saray bahçelerinden taşan esintiler, ulu ağaçların sesleri, altın, gümüş, telkari kafeslerdeki nadide kuşların ötüşleri, kışın kürk giydirilen, boyunlarına mücevherli tasmalar, kulaklarına küpe takılan nazlı kediler, çiçek saksılarıyla bezenmiş taşlıklar, konsollu saatlerin vuruşları, ud ve santurlardan yayılan nağmeler, cariyelerin berrak sesleri ve gülüşleri; duvarları örten renk renk çiniler, göz alıcı tavan ve kubbeler, ocak yaşmakları, figürsüz doğa, kent, köşk betimlemeleri; Edirnekari, İstanbulkari üsluplarda ve çini, abanoz, bağa işlemeli nişlerdeki fağfuri kaseler, kupalar, altın gümüş sürahiler, ibrikler, gülabdan ve laledanlar; tavan ve kubbelerden sarkan mücevherli top kandiller, necef işli kandil ve şamdanlar, sedirlerin ipek ve kadife yastıklar, şehzade beşikleri , sedefli sandıklar, çekmeceler, gümüş çerçeveli aynalar bu gizli cennet ortamının öğeleriydi.*

Haremdeki yaşama sorunları

- *Gizlilik: Bayanların yaşadığı yer olduğu için çok pencere yoktur.*
- *Işık: Fenerler ve tavandaki pencerelerden sağlanmıştır.*
- *Isınma: Ocaklar ve şömine sistemi*
- *Duvarların çini kaplı yüzeyleri rutubeti ve sıcağın emilmesini nispeten önlemekteydi.*
- *Soğuk taş zeminler, hasırlar ve halılarla yalıtıldığı gibi duvarlara, kapı ve pencere açıklıklarına da kumaşlar, perdeler, kilimler geriliyordu.*
- *Soğuktan korunma, daha çok kış giysileri ve kürk giyilerek mümkün oluyordu. Duvardaki kandil dolaplarına konulan şamdanlar ve fenerler iç içe odalara, sofalara ışık vermekteydi.*

VALİDE SULTAN DAİRESİ

- *Haremin en özenli ve geniş bölümlerindendir.*
- *Odanın büyüklüğü ve özenli yapılışı imparatorluğun anneye ve bayanlara verdiği önemi göstermektedir.*
- *Her çeşit gereksiniminin karşılanabilmesine, dinlenmeye, yatmaya, yıkanmaya, ibadete, konuk kabulüne, hatta gerektiğinde özel yemekler hazırlanmasına göre planlanmıştır.*
- *Hamamı, çeşmesi, mutfağı, kileri, odaları, vardır.*
- *Daireye duvarları sarı İtalyan çinileri ile kaplı holden girilmektedir.*
- *Bu holün sağında, Harem dilinde "Valide Sultan Odası" denegelmiştir.*
- *Çini, ahşap ve kalem işi süslemeleriyle son derece özenli, tavanında, duvar bordürlerinde al rengin egemen olduğu bir oda vardır.*
- *Hol ve oda; ahşap işçilikleri, duvarları örten Avrupa, çinileri, tavana yakın seviyedeki Boğaziçi ve Kağıthane manzaraları 18. yüzyıl eklentisidir.*
- *Biz harem kısmındaki Valide Sultan Odası ve Mimar Sinan Tarafından yapılmış 3. Murat has Odasındaki kaplama ve motifleri inceleyeceğiz.*

III. MURAT HAS ODASI / HAVUZLU KÖŞK

- *Mimar Sinan'ın yapısıdır.*
- *Harem'de sultanlar için yapılan bağımsız köşklerin bilinen ilki*
- *Saraydaki padişaha özgü kubbeli mekân formlarının en büyüğü ve özenlisidir.*
- *Osmanlı saray mimarisinin en özgün ve kusursuz mekânı olmak özellikleriyle tektir.*
- *Duvarlarındaki 16. yüzyıl İznik çinilerinden, yazlık-kışlık oturma sorununu alt ve üst katlarda çözümlenmesi gibi, daha başka özelliklerinden de söz edilebilir.*
- *Köşk, sultanlığın karakterine uygun uzun ömürlü malzeme ile inşa edilmiştir.*
- *Yangına dayanıklı olan bu bina alt katta taşlık üst katta asıl kullanım mekanı ve yardımcı mekanlardan oluşur.*
- *Küçük pencerelerle dışa kapalı olarak hazırlanmış bir mekandır.Köşk aslen tek oda nşteliği nedeniyle bşr Türk evi odasında görüldüğü gibi "çadır" anısını yaşatan bir öğedir.*
- *"Yükseltilmiş çok amaçlı mekan" karşılığındaki kare iç mekanda bulunan ögelerden ocak, çeşme, niş, ve dolap malzemeleri, boyutları, sayıları, özenli işçilikleri ve bezemeleri ile normal konutlara göre, daha çok itinalı ve özgün tasarımlar uygulanmıştır.*
- *Bu odada çeşitli törenler yapılır ve misafirler ağırlanırdı*
- *Bu odada kullanılan kırmızı renk ustaların sırlarını açıklamamasından dolayı halen tekrar oluşturulamamıştır.*
- *Çeşme vehHavuzların Faydaları*
- *Temizlik,*
- *İçeride konuşulan seslerin dışarıdan duyulmaması*
- *Sıcak yaz aylarında serinlik de sağlamıştır.*

