Yıldız Sos Bil Ens Der, Cilt. 9, Sayı. 2, pp. 67–82, 2025

Yıldız Sosyal Bilimler Enstitüsü Dergisi
Yıldız Social Sciences Institute Journal
Web sayfası bilgisi: https://ysbed.yildiz.edu.tr
DOI: 10.14744/ysbed.2025.00009

Original Article / Orijinal Makale

Examination of perspectives of 10th grade students about mathematics and culture in the context of inter-disciplines relations and informal learning environments

Disiplinlerarası ilişkiler ve yaygın öğrenme ortamları bağlamında 10. sınıf öğrencilerinin matematik ve kültüre yönelik bakış açılarının incelenmesi

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ARTICLE INFO

Article history
Received: 4 November 2024
Revised: 15 December 2024
Accepted: 23 December 2024

Keywords:
Culture, ethnomatematics, mathematics education, informal learning environment museum education.

MAKALE BİLGİSİ

Makale Hakkında
Geliş tarihi: 4 Kasım 2024
Revizyon tarihi: 15 Aralık 2024
Kabul tarihi: 23 Aralık 2024

Anahtar kelimeler:
Etnomatematik, informal öğrenme ortamı, kültür, matematik eğitimi, müze eğitimi.

ABSTRACT

In this study, through a museum visit, which is an informal learning environment, it is aimed to reveal the students' perspectives on the existing relationship between their culture and mathematics. The study also aims to provide an opportunity for them to correlate their cultural heritage with mathematics, gain awareness about mathematics in their culture, realize the usage areas of mathematics in real life, and see the connection between mathematics and other disciplines. For these purposes holistic multi-case study design was used. Within the scope of the study carried out with 13 high school students, Museum of the History of Science and Technology in Islam and Museum of Turkish and Islamic Arts were visited. The data of the study were collected through the questionnaire applied to the students after the visit. The data were analyzed by creating categories and codes according to the characteristics of the questions in the form. As a result of the study, it was seen that students gained awareness of the relationship between their culture and mathematics, but they could superficially make the correlation. About half of the students stated that they wanted mathematics classes to be correlated with history and culture, while the rest of them stated that they did not want it to be correlated with the worry of not being successful. On the other hand, through the application, it was found that the students were able to discover mathematics in daily life and correlate mathematics with other disciplines.

Cite this article as: Yazıcı EZ, Özdemir AŞ, Bahadır E. Examination of perspectives of 10th grade students about mathematics and culture in the context of inter-disciplines relations and informal learning environments. Yıldız Sos Bil Ens Der 2025;9:2:67–82.

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ÖZ

Bu çalışmada, gayri resmi bir öğrenme ortamı olan müze ziyareti aracılığıyla, öğrencilerin kültürleri ile matematik arasındaki mevcut ilişkiye dair bakış açılarını ortaya koymak amaçlanmıştır. Çalışma ayrıca, öğrencilere kültürel miraslarını matematikle ilişkilendirme, kültürlerindeki matematik hakkında farkındalık kazanma, matematiğin gerçek hayattaki kullanım alanlarını fark etme ve matematik ile diğer disiplinler arasındaki bağlantıyı görme fırsatı sunmayı amaçlamaktadır. Bu amaçlarla bütünsel çoklu vaka çalışması tasarımı kullanılmıştır. 13 lise öğrencisiyle gerçekleştirilen çalışma kapsamında İslam Bilim ve Teknoloji Tarihi Müzesi ile Türk ve İslam Sanatları Müzesi ziyaret edilmiştir. Çalışmanın verileri, ziyaretin ardından öğrencilere uygulanan anket aracılığıyla toplanmıştır. Veriler, formdaki soruların özelliklerine göre kategoriler ve kodlar oluşturularak analiz edilmiştir. Çalışma sonucunda, öğrencilerin kültürleri ile matematik arasındaki ilişki konusunda farkındalık kazandıkları, ancak bu ilişkiyi yüzeysel olarak kurabildikleri görülmüştür. Öğrencilerin yaklaşık yarısı matematik derslerinin tarih ve kültürle ilişkilendirilmesini istediklerini belirtirken, geri kalanı başarılı olamama endişesiyle bunun olmasını istemediklerini belirtmiştir. Öte yandan, uygulama sayesinde öğrencilerin günlük yaşamda matematiği keşfedebildikleri ve matematiği ilişkilendirebildikleri görülmüştür.

Atıf için yazım şekli: Yazıcı EZ, Özdemir AŞ, Bahadır E. Disiplinlerarası ilişkiler ve yaygın öğrenme ortamları bağlamında 10. sınıf öğrencilerinin matematik ve kültüre yönelik bakış açılarının incelenmesi. Yıldız Sos Bil Ens Der 2025;9:2:67–82.

INTRODUCTION

The rapid changes in the fields of science and technology in the modern world, developments and innovations in the needs of the individuals and the society in which they live have also affected the roles expected from individuals and the skills they are asked to exhibit. With this change, individuals are required to have the qualifications of being able to produce information, use them in their lives, think critically and find solutions to problems they encounter, be entrepreneurs, offer creative ideas, have effective communication skills, empathize with, respect and contribute to society and culture, etc. This situation also brings along the changes in the theories and approaches used in the education process. In this direction, instead of the traditional teaching method in which knowledge is expected to be transferred and understood in the way it is transferred, learning environments including different features that will arouse curiosity and enthusiasm have been expanded. These learning environments include out-of-school learning environments, and aim to enable individuals to produce the information themselves and learn the concepts in line with the acquisitions specified in the curriculum (Demirel, 2019, p.15).

Effective learning is thought to realize when individuals are provided with an environment in which they play an active role in the process, by learning through their own experiences, and by interacting with their environment. As the restructuring of minds, the learning process is divided into two groups under the heading of lifelong learning as formal (structured) and informal (semi-structured) learning (Şimşek, 2011, p. 1). Contrary to formal learning, where certain knowledge and skills are tried to be acquired in a pre-designed, programmed and controlled way in a specific place and time period, the learning process in informal learning environments is carried out in line with individuals' intrinsic motivations, own controls, preferences and curiosities. The learning process in informal learning environments also draws attention to out-of-school learning environments (Dilli, 2017; Demirel, 2019, p.16; Bahadır and Hırdıç, 2018, p.156). Informal learning is defined as the spontaneous learning of individuals as a result of their interaction with the environment starting from their birth and shows its existence at every stage of life. Informal learning, also known as out-of-school learning or learning that takes place outside of the classroom, aims to complete the learning process by addressing the acquisitions included in the curriculum and to ensure that academic skills are acquired more effectively. In addition, it is defined as trips and activities organized in environments such as planetarium, zoo, museum, nature camps, aquarium, which are carried out in a planned and programmed way for predetermined purposes by extending education beyond the school boundaries (Şimşek, 2011, p.2). In the context of the aim of enabling innovative practices of Turkey's 2023 Education Vision theme, it is aimed to increase the cooperation of schools with science centers, museums, art centers, techno parks and universities in their regions. In the direction of the goal of transforming academic knowledge into skills in the secondary education theme, it has been decided that all provinces' National Education Directorates will prepare out-of-school learning environments guide books belonging to their provinces. This decision will provide students and teachers to use natural, historical and cultural places in their provinces, and out-of-school learning environments such as science-art centers and museums more effectively in line with the acquisitions of educational programs. In

this way, these environments were tried to make a part of educational activities instead of being places that are visited arbitrarily in leisure times (MoNE, 2019; Commission, 2019).

