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THE EFFECT OF MATHEMATIZATION ACTIVITIES PERFORMED IN THE INFORMAL LEARNING ENVIRONMENTS ON THE OPINIONS OF GIFTED STUDENTS ON MATHEMATICS DISCIPLINE[i]

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Abstract:
The main purpose of this research is to create an educational environment including real mathematical problems that can be solved through the interdisciplinary approach and inductive methods and to examine the change brought about by this environment in terms of the opinions and perspectives of special talented students related to the mathematics discipline. The study was conducted in Kayseri Province through the project "Mathematics Energising in Nature and Structures" supported within the context of Nature Education and Science Schools Support Program of Scientific and Technological Research Council of Turkey (STRCT). The study group of this research is composed of 35 special talented students (22 males, 13 females) going on the project education at 9th and 10th grade in the science and art centre (SAC) in Ankara province during 2017-2018 academic year. In this study, the case study method, one of the qualitative research approaches, was used so as to examine the opinions of the students before and after the project process. Pre-interview through the semi-structured interview form before the project period and post-interview after the project period were conducted to the students in the study, and the data obtained about how the students were affected by the case were analysed. Upon the practice, it was determined that there were some findings indicating that it enabled the students to associate

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mathematics with the other disciplines and real life. It was concluded that the scientific activities carried out in informal learning environments significantly increased the attitudes of the students attending the science camp towards the science after the practice when compared to case before the practice, and that these activities also brought about positive changes in the perspectives of the students on science, scientific knowledge, and scientific environments.

Keywords: gifted/special talented student, mathematization, informal learning, nature of science, interdisciplinary teaching

1. Introduction

Humanity owes its development to its sense of curiosity and its desire to solve problems. In the beginning, the curiosity about nature and the urge to solve the problem of survival left its place for more specific curiosities and the desire to solve more complex problems. Every stage proceeded by the humanity has brought new problems and forced the people to seek for new solutions. In this process, the people have sometimes discovered mathematics to cope with nature, to regulate social life, to make life easier, and only to wonder from time to time. This discovery adventure will continue as long as the humanity exists.

The main purpose of the science is to comprehend the universe and to direct it in favour of the humanity. In order to achieve this goal, in the words of Galileo, it is necessary to read the book of nature which is written in the language of mathematics and whose shapes are the shapes of geometry (Umay, 2007; Ülger, 2005). However, mathematics in our environment is often not observable. For example, mathematics in the factors affecting climate change, in the architectural features of buildings, in the working principles of machines or in shaping the social life can only be seen indirectly (Adam, 2003; Nesin, 2008). Although it is not often easy to see and understand this latent mathematics on Earth, the experiences that the students can gain in this field are of critical importance since the people and societies will have the opportunity to shape their future as long as they can read the language of mathematics in the ever-changing world (National Council Of Teachers Of Mathematics [NCTM], 2000).

2. Related Literature

The people acquire many knowledge, abilities, attitudes and behaviours through inductive reasoning (Hayes, 2007). This process includes the stages of observation, defining patterns, making generalizations and generating assumptions. Inductive reasoning is very important in learning mathematics, and it forms the basis of spatial thinking (Haverty, Koedinger, Klahr and Alibali, 2000; Serra, 2008). Therefore, the educational activities and software to be used in mathematics education and especially in the field of geometry should be designed in such a way as to enable the students to generate inductive reasoning (French, 2004; Şahin and Kabasakal, 2018; Van de Walle, Karp and Bay-Williams, 2013). In these activities, the students should be able to discover mathematics in the models that are given to them by working on the real life cases (NCTM, 2000; Van de Walle, Karp and Bay-Williams, 2013).

It is fundamental to adopt the interdisciplinary teaching approach so as to increase the diversity and richness in the educational activities that can support the inductive reasoning processes of the students since this approach is based on examining a real event or problem from the point of view of more than one discipline. The interdisciplinary teaching approach aiming to integrate art, mathematics, natural sciences, and social sciences, enables the students to analyse and synthesize through the concepts by combining their knowledge in different fields. Moreover, it positively affects the high level cognitive skills of the students and their attitudes towards the course (Demirel, Tuncel, Demirhan and Demir, 2008; Jacobs 1989; Ozkok 2005; Yildirim 1996).