3. Murat Hasodası Çeşmesi

- *Hasodaya özgünlük kazandıran anıtsal çeşmedir.*
- *Mermer dış çerçevesi vardır.*
- *Çeşme ile iki yanındaki pencereler arasına karşıdaki ocağın gözleriyle simetri oluşturan çinilerle kaplı nişler yerleştirilmiştir.*
- *Musluklardan suyun akışı ile bir müzik sağlanması*
- *Ocağın ve şamdanların yaydığı karbondioksitin arıtılması*
- *Elvan somaki mermerden ve ortasında mavi mozaik işlemeleri olan ayna taşında ve musluğun iki yanında renkli, sürahilerle laleler ve çiçekler işlidir.*
- *Çeşmenin mermer cephesi de detaylı ve renkli süslemeler yansıtır.*
- *Köşkün bağa ve sedef işli ahşap kapı kanatlarında sedefle işlenmiş yazılar vardır*
- *Çini, seramik ve kaplamaların faydaları*

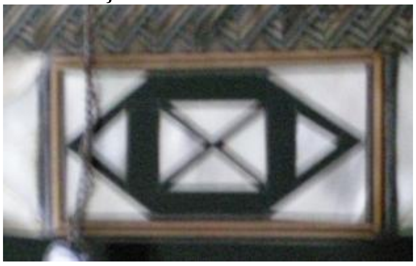
3. Murat kimdir?

- *III. Murat annesinin ölümünden sonra Mimar Sinan'a yanan Topkapı Sarayını onartmıştır. .*
- *Harem Kompleksinde Mimar Sinan'dan başka, Mimar Davud,un, Dalgıç Ahmet Ağanın, Sedefkar Mehmed Ağanın da çalışmaları olmuştur.*
- *Ayrıca o zamanlar saray müneccimi olan Takiyettin Efendi, III. Murat 'ı bir gözlemevi açmaya ikna eder.*
- *Bu bilim adına Avrupalılarla eş zamanda yapılmş bir ilerlemdir. Ancak o sıralar Osmanlı semalrında görülen kuruklu yıldız ve İstanbulda baş gösteren bir salgın hastalık, rasathane ile ilgili olumsuz düşünceleri pekiştirir ve rasathanenin yıkılmasını zorunlu hale getirir.*

- Yansıma doğruya göre simetri (ayna simetrisi) oluşturur.
- Bir şeklin kendisi ile yansıması eştir.
- Bir yansımada şeklin biçimi ve boyutu değişmez sadece şeklin yönü ters çevirilir ve yeri değişir.

Etkinlik :Aynısını bulalım: Çalışma Kağıdı 1

- Simetri aynası yardımı ile Valide Sultan Odasındaki dolabin ortasindaki şeklin ve 3. Murat Has Odasındaki çekmecenin doğruya göre simetriğinin simetri aynası yardımı ile çizilmesi



Şeklin kendisi ve yansıması arasındaki benzerlikler ve farklılıklar öğrenciler tarafından belirlenir ve simetri aynasını oluşturan çizgiye simetri ekseni adı verildiği söylenir.

Ayna simetrisi

- Bir şeklin simetriği oluşturulurken şeklin üzerindeki her noktadan simetri eksenine dik inilip uzatılır: Noktalı kağıt üzerinde bir şeklin simetriği çizilir.
- Eksenin diğer tarafında bu noktanın eksene eşit olan uzaklığındaki nokta işaretlenerek simetrik şekil bulunur.
- Ters yazılmış olan yazılar bir ayna yardımıyla okutularak aynadaki görüntünün yansıma olduğu, yansımada şeklin biçim ve boyutunun değişmediği, sadece şeklin yönünün ters çevrildiği ve yerinin değiştiği fark ettirilir.

Çalışma Kağıdı 2: Etkinlik

Kare, eşkenar dörtgen ve yamuk şekillerinin simetri doğrularının çizilmesi ve kaç tane simetri doğrusu çizilebileceğinin belirtilmesi

Simetri Doğrusunun Çizilmesi

3. Murat odasındaki süslemelerden olan şekillerin simetri doğrularını çizme.



- Gösterilen simetri doğrularına göre simetriklerini çizerek şekil tamamlama

Öğrenciler, düzlemsel şekillerin yansıma altındaki görüntülerini noktalı, izometrik veya kareli kâğıtlara çizerler

- AMBULANS ve İTFAİYE yazılarının niçin ters yazıldığının araştırılması. Şekillerin ve yazının yansıma altındaki görüntülerinin bulunması.