As an informal learning environment, museums are the leading institutions where the most effective learning can take place (Dilli, 2017). Museums are the direct learning environments, which stimulate the various senses of individuals by seeing the exhibits and sometimes even touching them; offer the opportunity to develop their cognitive, affective and psychomotor aspects by moving their learning beyond the school boundaries in interaction without memorizing the information. They also provide unique opportunities to explore the concepts of science, mathematics, art and social science on site (Andre et al., 2017, pp.47-48). It is claimed that museums play an important role in permanent and effective learning, since students are more curious, interested and excited in informal learning environments (Buyurgan, 2017).

As with the studies on many informal learning environments, it is seen that in museums, many researches are carried out generally in the context of social studies, science or visual arts classes. It was observed that the studies conducted within the context of the science course referred to science and technology museums mostly as the learning environment, while the studies conducted within the context of the social studies course referred to history museums. In these studies, parent-child interaction in museums, the function of museum experts, the place and importance of museum visits in education, the views of teachers, students or museum experts on the use of museums as an educational environment, assessment and evaluation applications that can be used in museum activities, teaching techniques that can be used in museum education, the effect of museum education on various cognitive skills and similar subject areas were examined (Yarbrough, 1996; Tal et al., 2005; Cary, 2004; Bozdoğan and Yalçın, 2009; Falk and Dierking, 2000; Maccario, 2002; Bozdoğan, 2007; Sofuoğlu, 2019, Dilli, 2017; Yılmaz and Şeker, 2012; Pattison et al. 2018). Although there are studies about out-of-school learning environments specific to mathematics education, not many studies have been found specific to mathematics education on the use of museums as an educational environment.

Yıldız and Göl (2014), who see the absence of comprehensive studies as a deficiency in the context of out-of-class activities that can be used in mathematics education, presented suggestions and worksheets on the use of museums in mathematics courses in their study. And they proposed the activities to be carried out within a predetermined framework plan including before, during and after the visit for a productive museum visit. On the other hand, Bahadır and Hırdıç (2018) conducted real-life based-mathematics experiments with 8th grade students at Rahmi Koç Museum-Colorful World of Mathematics using experiment sets. And they obtained the results that these experiments contributed to the students to see the aspects of mathematics reflected in daily life, to embody abstract mathematics and to associate mathematics with other disciplines.

The museums offer an alternative learning environment to the traditional classroom learning environment by means of historical and cultural assets and concrete objects. Studies have suggested that museums facilitate the acquisition of important skills such as empathizing, developing evidence-based arguments, understanding continuity and change in history and establishing a relationship between the past and the present (Yılmaz and Şeker, 2015). It is obvious that including museums, which are informal educational environments where real life situations can be seen more easily, into the education process from the early ages has a great importance in terms of individuals' awareness of their cultural heritage, their protection of this heritage and their transferring it to future generations. This study was conducted in the context of the ethnomathematics approach, which aims to enable students to value both their own and other cultures by teaching mathematics by associating it with the cultural practices of the society. And the focus of this study is to reveal students' perspectives on the relationship between their own culture and mathematics through museums, which are informal learning environments. With this study, it is also aimed to enable students to correlate their real-life cultural heritage with mathematics, thus gain awareness of mathematics in their own culture, realize the usage areas of mathematics in real life and see the connection between mathematics and other disciplines.

Conceptual Framework

This study was conducted in the conceptual framework of the ethnomathematics approach that Ubaritan D'Ambrosio conceived to the mathematics education literature. Mathematics was born from the struggle of man to perceive the world he lives in and to struggle with the daily life conditions, but day by day it ceased to be a thesis based on trial and error and turned into a structure consisting of axiomatic and theorems in itself. And because of this ultimate axiomatic structure that it has reached over time, it has been judged that it is independent of culture (Baki, 2014, s. 4). Researchers (Adam, 2004; Kelly, 2005) found that most students who could not find a counterpart of mathematics subjects in their daily lives and their own cultures started to dislike mathematics, and therefore, culture had an impact on mathematics. In response to this situation, a field of study called 'ethnomathematics' has emerged, which takes into account the socio-cultural characteristics of students and accepts their cultural background as a resource for mathematics activities in order for mathematics learning to be meaningly realized (Fasheh, 1997). The concept of ethnomathematics is defined as the studies of revealing what kind of techniques (tics) people in a certain culture (ethno) have developed in order to explain and understand the world (math) as a result of the problems, struggles that they encounter in their daily lives and their survival efforts (D'Ambrosio and Rosa, 2017). It suggests to research the

mathematical ideas and practices that exist in societies' own cultures and to include these in the teaching process.

Most students see mathematics as a difficult and unnecessary course that they only encounter in class that does not work in real life. It has been argued that the reason for this situation is that the teaching programs are not in harmony with the cultures of the students, the academic mathematics shown in the class is not associated with the cultural practices of the society, and the mathematics is presented as an "imported product" (D'Ambrosio, 2001). On the other hand, when the mathematics curriculum containing elements related to the cultural heritage of the society in which students live was implemented, it was observed that significant effects occurred on the cognitive and affective areas of the students. And these cultural elements in the program contributed students to deepen their understanding of mathematics, to see mathematics as a part of their lives and thus to develop meaningful connections (Bishop, 1988; Gerdes, 1988; Eglash, 1997, Rosa and Orey, 2007).

METHOD

In this study, a holistic multi-case study design was used. As it is known, the case study design is a qualitative research design that has a current quality and is used to answer how and why questions of researchers in cases where they cannot manipulate variables (Yin, 2003). In this study, various situations such as how the perspective of a study group, considered as a unit of analysis, about the relationship between their own culture and mathematics are, their previous learning experiences, and their correlations mathematics with other disciplines were examined in depth.

Study Group

The purposeful sampling technique, which is a non-probability sampling method that allows the discovery and explanation of facts and events, was used in determining the study group of the research (Patton, 1990; Yıldırım and Şimşek, 2008). The study group consists of 13 10th grade students who are studying in a state high school in Sancaktepe district of Istanbul province in the 2019-2020 academic year. Students were determined from two different classrooms on a voluntary basis.