The primary purpose of realistic mathematics education, an educational approach that deals with mathematical education on the basis of inductive reasoning, is to enable the students to discover mathematics in real life (Freudenthal, 2002). The mathematics in life in educational environments fictionalised according to this approach is revealed by the students with the help of interdisciplinary studies, and the findings are converted into a mathematical language. In this process, which is called as "Mathematization", the students try to discover the related mathematical structure by examining their observations and measurements in life and to express their discoveries mathematically. At this point, the task of the teacher is to provide the environment in which the students can observe, examine, and discover and is to guide the students. In realistic mathematics education, mathematization takes place in two stages such as horizontal and vertical. Horizontal mathematization represents the transition from the real world to the world of symbols. In horizontal mathematization, the students acquire mathematical relations by making examinations and experimentations based on real models. Vertical mathematization takes place in the world of symbols. In vertical mathematization, the students aim to acquire the abstract mathematical structures and concepts by using the mathematical relations that they explore in horizontal mathematization. Freudenthal (2002) argues that the students taking mathematics education should respectively go through horizontal and vertical mathematization processes, otherwise the activities would be far from didactic.

Superior ability is defined as the synthesis of high mind, intelligence, and creativity, and it is generally known that the gifted individuals have developed analytical, creative, and practical thinking skills (Davidson, 2012; Sternberg, 2009). Furthermore, the gifted individuals have such high level skills as abstraction, conceptualization, analysis, and synthesis (Hoctor, 2013). In addition, their high level of cognitive abilities allows them to easily transfer their knowledge and skills into the new cases (Carr and Alexander, 1996). The behaviours and skills in learning mathematics that are gained through these general characteristics of the gifted individuals are described in the literature as follows (Sheffield, 1994: 1. Fast and precise awareness, curiosity, and comprehension related to numerical data 2. Perception, visualization, and generalization of the patterns and relations 3. Analytical, inductive and deductive reasoning 4. To reverse the reasoning processes, to make easy and logical transitions between methods 5. Energy and durability in solving difficult problems 6. Working with fluent, flexible, and creative ways with mathematical concepts 7. Easily conveying what they have learned into the new cases 8. In addition answering mathematical questions, formulating these questions and solutions 9. Organizing data and working on these data through the various methods and eliminate the unnecessary data. It is stated that the gifted students need enriched and differentiated educational activities so as to use their potential at the highest point owing to the characteristics mentioned above (Clark, 2002; Şahin, 2018; VanTassel-Baska and Strambaugh, 2012; White, 2011). Designing these qualified activities on the basis of the interdisciplinary teaching approach and realistic mathematics education is very important in supporting the mental development of the gifted students. In addition, the exclusion of these activities from the classroom environment will make the activities interesting for students by removing these activities from being boring and abstract. Sheffield (1994) argued that the educational programs prepared for these individuals by considering the different readiness, interests, and needs of the gifted individuals should have the following characteristics:

- The educational program should ensure that the students make logical inductive and deductive reasoning.
- It should encourage the students to ask questions and make generalizations by going beyond the given problems.
- It should propose a variety of methods, materials and technological support to solve the problem.
- It should include the integration of geometry, algebra, statistics, and probability fields.
- It should include such assessment methods as observation, interviews, exhibitions, performances, portfolios, open-ended questions and performance activities.
- It should offer the students both independent working environments and working and discussion environments with the other gifted students.
- It should give the students the tasks in the subjects in which they can both do in-depth research and work flexibly.
- The duration of the lecture and the review courses should be kept to a minimum in order for the students to have time to do research with their instructors and with each other.
- If necessary, the needed concrete materials should be used in order for the students to make abstract generalizations.
- The students should be expected to convey their previous learning into the new cases. The students should associate their mathematical knowledge with other subjects and daily life.