Ödev Kağıdı1: Görev

- Çevrenizdeki şekillerden, doğruya göre simetri (masa üzerinde tam açılmış bir kitabın sayfaları gibi) oluşturanları araştırıp, şekillerin fotoğraflarını çekerek veya resimlerini yaparak bir rapor yazınız.

3. Murat Has Odası ve Valide Sultan Odası süslemelerinde doğruya göre simetri olanlar belirlenir.

2. DERS

Dönme Hareketi

Çalışma Kağıdı 3: Etkinlik: Kartona yapıştırmalı süsleme
Valide Sultan Odası ve 3. Murat Has odasında yer alan şekilleri kullanarak şekilleri değişik yönlerde döndürerel karton üzerine yapıştırmalı süsleme yapma

- Kağıt üzerine patetesi değişik yönlerde döndürerek baskı yapılması

Örnek: Ders kitabında yer alan hangileri ters Z şeklinin döndürülmüşş hali olduğunu bulma etkinliği, “Ok neyi gösteriyor?” ve ayakkabı şeklinin belli açılara göre topuğunun etrafında döndürülmesi etkinlikleri yapılır.

Etkinliklerden sonra dönme hareketi ve belli açılarla bir nokta etrafında döndürme sonucu ortaya çıkan şekiller arasındaki ilişki öğrenciler tarafından açıklanır.

- Öğrenciler dönme hareketini açıklar.
- Saatin yelkovanı, rüzgâr gülü, salıncak, yelpaze, pervane, kapı ve pencere kolundaki hareketler gözlemlenerek dönme hareketinin bir çember hareketi olduğu fark ettirilir.
- Döndürülen şeklin biçim ve boyutunun değişmediği, ancak şeklin duruşunun ve yerinin değiştiği vurgulanır.
- Dönme hareketi ve dönmenin yönü sırasıyla, çember çizme ve çemberin çizim yönü ile ilişkilendirilir.

Etkinlik: Düzlemde bir nokta etrafında ve belirtilen bir açıya göre şekilleri döndürerek çizimini yapar.

- Saatin akrep ve yelkovanının bağlı olduğu pimin, rüzgâr gülündeki pimin, salıncakta oturağı taşıyan iplerin veya zincirlerin bağlandığı yerin dönme hareketinin merkezi olduğu keşfettirilir.
- Yelkovanın ilk durumu ile son durumunun oluşturduğu açıya “dönme açısı” denildiği belirtilir.

- Bir şekil, bir nokta etrafında döndürüldüğünde , o nokta dönme hareketinin merkezi olur.
- Çeyrek dönmenin 90° lik dönme, yarım dönmenin 180° lik dönme olduğu vurgulanır.
- 180’lik dönme (yarım dönme), merkezi dönme veya noktaya göre simetri olarak adlandırılır.

3. DERS

Çalışma Kağıdı 4

3. Murat Odasında yer alan 6 yapraklı şeklin hareketleri:

- Kartona 2 eş şekil çizilir.
- Kartondaki şekil ile kestiğimizşekli üst üste getirip raptiye ile tutturalım.
- Kestiğimiz şekli döndürerek hangi açılarda kartondaki ile çakıştığını not edelim. Not edile açıların ölçülerini 360 ile kıyaslayalım.
- Şeklin dairesel görünüme sahip olmasını sağlayan 12 yapraklı dış kısmı ile birlikte hangi dönme açılarına sahip olduğunu bulalım.

6 yapraklı şeklin dönme simetri açıları

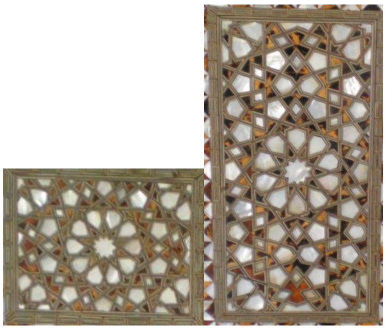
- Tam dönüşü 360.
- 6 yapraktan oluştuğu için en küçük dönme simetri açısı 360:6=60.
- Her 60 ta bir dönme simetrisine sahiptir.

12 yapraklı dış şeklin dönme simetri açıları

- Tam dönüşü 360.
- 1 sedef bir tahta olmak üzere yine 6 yapraktan oluştuğu için en küçük dönme simetri açısı 360:6=60.
- Her 60 ta bir dönme simetrisine sahiptir.

- Bir şekil kendi merkezi etrafında döndürüldüğünde 360° den küçük açılı dönmelerde en az bir defa kendisi ile çakışıyorsa bu şeklin *dönme simetrisi*ne sahip olduğu vurgulanır.
- Kare, dikdörtgen, eşkenar üçgen, düzgün beşgen ve düzgün altıgenin hangi dönme açılarında dönme simetrisine sahip olduğunu bulunuz
- Dönme sırasında şeklin kendisiyle çakıştığı açıların 360°'den küçük olduğu vurgulanarak böylesi şekillerin, *dönme simetrisi*ne sahip şekiller olduğu keşfettirilir.