Data Collection Tool

In this study, a questionnaire consisting of eleven open-ended questions developed by the researchers was used as the data collection tool. The questions were designed to explore the relationships between mathematics and culture, as well as the impact of the museum experience on participants' interdisciplinary perspectives. During the development process, similar studies in the literature were reviewed, and examples of open-ended questions used in mathematics and museum education research were examined. A draft version of the questionnaire was then prepared in accordance with the research objectives and submitted to three experts (two in mathematics education and one in museum education) for review. Based on their feedback, necessary revisions were made to improve clarity, content validity, and conceptual consistency. After this process, the final version of the questionnaire with eleven questions was established.

In this study, a questionnaire consisting of eleven open-ended questions prepared by the researchers was used as a data collection tool. The open-ended questions in this questionnaire are as follows:

1. What were the artifacts you could correlate with mathematics or geometry during your museum visit? List these artifacts and write next to them with which mathematics topics you correlate.
2. Which artifacts did you like the most? Why?
3. Do you have any ideas about the mathematical and geometrical techniques of these artifacts you liked?
4. Have you observed any interaction between scientific developments in the fields of science and mathematics and the historical and cultural characteristics of the period? What were the artifacts you can give an example to this?
5. With which disciplines did you correlate the artifacts on the visit in general, mark your correlation status according to the scale below (0= no correlation, 10= highly correlated). If there is any discipline you would like to add, please write.
6. How much has this visit helped you correlate mathematics to Turkish history and our own culture? Please mark your correlation status according to the scale below (0= no correlation, 10= highly correlated). Explain this correlation with two examples.
7. Have you ever done activities in which you correlate the subjects in school mathematics classes with different disciplines such as history, geography, physics, chemistry, biology? If yes, what kind of activity was it?
8. Based on your experiences on the visit; would you like the mathematics subjects to be taught in association with different disciplines at school? If your answer is "YES", the reason is:/ If your answer is "NO", the reason is:
9. Based on your experiences in the visit, would you like to correlate the topics of mathematics with history and culture at school? If your answer is "YES", what is the reason? How do you think this correlation would be useful? / If your answer is "NO", what is the reason?
10. Could you please share two new information you learned during the visit?
11. Was this museum visit useful for you? Could you explain your opinion and share it with us?

Validity and Reliability

The validity and reliability of the data collection tool were evaluated in line with qualitative research criteria. Content validity was ensured through expert review. The experts evaluated each question in terms of its relevance to the research

purpose and conceptual accuracy, and the researchers made the necessary linguistic and content revisions accordingly. For reliability, the data collection process was described in detail, and the obtained data were independently analyzed by two researchers. The resulting codes were compared, and the inter-rater agreement rate was calculated (90%), indicating a high level of consistency. Furthermore, direct quotations from participant responses were included in the findings section to enhance the confirmability and credibility of the results.

Data Collection Process

It was decided to visit Museum of the History of Science and Technology in Islam (MHSTI) and Museum of Turkish and Islamic Arts (MTIA) because they consist of objects belonging to Turkish culture and contain the artifacts of Turkish-Islamic scientists. In order to turn the information acquired during the museum visit into effective and permanent learning, and for the students to internalize these learning, a programmed path consisting of three stages was followed by the researchers: before the visit, during the visit and after the visit. First of all, in the week before the visit, students were informed about the museums they would visit and what they should pay attention to while visiting. In order to learn students' views on the relationship between mathematics and their cultures during the visit, introductory information about the museums prepared by the researchers with expert opinion and the Museum Visitor Guide that consists of a questionnaire with 11 open-ended questions which is the data collection tool of the study, were distributed to the students one day before the visit. The reason for distributing the questionnaire in advance was to ensure that the students read the questions that they would be asked to answer at the end of the visit before starting the visit, and that they were aware of which questions they were going to answer. Within the scope of the event, HMIST was firstly visited. The visit started at 11.00 in the morning, and was completed in approximately 90 minutes, accompanied by the museum's own guide, who is also a student of Prof. Dr. Fuat Sezgin. The MTIA visit, followed by the MHSTI, lasted approximately 45 minutes under the guidance of the History teacher of the school. After the MTIA visit, free time was given to the students and they were asked to complete their questionnaires. The students completed the questionnaires in approximately 35 minutes, using the photographs they took, the information given by the guides and the notes they took in the meantime.

Analysis of Data

The obtained data were analyzed by categorizing the codes determined according to the characteristics of the questions in the questionnaire and the categories created according to the similarities/differences between these codes. The results of the analysis are presented through categories.

Findings

In this section, the findings obtained from the analysis of the answers given by the study group students to 11 open-ended questions in the questionnaire applied after the museum visit were included, with each question as a subheading. In order to provide fluency, an important part of the obtained data obtained was directly presented.

The artifacts that students mostly correlate with mathematics or geometry during the visit are as follows: astrolabes (n=9), clocks (n=6), carpets (n=5) and observatories (n=4). When asked which mathematics subjects they correlated these artifacts with, it was seen that they correlated them with the subjects of time measurement (n=10), pattern (n=6) and angles (n=5). However, no students explained the correlation they wrote. Most of the correlations (n=16) are given superficially in the form of "The artifact name → Mathematics" or "The artifact name→ Geometry" without giving a specific mathematical or geometrical subject names. Therefore, it is seen here that students realized

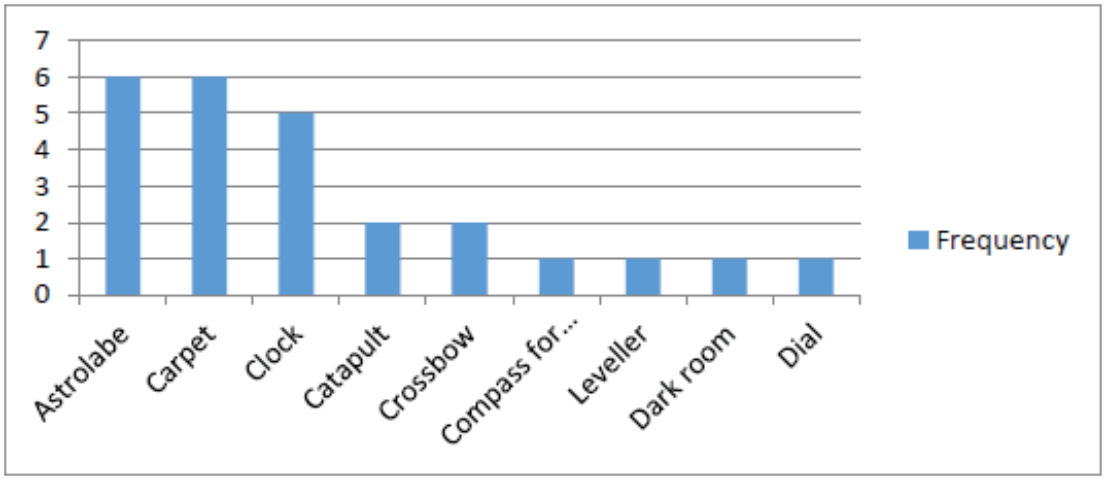

Figure 1. Frequeency graph of the answers given to the question of "Which artifact or artifacts were your favorite among them?"