To sum up, even though mathematics seems to be only a thought-based and abstract field, it is found in many parts of life in a way that is concrete, but it does not clearly show itself. Seeing, discovering, and understanding this mathematics in life is of critical importance for especially gifted students. However, the education carried out in closed classroom environments through the idealized numbers, shapes, and problems takes mathematics away from the reality, and the students are not enough to use their real potential and development.

The main purpose of this research is to create an educational environment including real mathematical problems that can be solved through the interdisciplinary approach and inductive methods and to examine the change brought about by this environment in terms of the opinions and perspectives of special talented students related to the mathematics discipline.

3. Method

This section is composed of such subjects as the research model, the study group, the data collection instrument, the practice of the study and the data analysis.

3.1. Research Model

In this study, the case study method, one of the qualitative research approaches, was used to examine the opinions of the students before and after the project process. The most important feature of qualitative case studies is the in-depth examination of one or more cases. In other words, the factors (environment, individuals, events, processes, etc.) related to a case are examined through a holistic approach, and they are focused on how they affect the case and how they are affected by the case. The case studies are a research method that gives the researcher the opportunity to deeply examine a phenomenon or an event that he / she cannot control (Yıldırım & Şimşek, 2016). According to Creswell (2007), the case study is a qualitative research approach in which the researcher examines one or more cases in depth through the data collection instruments (observations, interviews, documents, reports) containing multiple sources within a certain period of time and define the cases and contextual themes. Pre-interview through the semi-structured interview form before the project period and post-interview after the project period were conducted to the students participating in the study, and it was focused on how the students were affected by the case.

3.2. Study Group

Criterion sampling method among the purposeful sampling methods was conducted in determining the study group of this research. The study group is composed of 35 students (22 males, 13 females) who are defined as gifted students and are educated at 9^{th} and 10^{th} grade in high school during 2017-2018 academic year. All of these students are having project-based training in science and art centres (SAC) which are the institutions carrying out various activities outside of school for the gifted students in Turkey.

3.3. Data Collection Instrument

In this study in which semi-structured interview method was used, the interview form was generated by the researchers. After generating the interview form, a pilot study was carried out with five students out of the study group, and the questions that the students had difficulty in understanding were rearranged. Voice recording and note-taking methods were implemented in the practice phase of the interview form. Each interview lasted for approximately 20 minutes.

3.4. Practice Process

Within the scope of the study, five different practices were included during the five-day practice process. The cycle of observation, data collection, data analysis, and evaluation of the analysis results were completed for a different historical area in each practice. The students were guided by three mathematics teachers, a physics teacher, a history teacher, an academician from the field of mathematics education, an architect, an art historian, and a sociologist during these practices. Before the practice process, this group was provided with extensive knowledge about the historical areas to be visited. In line with the various directions of the guide group, the students collecting the numerical data related to the historical structures examined and analysed their data with the help of GeoGebra, a dynamic mathematics / geometry program, by transferring the collected data into the computer environment in the afternoon. Then, the students shared their findings and their results with each other and acquired more general conclusions. These general results were examined together with the students and the guide group. Table 1 shows an example of a general plan for a one-day practice cycle.

Table 1: A General Plan for A One-Day Practice Cycle

Time and Location	Activities Carried Out	Guide Group
09:00 – 11:30 Gevher Nesibe Darüşşifa	Observations made with the directions of guide Data collection by the students through the measurement instruments	Responsible teachers Mathematics academician Architect Sociologist Art historian
13:30 – 16:30 Kayseri Science Centre	Transferring the data into computer and analysing them through GeoGebra Discussion of the analysis results within the group	Responsible teachers Mathematics academician
18:00 – 20:00 Hotel Meeting Room	Examining the results with guide group and students from the mathematical, historical, architectural, and social perspectives	Responsible teachers Mathematics academician Architect Sociologist Art historian

Within the scope of the practice cycle given in Table 1, after breakfast, the students were taken to Gevher Nesibe Darüşşifası, a hospital built in 1200s. During the transportation, the students were informed about the expected results of the observation and data collection processes. After arriving at the area, the students participated in the observation activity that they carried out in accordance with the directions of the experts related to their fields. Then, the students were given free time, and they were asked to make the measurements they desired on the area. In this process, the students took photographs of various parts of structures and collected their data by making measurements through ruler, laser meter, and various telephone applications (Figure 1).