Çalışma Kağıdı 5



Değerlendirme: Yukarıdaki şekillerin simetrilerinin tartışıldığı çalışma kağıtları hazırlanır.

4. DERS

ÖRÜNTÜ VE SÜSLEMELER

Örüntülerin en çok kullanıldığı alanlardan biri olan **"Kaplamalar**" hakkında öğrencilere bilgi verilir:

- *Yüzeylerin kaplanması ve daha güzel görünmesi için, geometrik desenlerle süslenmesi yüzyıllardır süregelen bir gelenektir.*
- *İnsanoğlu evlerini inşa ederken yerleri ve duvarları kaplamak için taşlar kullanmaya başladı.*
- *Güzel görünümlü dizaynlar için taşların şekillerinde ve renklerinde seçici davranmayı öğrendi.*
- *"Örüntü" adı verilen ve birbirini tekrar eden sistemli tasarımlar ortaya çıkmaya başladı.*

Aşağıdaki konuları anlatan görsel içerikli sunum yapılır.

- Kaplamaların kullanım alanları
- Tarihte ve gündelik hayatımızda örüntü ve kaplama kullanımına örnekler
- Kaplamaların yapımında dikkat edilecek unsurlar ve geometri ile ilişkisi

Örüntü ve Süslemeler: Kaplamalar

- Yüzeylerin kaplanması ve daha güzel görünmesi için, geometrik desenlerle süslenmesi yüzyıllardır süregelen bir gelenektir.
- İnsanoğlu evlerini inşa ederken yerleri ve duvarları kaplamak için taşlar kullanmaya başladı.
- Güzel görünümlü dizaynlar için taşların şekillerinde ve renklerinde seçici davranmayı öğrendi.
- "Örüntü" adı verilen ve birbirini tekrar eden sistemli tasarımlar ortaya çıkmaya başladı.
- Şimdiye kadar her toplum döşeme ve örüntüleri bazı kavramları sembolize etmek için kullanmıştır.
- Örneğin, Romalılar ve Akdeniz ülkeleri insanları insan ve doğa resimlerini mozaiklerde işlemişlerdir.
- Araplar bazi figür ve renkleri sadece birkaç şekil içinde gösterrek çok karışık geometrik desenler elde etmişleridir.
- Bunun en ünlü örnekleri İspanyada Elhamra Sarayı ve İslami eserlerde bulunabilir.
- Dünyada kaplamaların yapısı, sanatı ve teknolojisi halen araştırılmaktadır.
- Tüm toplumların örüntüleri ve kaplamaları karışıktır.
- Amaç yüzeyi hiç boşluk bırakmadan en ekonomik şekilde en az malzeme ile süslü bir şekilde kaplayabilmektir.
- Günlük hayatımızda kaldırımlarda, yollarda hatta parkelerde kaplamalara rastlamak mümkündür.
- Kaplamaların kullanılmasında estetik nedenin yanı sıra bozulduklarında tamirinin kolay olması da etkilidir.
- Bu parçalar asla üstüste gelmeyecek şekilde yanyana dizilir. Arada boşluk kalmaz.
- Rasgele olmadan birbirlerini tekrar edebiliecek şekilde hazırlanmışlardır.
- Belirli aralıklarla kendini tekrar eden kaplamalara "periyodik kaplama" denir.

Örnekler

- Halılar üzerindeki desenler
- Sepetler
- Seramik ve taşlardan oluşan kaplamalar

Çalışma Kağıdı 6

- Kaplamaların günlük hayatta kullanım alanlarına örnek veriniz.
- Kaplamaları yaparken dikkat edilecek en önemli unsur nedir?
- Gördüğünüz kaplamalarda hangi tür geometrik şekiller kullanılmış?

- Türk kültüründeki süslemeler yansıma, dönme, öteleme simetrisi ve örüntülere sıkca rastlayabiliriz.
- Osmanlı İmparatorluğu zamanındaki eserlerde süslemelere sıkca rastlayabiliriz.

Osmanlı İmparatorluğu döneminde yapılmış bir eser olan Topkapı Sarayı'ndaki Valide Sultan Odası ve 3. Murat Odası'nı inceleyelim:

Türk desenleri ve Topkapı Sarayı

Türk desenleri 3 çeşittir.
Saygınlık ifade eden süslü yazılar ve desenler
•Eğri çizgilerden ve çiçek desenlerinden meydana gelen Arabesk desenler
•Çokgenlerden ve kendini tekrar eden örüntülerden oluşan kaplama örüntüleri

Örüntü ve simetrilerin Türk sanatında kullanıldığı alanlar
•Tahta, kumaş, başörtüsü,-topkapıdan al
•Taşlar-mermer-mozaik
•Sonsuz motifler
•Bordürler
•Kemerler
•Madalyonlar

Türk desenlerinin ve örüntülerin özellikleri:
•En önemli özelliği simetrik şekillerin 5 veya çok kollu yıldızların kullanılmasıdır.
•Bu desenler genellikle içiçe geçmiş haldedirler.
•Sayısız tekrarlar
•Ana desenin tekrar edilmesi ile istenilen kadar alan veya sonsuz alan doldurulabilir.
•Gözün odaklanacağı bir merkez bulunmayabilir.
•Desene baktığımızda, gözümüzün odaklanacağı doğal bir nokta yoktur.
•Gözümüz desen üstünde çizgilere ve desenlerin ilişikleri arasında kayar gider.