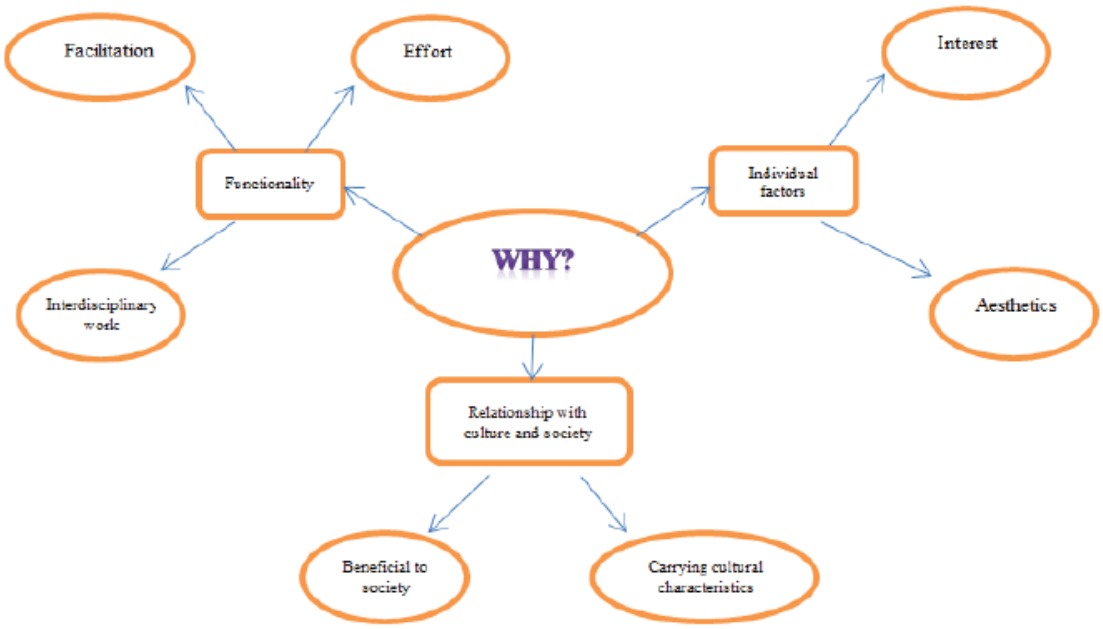

Figure 2. The reasons why the students liked the artifact they like most during the visit.

that mathematics is the main idea of the artifacts, but they did not know how to make a correlation with mathematics. In addition, although they were asked to correlate them with mathematics or geometry topics, it was observed that students (n=15) correlated many artifacts with the fields related to mathematics, such as astronomy and architecture, but not directly related to mathematics/geometry.

When Figure 1 was examined, it was seen that astrolabe, carpet and clocks were the most admired artifacts. When the answers given by the students to the question of why they liked these artifacts were analyzed, the result in Figure 2 was reached.

The reasons why the students liked the artifact they like most differ as shown in the Figure 2. When these reasons are analyzed, some of them are explained with individual factors such as the artifact's being within the student's own area of interest and its appealing to him/her aesthetically/visually as seen in Figure 3**.**

As in Figure 4, some students explained the reasons for their appreciation by establishing a relationship with culture and society, because the artifacts are beneficial to the society in which they were produced and they provide information about the period through their cultural characteristics.

Some of the students referred to functionality of the artifact and listed the reasons as follows: the fact that the production process requires a hard artifact and a lot of efforts, that some of the artifacts were designed in a way that makes life easier in today's life, and that the artifacts were made by collaborating in different fields (Fig. 5).

When the answers to the question of "Do you have any idea about the technique of the artifacts you like mathematically and geometrically?" were examined, it has been noticed that in spite of the guide's detailed explanations and explanatory video recordings of the artifacts in the MHSTI during the visit, students could not give any technical information about mathematics and geometry. Although it was stated that there was a relationship between the artifacts and mathematics/geometry, most of the students could not give any math or geometry topic names. Even some students

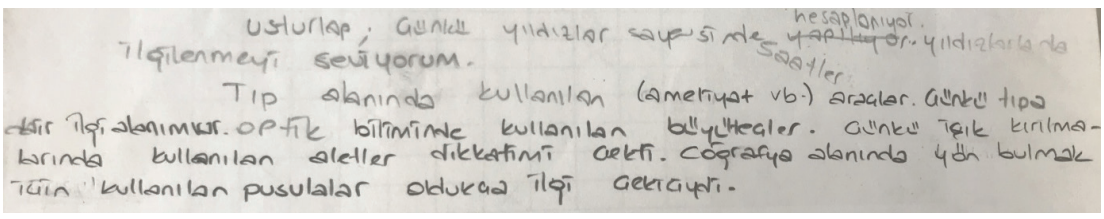

Figure 3. Student response explaining her/his admiration through individual factors.

(In English: Astrolabe...Because hours are calculated through the stars. I like stars, they are within my area of interest. Tools used in the medical field such as surgery, etc.. Because I am also interested in medicine. Magnifiers used in the optical unit. Because the tools used in refraction caught my attention. Compasses used to find directions in the field of geography were very interesting.)

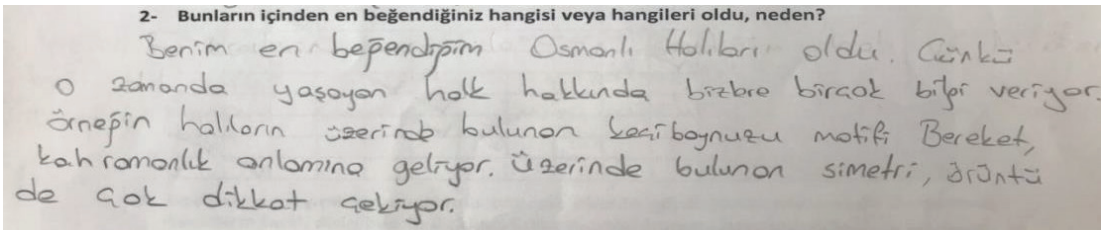

Figure 4. Student response explaining her/his admiration by relating to culture and society.
(In English: What I liked most was Ottoman carpets, because they inform us about the people who lived at that period. For instance, the motif of goat antler on the carpets means blessing and heroism. Symmetry and pattern on them also draw attention.)

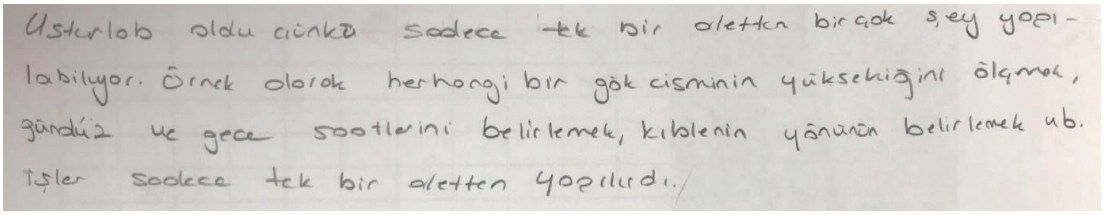

Figure 5. Student response saying that s/he liked the artifact because of its functionality.
(In English: I liked the astrolabe most, because a lot of things can be done with only one tool. For example; measuring the altitude of any celestial body, determining the daytime and nighttime hours, determining the direction of Mecca used to be done with only one tool.)

stated in their written answers that the artifacts were related to the main discipline such as astronomy, medicine, and geography and mathematics, but did not write what subject of math they were related to.