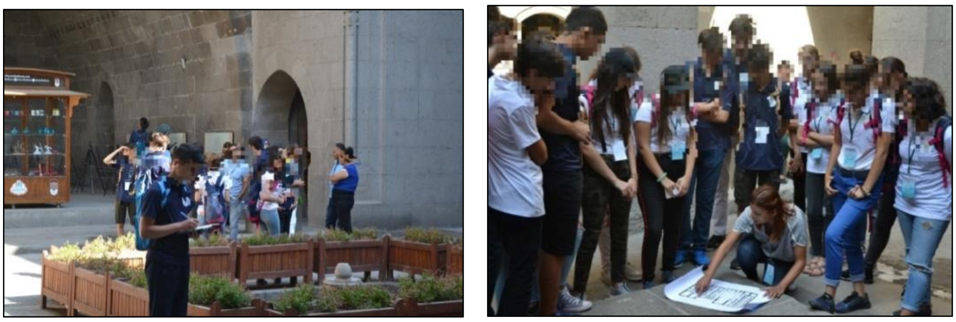

Figure 1

Upon completing the data collection process, all group were taken to Kayseri Science Centre where analysis studies were carried out. Here, the students transferred the visual and numerical data that they collected into the computer, analysed them with the help of GeoGebra software, and discussed the mathematical findings and results with each other (Figure 2).

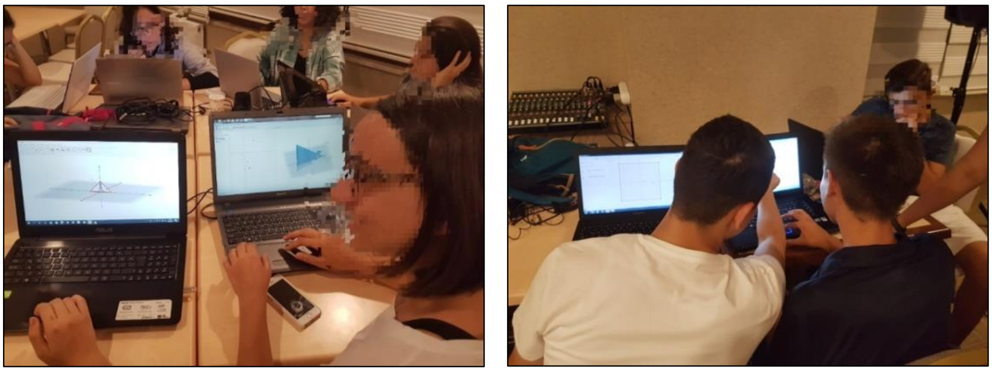

Figure 2

After the discussions in the science centre, the group was returned to the hotel where they rested. Following the dinner, the results of the students were examined from mathematical, historical, architectural and social perspectives with the help of all experts, and various cause and effect relations were acquired (Figure 3).

Figure 3

4. Findings and Conclusion

The findings of the interviews conducted with the students before and after the practices within the scope of the research are given in this section.

4.1. Findings related to the First Question

Before and after the practice, the students were asked the question "What is mathematics?". The numerical values of the responses by the participants to this question are presented in Table 2.