Türk desenlerinin ve örüntülerin özellikleri:
•Mantıklı ritmik, melodik ve matematiksel
•Akıcılık ve sonsuzluk
•İlk bakışta tüm şekiller birbirinin aynı gibi görünse de incelendiğpinde farkları ortaya çıkar.
•Ustalar isimlerini saklı tutarladı. Bu neden Mimar Sinan'ın bile bazı eserlerini henüz bilememekteyiz.
•Aynı iki renkli şekil asla biraraya gelmez. Her geometrik şekil sadece bir renkle kullanılmıştır.
•Tüm kaplamalar x ve y eksenine göre simetiktirler.

- Türk sanatçılar, mimarlar, geometriciler ve tasarımcılar yaptıkları çalışmaların sırlarını açıklamazlardı.
- Sadece seçilmiş insanlara bu desenleri oluştururken kullandıkları metodları ve keşfettiklerini söylüyorlardı.
- Bu kişiler erkek çocukları veya çok sevdikleri çıraklar olabiliyordu.

- Avrupa sanatçıları mimarları bu eserlerde kullanılan renklerin parlaklıklarına ve soyut geometrik desenlere hayran kalıyorlardı.
- Şekillerin kendi aralarında oranları vardı

Simetrik, Çokgenli döşemelerin Türk sanatında kullanılmasının nedenleri:
•Türklerin dini olan İslamiyette heykel ve canlıların resimlerinin kullanılması yasaktır.
•Bu kuralla cansız nesnlerin yanı geometrik desenlerin kullanılmasında değişik yöntemler bulmuşlar.
•Simerilerinin kullanılmasıyla çeşitlilik sağlamışlardır.
•Soyutluğa ulaşma ve bütünlüğü arama
•Döşemelerde kullanılan yıldızların insan psikolojisinde önemli etkileri vardır.
•Ülke bayraklarında veya piramitlerin yapım amacında da aynı neden yatar: "Onlara ulaşabilmek"
•İslamda ise yıldızlar cennete ulaşmayı ifade eder.

Çalışma Kağıdı 7: Simetri ve örüntünün Valide Sultan Dairesi, Üçüncü Murat Odasındaki desenlerde kullanımlarının incelenmesi

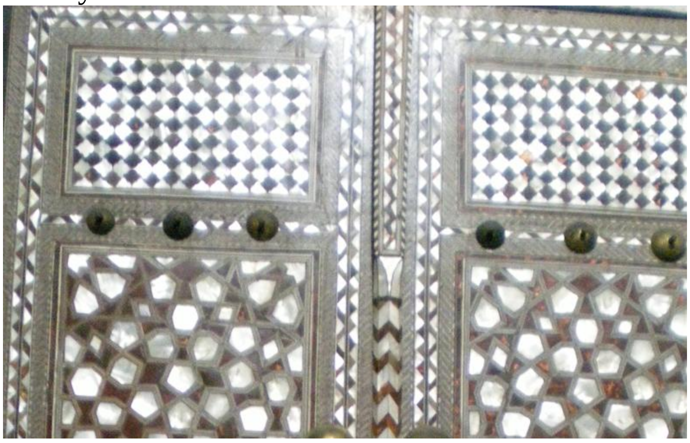
Dolap Deseni

- Öğrenciler bu şekildeki yansıma, dönme ve öteleme hareketlerini belirlerler.

5. DERS

Çalışma Kağıdı 8: Süsleyelim Etkinliği

- İzometrik kağıt üstünde üçgen, dörtgen veya altıgen kullanarak süsleme yapma ve farklı renklere boyama.



Örnek: Yamuk ve parelelkenar ile desenler oluşturarak arada boşluk kalmadan süsleme oluşturulması.

- Etkinliklerde kareli, noktalı veya izometrik kâğıt kullanılır. Yapılan süslemelerde boşluk kalmamasına dikkat edilir.
- Üçgensel ve dörtgensel bölge çeşitlerinden her biri tek başına kullanılarak süsleme yapılabilir mi? Açıklayınız.
- Eşkenar dörtgen modelini kullanarak süsleme yapınız.