Some of the students correlated the artifacts with the concepts of angles, solid objects, quadrilaterals, symmetry, pattern, ratio, and proportion. Table 1 shows which topics are correlated with which artifacts and how often.

As is seen in Table 1, it has been revealed that students who have an idea about the technique of the artifacts they like in terms of mathematics/geometry could mostly establish a relationship with the field of geometry. It was seen that the students mentioned the technique for carpets, both geometrically such as geometric shapes, symmetry and pattern, and mathematically such as the ratio-proportion. In Figure 6, the opinions of a student, who likes crossbows most, about the mathematical/geometrical technique of these artifacts are given.

When the answers of the question of "Have you observed any interaction between the scientific developments in the fields of science and mathematics and the historical and cultural characteristics of the period? What are the artifacts you can give an example to this?" were examined, it was seen that although all students stated that they observed interaction, nine of the students explained the reason by giving an example to this interaction, but two students could not make a statement about the subject. When the explanations about the interaction were analyzed, it was revealed that the students stated that there was a sequential relationship between the scientific developments and the historical and cultural characteristics of the period (Scientific developments affected the characteristics of the

Table 1. Opinions about the mathematical/geometrical techniques of the favorite artifacts

Mathematics/Geometry Subjects	Artifacts	Frequency
	Compass for Mecca	
Angle	Sundial	2
	Crossbow	1
Solid Objects	Astrolabe	1
Triangle - Quadrilaterals	Carpets	3
Symmetry - Pattern	Carpets	5
Ratio- Proportion	Carpets	3
Time measurement	Astrolabe	1

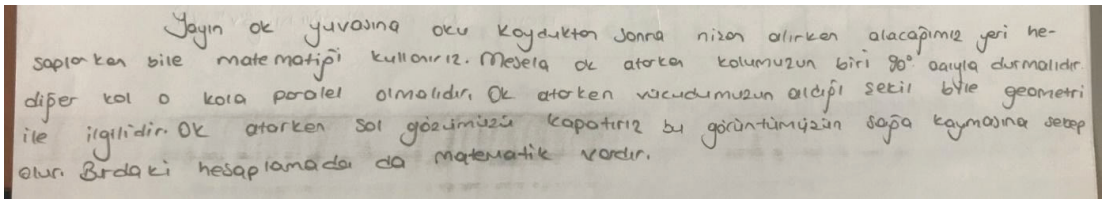

Figure 6. The information given by the student, whose favorite piece is Crossbow, about the technique of the artifact.

(In English: We use math even when we calculate the place we will stand while aiming after placing the arrow in the arrow slot of the bow. For example, one of our arms should be at an angle of 90 degrees while throwing the arrow and the other arm should be parallel to that arm.)

Table 2. Opinions on the interaction between scientific developments and the historical and cultural characteristics of the period

Interaction	Opinions
Historical and cultural characteristics ⬇ Scientific development	Inventions emerged as a result of people's needs.
	In ancient times, since there were many battles, defense technology such as cannon and catapult developed.
	During the period, materials commonly used by the public were used in the production of the artifacts.
	Societies have produced their artifacts by culturally influenced from each other.
Scientific development ⬇ Historical and cultural characteristics	Humanity has progressed with the artifacts invented as a result of scientific developments.
	Societies interested in astronomy have reflected their efforts on carpet motifs.
	Scientific developments have caused the public's attention to this field.

period or the characteristics of the period affected scientific developments) (Table 2).

As seen in Table 2, some of the students stated that the historical and cultural characteristics of the period affected the course of scientific developments, and some of them stated that the historical and cultural characteristics of societies were shaped as a result of scientific developments. Additionally, students who stated that mathematics is also used in making various tools that will facilitate daily life in the answers given to this question can be said to have been able to see mathematics in the elements of life.

The answer given by a student who stated that the scientific developments in the fields of science and mathematics affected the historical and cultural characteristics of the period is shown in Figure 7. The answer given by a student who stated that the historical and cultural characteristics of the period affected scientific developments is given in Figure 8.

The answers of the students regarding the question asked in order to understand whether the artifacts on the

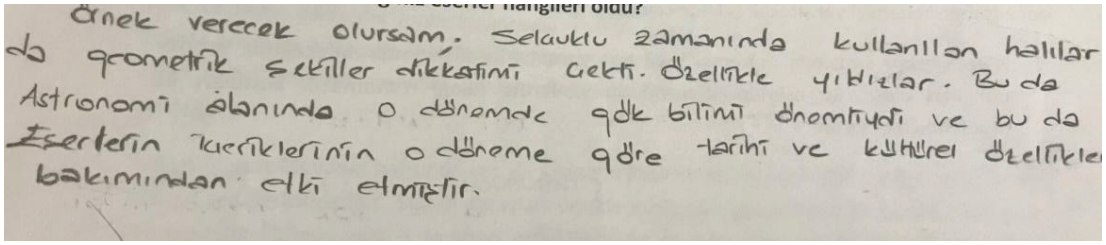

Figure 7. A student's response, who stated that scientific developments affected the historical and cultural characteristics of the period.

(In English: To give an example, the geometric shapes in the carpets used in the Seljuk period caught my attention, especially star shapes. At that time, astronomy was important, and this influenced the artifacts of that period in terms of historical and cultural characteristics.)

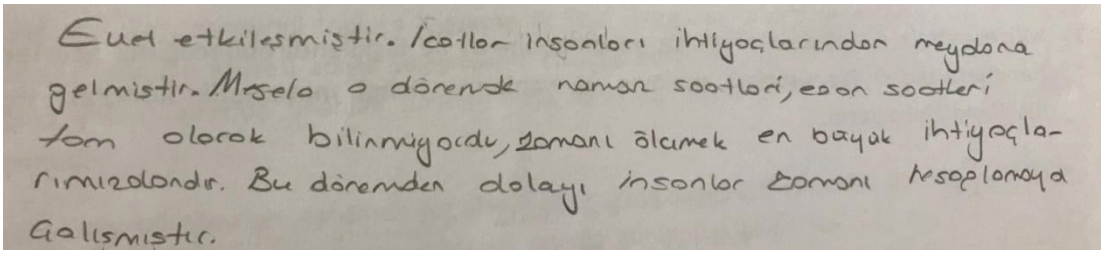

Figure 8. A student's response, who stated that the historical and cultural characteristics of the period affected scientific developments.

(In English: Yes, they interacted. Inventions emerged from people's needs. For example, prayer times and azan times were not known exactly at that time. Measuring time was the biggest need. During this period, people tried to measure time.)

visit are generally related to which disciplines and to reveal the correlations they made are presented in Table 3. The following table is obtained by summing the scores given by students who assign a score between 0 and 10 according to the degree of relation to each discipline.

When Table 3 is examined, it is seen that students mostly correlate the artifacts on the museum visit with mathematics, astronomy, history, engineering, art and geography disciplines. The least correlations have been with the disciplines of music, sociology, psychology, and philosophy. Although many students gave information about artifacts in the field of medicine in other questions, it was seen that only one student in this section stated this relationship status in the other disciplines section.

Table 3. The disciplines to which the artifacts are correlated and their average scores regarding this correlation

Discipline	Avernge Scores
Mathematics	9.69
Physics	7.77
Chemistry	7.3
Biology	6
Language and literature	5.9
History	8.38
Geography	7.85
Engineering	8.23
Astronomy	9.08
Music	2.46
Philosophy	4.46
Sociology3.15	
Psychology	3.77
Art	7.85
Economy	5.62
Other	Medicine (3)
	Opticial (2)
	Archaeology (not scored)

When asked about the contribution of the visit to correlating mathematics with Turkish history and culture, it was revealed that the students gave an average of 8.62 points with a standard deviation of 1.66, and evaluated them as highly correlated. Similar to the answers given to the question about the mathematical and geometrical techniques of the artifacts they liked, it was seen that in this question, students gave the name of the artifact by answering "this artifact is related to mathematics," instead of explaining how they established a connection by giving examples with mathematical subjects.

To the question of whether or not activities that associated the mathematics subjects with different disciplines were done before, 9 students answered that they had not been taught any courses containing such a correlation before. Two students stated that they conducted projects which involved the lives of mathematicians and their contributions to mathematics, and that the life of Pythagoras was mentioned while studying the Pythagorean Theorem, and that the history of mathematics was used in some courses. Both students stated that they utilized mathematics while learning the subject of ratio-proportion in chemistry class and while making some calculations on the concept of Mole in chemistry class in physics class. Although it was not asked in this question, it was observed that two students stated that such activities were not performed, but they wanted them to be performed. It was surprising that one of the students, who stated that he wanted these activities to be performed, answered as "No, I would not" to the question of "Based on your experiences during the visit, would you like the mathematics subjects to be taught in association with different disciplines at school?"

Based on their experiences during the visit, when asked whether they would like the subjects to be correlated with other disciplines in their mathematics courses at school, nine students stated that they wanted it, while four students stated that they did not want such an application. Table 4 gives the reasons for willingness or unwillingness.

When the answers given by the students to correlating the mathematics course with different disciplines were analyzed, it was seen that they considered the effects of

Table 4. Students' requests to correlate subjects with other disciplines in mathematics courses

Situation	Statement	Category
Yes	We can find the place of mathematics in our lives from these correlations.	Mathematics perception
	Mathematics is integrated with other disciplines.	
	We can see the change in mathematics.	
	This correlation can also attract the attention of those who do not like Mathematics.	Learning process
	The topics would have been more permanent and understandable.	
	We would have been taught and reinforced other courses.	
No	Mathematics contains many different subjects within it and we see them enough in the courses.	Mathematics perception
	It can be difficult to understand if different disciplines are included.	Learning process

these courses on their thoughts on mathematics and their learning processes. Some of the students who wanted the course to be taught in this way stated that they would enable them to see the place of mathematics in real life, its integrity with other disciplines or its change within other disciplines. It was seen that these students evaluated the effect of the courses to be taught in this way in the context of their thoughts regarding mathematics. Another group of students, who were willing, mentioned about the effects of the courses to be taught in this way on the learning process, such as drawing attention, providing permanent and understandable learning, and helping to reinforce other courses. Students who do not want math to be correlated with other disciplines in mathematics courses stated that they have already seen many disciplines in mathematics sufficiently in courses and that when different disciplines are included, mathematics, which is already difficult, will be even more difficult to understand.

Based on the students' experiences during the visit, when asked whether they want to correlate the subjects with history and culture in their mathematics courses at school, six students stated that they wanted and seven students stated that they did not want such a practice. Table 5 gives the reasons for their willingness or unwillingness.

When their responses to the correlation of mathematics course with history and culture were analyzed, it was seen that students answered 'yes' or 'no' according to the effects of this correlation on mathematics perception, learning processes and culture-history awareness. The students who were willing the course to be taught in this way stated that the importance of mathematics in life could be understood in this way and pointed out the place of mathematics in daily life. They also stated that to see when and in what environment the Math subjects took place would make mathematics more understandable, permanent and remarkable. In addition, it was observed that students expressed that correlating the information belonging to their cultural background with mathematics would contribute to the creation of cultural and historical awareness. When the answers given by unwilling students are examined, it is understood that they mostly focus on the success of the exam. They stated that the History course to be related requires memorization according to them, and because they will need to memorize in the mathematics courses to be taught in this way, they predicted that the course will become more difficult, boring and confusing and therefore they will fail in mathematics, so they do not want the course to be taught in relation to it. Another finding a student's statement was found remarkable. The student stated that it was not necessary to know the history of the subject in order to be successful by correlating this relationship with academic success.

The analysis of the answers given to the relevant question by the students who were asked to share two new information they learned during the excursion is presented in Table 6.

When the answers given by the students to the question about the two new information they acquired during the visit were examined, it was seen that they gave these answers in the context of the artifact or discipline. While some of the students explained the working principle, usage area or purpose of a particular artifact (astrolabe, observatory, clocks, carpets, catapults, instruments of medicine, etc.), some of them gave general information about the owner of the artifact or the artifacts. And some of the students only wrote the name of the artifact without any explanation.

Four students gave one of their examples in the context of discipline. While two students wrote that they learned that the word "mathematics" meant "brain sport" (Fig. 9), one student stated that they learned that mathematics, which is one of the main purposes of this visit, covers a very wide scope, and is related to other disciplines (Fig. 10).

All of the students stated that the visit was very beneficial for them and detailed their opinions about the visit with the explanations given in Table 8.

As is seen in Table 8, some of the students who were asked to evaluate the museum visit stated that they found it useful as they learned a lot of new information which they

Table 5. Willingness or unwillingness situations for subjects to be associated with history and culture in mathematics lessons

Situation	Statement	Category
Yes	We could have understood the importance of mathematics in our lives.	Mathematics perception
	It would be more attractive.	Learning process
	Seeing when and how the subject will present allows us to understand it much better.	
	Subjects become more memorable.	
	We would learn the history of mathematics by learning our own history through mathematics.	Culture-History awareness
	I would like to see mathematics subjects were applied to which artifacts of ours.	
	It would allow us to be a conscious individual who values our history.	
	We would learn how they used and developed mathematics in the bounds of possibility of that time.	
	Before learning any math topic, I would like to know where we can see it in our history and culture.	
No	I would constantly try to memorize it.	Learning process
	It would be boring.	
	Since I do not like verbal lessons, I want mathematics to be taught only by solving questions.	
	Although I understand, I cannot do well in History exams. I do not want mathematics to be included.	
	We may be confused.	
	There is no need to look back. We can be successful on a subject without knowing its history, as well.	Culture-History awareness
	Anyone who is curious about her/his history can research it by herself/himself.	