Çalışma Kağıdı 9: Çokgenlerle süsleme:

- Eşkenar üçgen kullanarak örüntü bloklarının oluşturulması ve bunlarla süsleme yapılması
- Bir eşkenar ücgende herbir iç açının ölçüsü kaç derecedir?
- Süslemenin içinde oluşan her bir köşenin etrafında kaç tane eşkenar üçgen vardır?
- Kare ve dikdörtgen kullanarak oluşturduğumuz örüntü blokları ile aynı adımları uygulayalım.
- Aşağıdaki gibi bir tablo yapalım ve uyguladığımız adımlara göre tabloyu örnekteki gibi dolduralım:

Çokgen	Bir iç açısının ölçüsü	Bir köşedeki çokgensel bölge sayısı	Bir köşedeki herbir çokgenin kenar sayıları	Süslemenin kodu	Süsleme yapılabilir mi?	Bir köşede oluşan toplam açı ölçüsü
Eşkenar üçgen	60	6	3	3;3;3;3;3;3	Evet	60x6=360
Kare						
Düzgün altgen						

- Tabloya göre, süsleme yapılabilmesi için bir köşede oluşan açıların ölçüleri toplamı şaç derece olmalıdır? Tartışınız.
- Süsleme kodu oluştururken hangi bilgilerden yararlanıldığını tartşınız.
- 3;6;3;6 süsleme kodunun anlamını tartışınız.

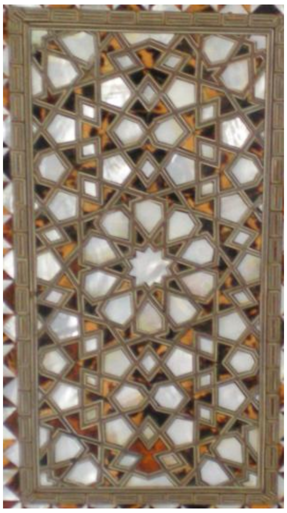
Tablo: Bir köşede oluşan açıların toplam ölçüsü
Oluşan toplam açı ölçüsü
Eşkenar üçgen6×60˚ = 360˚
Kare:4×90˚ = 360˚
Altıgen3×120˚ = 360˚

Süsleme yapılabilmesi için, her bir köşede oluşan açıların ölçülerinin toplamı 360 olduğu keşfettirilir. Her köşedeki düzgün çokgensel bölgelerin sayısı ile bunların kenar sayılarının "süslemenin kodu" olduğu keşfettirilir.

Süsleme kodu örnekleri

- (3;3;3;3;3;3): Bir köşede birleşen 6 adet eşkenar üçgensel bölge
- (4;4;4;4): Bir köşede birleşen 4 adet karesel bölge
- (6;6;6): Bir köşede birleşen 3 adet düzgün altıgensel bölge
- Birden fazla düzgün çokgensel bölge kullanılarak yapılan süslemelere ait tablo, benzer şekilde düzenletilerek süsleme kodları belirlenir. Ayrıca kodu verilen süslemeler de yaptırılır.

Çalışma Kağıdı 10: Valide Sultan Odasındaki süslemelerden birinin kodunun yazılması



Süslemesinin bir kısmı alınarak süsleme kodu bulunur.

6. DERS

Çalışma Kağıdı 11: Örüntü bloklarında altıgen kare ve eşkenar üçgenin üçünü birden kullanarak bir süsleme yapalım.

- Yaptığımız süslemeye ait kodu bulalım.

*Sadece düzgün beşgen kullanılarak süsleme yapılıp yapılamayacağı öğrencilere farkettirilir.

Etkinlik: Küçük Modelle Büyük Süsleme

Düzgün çokgensel bölge modelleriyle oluşturulan süslemelerdeki kodları belirler.

Desenlerdeki örüntü tiplerinin belirlenmesi için rehber sorular

- **Dönme simetrisi var mı?**
- **Varsa en küçük kaç derece ile döndürürsek yine aynı şekli elde edebiliriz?**
- **Ayna simetrisi var mı?**
- **Birden fazla noktada ayna simetrisi var mı?**
- **Öteleme var mı?**

Kodu (3;4;6;4) olan süslemeyi yaparlar.

Değerlendirme: Yansıma, dönme ve öteleme hareketlerini ayrı ayrı uygulayarak yeni modeller oluştururlar.

Bir çokgensel bölge veya süsleme modeli hazırlanıp çoğaltılarak öteleme, yansıma ve dönme hareketlerinden bir veya birkaçını içeren süslemeler yapılır. Bu süslemelerin nasıl yapıldığı açıklanır.
Öğrenciler modellerin simetrilerini tartışıp akran değerlendirmesi yaparlar.
Uygulama(sayfa 188)

Kaynakça

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APPENDIX J: PERMISSION FROM MINISTRY OF NATIONAL EDUCATION OF TURKEY

T.C.
İSTANBUL VALİLİĞİ
İl Milli Eğitim Müdürlüğü

Sayı : B.08.4.MEM.4.34.00.18.580/ 1251/32254 — 31 Mart 2008
Konu: Uygulama(**Melike KARA**)

BOĞAZİÇİ ÜNİVERSİTESİ
Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü'ne

İlgi a) Valilik Makamının 24/03/2008 tarih ve 18.580/1114/29399 sayılı Oluru.
b)Milli Eğitim Bakanlığına Bağlı Okul ve Kurumlarda Yapılacak Araştırma ve Araştırma Desteğine Yönelik İzin ve Uygulama Yönergesi.
c) 17/03/2008 tarih ve 627-1370 sayılı yazınız.

Üniversiteniz Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü Yüksek Lisans Programı öğrencisi **Melike KARA'nın** İlimiz Üsküdar İlçesi Sultantepe İlköğretim Okulu ve Hattat İsmail Hakkı İlköğretim Okulu'nda uygulanmak üzere **"7. Sınıflarda Etnomatematiğin Entegre Edildiği Öğretim Uygulamalarının Öğrencilerin Matematik Başarısı ve Matematiğe Karşı Olan Tutumları Üzerindeki Etkisi"** konulu uygulama çalışmalarını yapma istekleri İlgi (a) Valilik Oluru ile uygun görülmüştür.

Bilgilerinizi, gereğinin İlgi(a) Valilik Oluru doğrultusunda, gerekli duyurunun anketçi tarafından yapılmasını, işlem bittikten sonra 2 (iki) hafta içinde sonuçtan Müdürlüğümüz Kültür Bölümüne rapor halinde bilgi verilmesini arz ederim.

Erdem DEMIRCI
Müdür a.
Müdür Yardımcısı

EKLER :
Ek-1. İlgi(a)Valilik Oluru
2. Ek: Anket Soruları.

NOT : Verilecek cevapta tarih, kayıt numarası, dosya numarası yazılması rica olunur.
Adres : İstanbul Milli Eğitim Müdürlüğü A.Blok Ankara cad. No:2 Cağaloğlu
Tel. ve Fax : 212 526 13 82 Internet : www.istanbul-meb.gov.tr E-mail : apk@istanbul-meb.gov.tr

APPENDIX K: SCHEDULE OF TREATMENTS

Date	Sultantepe İlköğretim Okulu 7B: Control Group 7C: Treatment Group	Hattat İsmail Hakkı İlköğretim Okulu 7A: Control Group 7B: Treatment Group	Orgeneral Kami ve Saadet Güzey İlköğretim Okulu 7A: Control Group 7B: Treatment Group
1st week			
May 5, 2008			
May 6, 2008	7B- 2 lesson hours: Reflectional symmetry and rotational symmetry		
May 7, 2008	7B-1 lesson hour: Rotational symmetry 7C-1 lesson hour: Reflectional symmetry		
May 8, 2008		7A- 2 lesson hours: Reflectional symmetry and rotational symmetry 7B-2 lesson hours: Reflectional symmetry and rotational symmetry	
May 9, 2008	7B-1 lesson hour: Tilling with patterns 7C-1 lesson hour: Rotational symmetry		
2nd week			
May 12, 2008	7C-2 lesson hour: Rotational symmetry and tilling with patterns		
May 13, 2008	7B-2 lesson hour: Tilling with patterns	7A-2 lesson hours: Rotational symmetry and tilling with patterns	
May 14, 2008	7C-1 lesson hour: Tilling with patterns	7B-2 lesson hours: Rotational symmetry and tilling with patterns	

May 15, 2008		7A-Tilling with patterns 7B-2 lesson hours: Tilling with patterns	
May 16, 2008	7C-1 lesson hour: Tilling with patterns 7B-Posttests		
3rd week			
May 19, 2008	Holiday		
May 20, 2008			
May 21, 2008	7C-Posttests	7A-Posttests	
May 22, 2008		7B-Posttests	
May 23, 2008			7A- 2 lesson hours: Reflectional symmetry and rotational symmetry 7B-2 lesson hours: Reflectional symmetry and rotational symmetry
4th week			
May 26, 2008			7A-2 lesson hours: Rotational symmetry and tilling with patterns
May 27, 2008			7A-2 lesson hours: Tilling with patterns 7B-2 lesson hours: Rotational symmetry and tilling with patterns
May 28, 2008			
May 29, 2008			
May 30, 2008			7B-Tilling with patterns
5th week			
June 02, 2008			7A-Posttests
June 03, 2008			7B-Posttests

APPENDIX L: THE HISTORY OF TOPKAPI PALACE

When the Ottoman Sultan Mehmet II took the Constantinople, which has crucial importance in the Mediterranean world in 1453 and he immediately, moved the capital of his rapidly growing empire to his newest conquest whose name changed as Istanbul. One year later, Topkapı Palace will begin to be constructed with its gardens surrounded by high walls. The palace having around 700.000-m.² area during the foundation years has currently 80.000 m.² area. The main entrance of the Palace is near Hagia Sophia, which was changed from great church to mosque. Sultan Mehmet brought artists and artisans from Persia and Italy as well as employing many from his own empire to build his palace. The layout reflects an Ottoman encampment ready for siege with private inner quarters. When the palace was first constructed, it was known as “New Palace”, and then “Imperial Palace”. The name “Topkapı” originally comes from a very large wooded pavilion because its proximity to a sea gate located near the tip of the promontory. This palace has undergone a variety of changes and additions over the centuries; the plan remains essentially Sultan Mehmet II (Karaz, 2004).