Table 6. Students' answers to the question of "Could you please share the two new information you learned during the visit?"

Category	Content of the information	Learned information	Frequency
Artifact	• Working principle • Only the name of the artifact • Purpose of usage • Usage fields • General information about the artifact • Information about the owner of the artifact	Information about the Astrolabe	5
		Water clock working principle	2
		Information about various observatories	5
		Information about the sundial	3
		Information about the catapult	1
		Information about the carpets	2
		Development of various artifacts with limited possibilities	1
		Instruments used in medicine	1
		artifacts of various scientists	4
Discipline	• General information about discipline • Information about the mathematics	Information about medicine	1
		Mathematics is the brain sport	2
		Mathematics covers a very wide scope	1

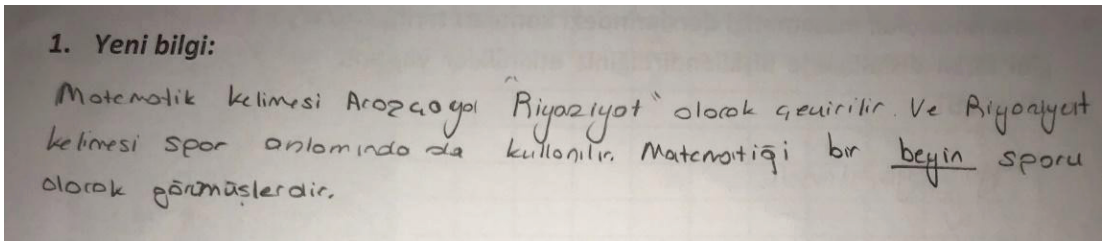

Figure 9. Student response saying that mathematics is seen as a "brain sport".

(The word "Mathematics" is translated into Arabic as "Riyaziyat". Riyaziyat also means "Sports" in Arabic. They also consider Maths as a "Brain sport").

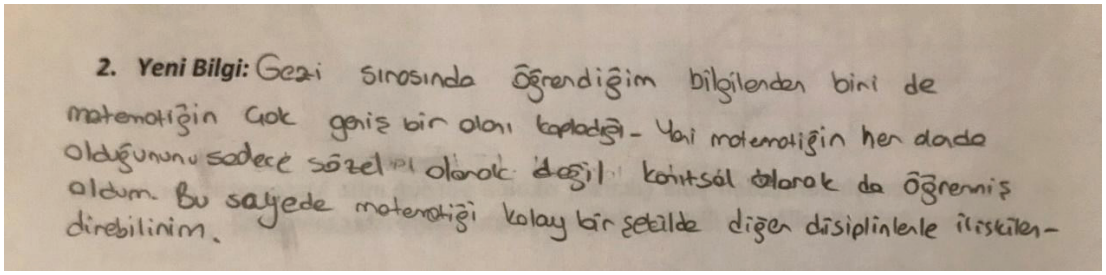

Figure 10. Student's answer indicating that s/he learned that mathematics covers a very wide scope.

(One of the information that I learned during the visit is that mathematics covers a very wide scope. I mean, I have learned that math is in all fields, not only verbally but also with evidence. In this way, I can easily correlate mathematics with other disciplines.)

Table 8. Evaluation of the museum visit

Category	Code samples
General Evaluation	I have enriched my general knowledge.
	I can use what I've learned in real life.
	I have seen how various branches of science went through changes since their emergence.
	I have learned many artifacts I did not know before.
	I learned that many instruments were made to meet the needs and to provide convenience.
Social evaluation	I spent much more time with my friends.
	It was a very joyful excursion.
Evaluation towards mathematics	I learned for what purposes mathematics was used in ancient times.
	I have realized the importance of mathematics in our lives.
	I have realized that mathematics is everywhere.
	Matematik soyut olanı somutlaştırır
	My perspective towards mathematics has improved positively
	I have noticed that mathematics is part of our lives
	I have understood how important mathematics is.
Evaluation towards the relationship between mathematics and culture	I have understood our culture and history
	I have realized how much mathematics we have in our history and culture.
	I have realized that many artifacts were made according to mathematics and geometry rules
	I have learned that people used mathematics in making all tools.

did not know before, while some of them stated that they had a good time with their friends during the excursion. The students who evaluated the benefits in the context of mathematics stated that they could notice many new aspects of mathematics through the visit. Some students, on the other hand, stated that they were able to notice the use of mathematics in tools by correlating mathematics with culture, which is the main focus of the visit, and enable them to see that our history and culture are correlated with mathematics.

DISCUSSION AND CONCLUSION

In this study, through a museum visit, an informal learning environment, it is aimed to reveal the students' perspectives on the existing relationship between their culture and mathematics, and to provide an opportunity for them to correlate their cultural heritage with mathematics, gain awareness about mathematics in their culture, realize the usage areas of mathematics in real life, and see the connection between mathematics and other disciplines. In this study, through a visit to museums, which are an informal learning environment, it is aimed to reveal the students' perspectives on the relationship between their culture and mathematics, to correlate their cultural heritage with mathematics, to gain awareness of mathematics in their culture, to realize the usage areas of mathematics in real life and to enable them to see the connection between mathematics and other disciplines. For this purpose, a visit to two different museums was organized with thirteen high school students, and the opinions of the students were taken after the visit. This study is important because it provides the opportunity to observe that there is a relationship between culture and mathematics concretely through museums that contain real life situations. Additionally, the fact that there are almost no studies conducted about mathematics education and informal learning environments in the context of ethnomathematics in the literature indicates that the results of the study have importance.

The students were seen to have mostly correlated the artifacts they saw with geometry in terms of mathematics during the visit. Similarly, Andersson (2008) indicated that students mostly correlate the objects they encounter in the out-of-school learning environment with geometry concepts. The reason of this might have resulted from the fact that geometric figures are frequently encountered in cultural artifacts in general (Spines and Moses, 2001), and especially in Turkish culture, which geometrical shapes were used in carpet and rug motifs, and in local dresses such as bindalli, caftan, and in architectural structures such as mosque, madrasa, mausoleum, caravansary (Bulut, 2017; Öz Çelikbaş, 2018). However, contrary to the study of Andersson (2008), in which he observed that the students were able to establish more in-depth relationships between the artifacts and mathematical concepts, the students in this study could establish more superficial correlations. The reason for this can be stated as that the students are at the beginning of the 10th grade in terms of their grade level and they do not have the mathematical competence to make this correlation. The fact that students do not know where and how mathematics exists in daily life indicates that they solely become aware of its existence. In addition, the students' inability to give a subject name other than "proportion" and "arithmetic" in correlating with mathematics may be due to the fact that mathematics was not associated with their culture in their courses before.