The parts of the palace are;

- Imperial gate and outer walls
- First Courtyard
- Second courtyard
- Third Courtyard
- Terraced Gardens (also known as Fourth Courtyard)
- Harem Section

In this study, the Harem part of Topkapı Palace will be examined ethno mathematically. The motifs in Valide Sultan (Valide Sultan) Stone Courtyard and Murat III’sPrivate room will be examined according to their shapes, symmetries employed and their importance in the history.

The Harem Section

The Harem entrances located in the left hand corner in second courtyard. Harem means by definition “taboo” or “sacred”. It was used for family concept in the Islamic society. Harem is the private and prohibited place where the dynasty lived in the Ottoman Palace. Harem is an important complex in terms of architecture since contains examples of palace architecture styles belonging to various periods starting from 16th century to early 19th century, where hundreds of concubines and harem chiefs that consisted the families of Sultans lived together. Harem has approximately 300 rooms, 2 mosques, 1 hospital and dormitories and 1 laundry room General plan of Harem consists of dormitories that surround the entrances divided by doors one after another, rooms, pavilion and service buildings.

Topkapı Palace, Harem Section divides the Harem residents into 4 groups through stony places from the entrance of Gate of Carts to Private Room.

I-Black Chiefs Stone Courtyard

- Common Gate / Sultanate Gate

II- Head of Wives Stone Courtyard/Concubines Stone Courtyard

- Kırkmerdiven (Forty Stairs)
- Hamam (Turkish bath)
- Head of Wives Flats
- Concubine Dormitories
- Hospital

III-Valide Sultan Stone Courtyard

- Valide Sultan’s Flat
- Valide Sultan’s Flat Sofa

IV. Mabeyn Stone Courtyard Sultan and Prince Flats

- Sultan’s Sofa / Hünkar Sofası
- Murat III’sPrivate Room
- Çifte (Double) Hamam
- Ahmed’s Room
- Ahmed’s Room
- Çifte Kasırlar / Summer Palace

- Goldenway / Altın Yol

Valide Sultan Stone Courtyard

Valide Sultan Stone courtyard had constituted the core of the construction group where Dynasty and Harem residents lived for centuries. It is assumed that Golden way which formed on wing of this Stone Courtyard and some other buildings are the buildings Harem that date back to first half of 15th and 16th century. This place turned into a internal courtyard upon construction of Valide Sultan's Flat and hamams at the end of 16th century.

Valide Stone courtyard, as a "Life" Stone Courtyard character in the middle sofa of Turkish house, is the most significant example of the Ottoman Architecture in this style. In this sense, it used to gather high level harem women staff around itself who were the central place of the Ottoman dynasty and Harem.

Valide Sultan's Flat

This flat was one of the most significant constructions of renewal and expansion activities in Harem by Murat III (1574-1599) in 1580s. The special importance and value on the mother in Turkish families put Valide Sultan into foreground in palace Harem instead of Sultan's main woman and the mothers of sultans became the true leaders of harem. (Sections of Harem, retrieved from the official website of Topkakı Palace).

Valide Sultan's Flat Sofa

It is known that this flat with its contemporary shape was built by Murat III for his mother Nurbanu Sultan. Valide Sultan Flat constitutes an integrity with its hamam, bathroom and all rooms. Across Valide Sultan Hall, the door right across leads to Valide Sultan Sofa. This section that belonged to women section of harem and is the largest place has a dome. Through the door on the left side of this majestic place, it leads to private office room, living room, and bedroom. The wooden division of this room that reminds baldaken symbolises the sultanate and power of Valide Sultan in harem. From this section, it leads to Valide Sultan's prayer room through an arch passage which can be visually linked through a window with bars. Through the other door of Valide Sultan's Flat Sofa, it leads to a place with tiles and fireplace. The reason of Sultan's mother's leverage in palace stems from the importance that the sultan displays for them. Sultan used to visit her every morning at Valide Sultan’s Flat to show respect and share his daily decisions. Later, chief of girls used to come to inform her about foundations and Valide Sultan’s business. It is also recorded that Valide Sultan entertains with dancers and singers, listens to Kur’anı Kerim or history book from reader kalfa after having lunch. (Sections of Harem, The official website of Topkakı Palace).

Murat III’s Private Room

This pavilion that was built after the point where the natural floor ends was placed on a gradual structure. Murat III’s Private Room, being one of most significant constructions of Harem as well as of the Ottoman Architecture, was designed and built in 1578 by Mimar Sinan who was the main architecture of that era. Mimar Sinan maintained the functional and decorational balance, matching the construction’s meaning and shape, with a classical view in the pool downstairs that he placed between levels. This pool with water ejector is connected to a big pool along Stone Courtyard.

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