The museum visit allowed students gain a lot of new information, expand their knowledge, and understand the place of mathematics in life realizing that mathematics has covered a wider scope. On the other hand, students, who noticed that mathematics and geometry were in the construction process of many artifacts, could see how much mathematics was involved in their history and culture. In this case, it can be said that the museum visit made important contributions not only in terms of developing the general culture of the students, but also in terms of being aware of mathematics in daily life, and seeing the relationship between culture and mathematics. The fact that they see how mathematics is related to their own culture through the visit and their own experiences shows that the aim of valuing the culture, one of the most important goals of the ethnomathematics program, has been achieved (D'Ambrosio & Rosa, 2017). This situation coincides with the study results of Adam (2004) in which he reached a result that field trips made by adopting the ethnomathematics approach will enable students to understand that mathematics is used outside of the school, in daily life, and is intertwined with culture.

While some students wanted the math subjects to be correlated with different disciplines or history and culture in their mathematics classes at school, some of them did not want it. The unwilling students are thought to have responded generally with the effect of their anxiety about failing and getting low marks. It can be said that students who think that especially verbal courses such as history are learned by memorization approach this situation negatively because they think that this memorization issue will also reflect in the mathematics classes when it is correlated with the mathematics course. Since similar activities had not been conducted before, it may be thought that the students approached the correlation of history and mathematics with a negative attitude because they thought that this correlation would only be made with activities at the knowledge level and that this verbal information would be asked in exams and they would need to memorize them. It can be said that the reasons of the students who did not want the course to be taught by correlating are the factors such as fear of failure in mathematics, lack of self-confidence and anxiety in students. Students may have thought that mathematics, which is already a difficult course, will become more complicated by correlating it with another course and this will cause them to fail.

When the reasons for appreciating the artifacts they liked were examined, it was seen that they made evaluations in terms of individual reasons, relationship with society and culture and functionality. The appreciation reason for the artifact, which is evaluated under the functionality dimension, is that it required a lot of effort in its production and this is also seen in the study of Bahadır and Hırdıç (2018). In their study, a museum visit was made within the scope of the research and some of the students liked the experiment sets most because they were difficult and they required a lot of effort. In this case, it can be said that students are more interested in the artifacts which are difficult and require more effort.

During the visit, it was observed that the students listened to the guides carefully and actively by asking questions to them, and took notes whenever they thought necessary. It can be said that the reason for this situation is that the students were informed of the museums they will visit through the distributed Museum Guide before the visit, why the museum is visited and what questions to be answered after the visit. It coincides with the view that an effective planning prior to visits to informal learning environments will ensure that these visits will be efficient and full of high learning potential (Buyurgan, 2002; Yıldız & Göl, 2014). The students who came to the visit after reading the questions in the Museum Guides before the excursion completed the visit in an interested, careful and motivated way without getting bored and obtained a lot of new information.

Suggestions

When considered the new vision of the Ministry of National Education (2018), which aims to enable students to build our national, moral, human and cultural values through their own life experiences, this study is considered to have importance. In the study, it was observed that students could correlate mathematics and culture, but they could correlate them superficially rather than deeply, and they had difficulty in creating this correlation. Therefore, investigating how the dimensions of this correlation should be through activities that contain cultural elements in mathematics courses has gained importance. In addition, when considered that mathematics teachers are not ready for the use of ethnomathematics (Lewis, 2016) as a result of their inability to establish the relationship between mathematics and culture, it is revealed that integrating cultural elements into the curriculum is not sufficient and raising this awareness in the teachers who are the implementers of the program is necessary. At this point, the importance of the topic should not be limited to verbal expressions, and it may be suggested to prepare various practical activities that include the relationship between culture and mathematics and present them to teachers. The effects of the teaching process, which will be realized with the implementation of this ethnomathematics program, on the variables of academic achievement, attitude towards mathematics, anxiety, belief and the beliefs about the nature of mathematics can also be investigated.

RECOMMENDATIONS

When considered the new vision of the Ministry of National Education (2018), which aims to enable students to build our national, moral, human and cultural values through their own life experiences, this study is considered to have importance. In the study, it was observed that students could correlate mathematics and culture, but they could correlate them superficially rather than deeply, and they had difficulty in creating this correlation. Therefore, investigating how the dimensions of this correlation should be through activities that contain cultural elements in mathematics courses has gained importance. In addition, when considered that mathematics teachers are not ready for the use of ethnomathematics (Lewis, 2016) as a result of their inability to establish the relationship between mathematics and culture, it is revealed that integrating cultural elements into the curriculum is not sufficient and raising this awareness in the teachers who are the implementers of the program is necessary. At this point, the importance of the topic should not be limited to verbal expressions, and it may be suggested to prepare various practical activities that include the relationship between culture and mathematics and present them to teachers. The effects of the teaching process, which will be realized with the implementation of this ethnomathematics program, on the variables of academic achievement, attitude towards mathematics, anxiety, belief and the beliefs about the nature of mathematics can also be investigated.

Acknowledgement: The study is part of the doctoral dissertation the first author completed under the supervision of the second and third authors.

Ethics: There are no ethical issues with the publication of this manuscript.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept: E.Z.Y.; Design: E.Z.Y.; Supervision: A.Ş.Ö., E.B.; Resources: E.Z.Y.; Data Collection and/or Processing: E.Z.Y.; Analysis and/or Interpretation: E.Z.Y.; Literature Search: E.Z.Y.; Writing Manuscript: E.Z.Y.; Critical Review: A.Ş.Ö., E.B.; Manuscript Submission and Revision: E.B.

Conflict of Interest: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Financial Disclosure: The authors declared that this study has received no financial support.

Teşekkür: Bu çalışma, birinci yazarın ikinci ve üçüncü yazarların danışmanlığında tamamladığı doktora tezinin bir parçasıdır.

Etik: Bu makalenin yayınlanmasıyla ilgili herhangi bir etik sorun bulunmamaktadır.

Hakem Değerlendirmesi: Dış bağımsız.

Yazarlık Katkıları: Fikir: E.Z.Y.; Tasarım: E.Z.Y.; Denetleme: A.Ş.Ö., E.B.; Kaynaklar: E.Z.Y.; Veri Toplanması ve/veya İşlenmesi: E.Z.Y.; Analiz ve/veya Yorumlama: E.Z.Y.; Literatür Taraması: E.Z.Y.; Makalenin Yazımı: E.Z.Y.; Eleştirel İnceleme: A.Ş.Ö., E.B.; Makalenin Dergiye Gönderimi ve Revizyonu: E.B.

Çıkar Çatışması: Yazar, bu makalenin araştırılması, yazarlığı ve/veya yayınlanması ile ilgili olarak herhangi bir potansiyel çıkar çatışması beyan etmemiştir.

Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

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