Table 2: Responses to the First Interview Question*

	Before Practice		**After Practice**	
Expressions	Number of Response	Percentage	Number of Response	Percentage
Discipline	14	27,45	9	13,64
Language-expression format	12	23,53	6	9,09
Course	2	3,92	0	0
Number-Figure-Symbol	13	25,49	10	15,15
Understanding and analysis needs	10	19,61	7	10,61
Relationship with nature	0	0	15	22,73
Daily life	0	0	12	18,18
Organization-System-Game	0	0	7	10,61

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

All the students answered the question "What is Mathematics?". Mathematics was defined as discipline in 27.45% of the responses, language and expression format in 23,53% of the responses, course in 3,92% of the responses, number, figure, and symbol in 25,49% of the responses, and needs for understanding and analysis in 19,61 of the responses. Some examples of student opinions on this question are shown below in the form of direct quotation:

S8: *"Mathematics is the need of every person from each profession and all ages."*

S14: *"I think mathematics is the language of the universe. It is the same all over the world."*

S19: *"Mathematics is to think through the numbers."*

All the students answered the question "What is Mathematics?" which was asked to the students again after the practices. Mathematics was defined as discipline in 13,63% of the responses, language and expression format in 9,09% of the responses, number, figure, and symbol in 15.15% of the responses, the needs for understanding and analysis in 10,61% of the responses, relationship with nature in 22,73% of the responses, daily life in 18,18% of the responses, and organization, system, and game in 10,61% of the responses.

S15: *"It is a kind of language which humanity develops in order to initially understand nature and then to satisfy his/her curiosity."*

S22: *"It is the rule and pattern of the universe. Everything that exists is in order and mathematics explains it."*

S35: *"It is a course, a discipline, and a science that takes its origin from nature."*

S13: *"It is to systematically organize and interpret the data."*

S7: *"It is the strength of developing regular study habits and concentrating on a subject."*

According to the findings of the first interview question, most of the students used general expressions in defining mathematics before the practices. Almost all of these facile expressions are in parallel with the dictionary definition of mathematics. It is emphasized in literature that such expressions are insufficient to define mathematics (Umay, 2002). After the practices, a significant part of the students made concrete definitions related to the practice areas of mathematics. In addition, the mathematical definitions of the students became more associated with their environment and daily life. By considering that the individuals tend to associate with the abstract concepts known by them when they express the abstract concepts (Saban, Koçbeker & Saban, 2005), it can be stated that the mathematical activities carried out in informal learning environments are effective in increasing the awareness of the students about mathematics discipline and its place in daily life. In parallel with this result of the research, Baykul (2009) mentioned that the experiences of people in mathematics form their definition of mathematics. In their study, Bahadır and Hırdıç (2018) also acquired the findings that the students are able to see the mathematics in life and increase their interest in mathematics through the education in informal learning environments.

4.2. Findings related to the Second Question

Before and after the application, the students were asked the second question "Which disciplines can mathematics be related to?". The numerical values of responses by the students to this question are presented in Table 3.

Table 3: Responses to the Second Interview Question*

	Before Practice		After Practice	
Expressions	Number of Response	Percentage	Number of Response	Percentage
All the disciplines	12	24	18	24,66
Physics	10	20	8	10,96
Chemistry	7	14	7	9,59
Biology	5	10	5	6,85
Philosophy	3	6	3	4,11
Art	4	8	5	6,85
Engineering	2	4	5	6,85
Medicine	2	4	4	5,48
Architecture	1	2	7	9,59
Astronomy	1	2	0	0,00
Geography	1	2	1	1,37
Music	2	4	2	2,74
Sociology	0	0	3	4,11
Anthropology	0	0	2	2,74
Visual arts	0	0	3	4,11

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

All the students answered the question "Which disciplines can mathematics be related to?". Mathematics was defined as related to all the disciplines in 24% of the responses, physics in 20% of the responses, chemistry in 14% of the responses, biology in 10% of the responses, philosophy in 6% of the responses, art in 8% of the responses, engineering in 4% of the responses, medicine in 4% of the responses, architecture in 2% of the responses, astronomy in 2% of the responses, geography in 2 % of the responses, and music in 4% of the responses. Some examples of the student opinions related to this question are stated in the form of direct quotation below.

S5: *"It is related to most of the numerical courses such as Physics and Astronomy."*

S19: *"I think it is related to all the disciplines since mathematics is the form of art of thinking that is converted into numbers."*

S22: *"It is clear and evidenced that it has a relationship with all the positive sciences. On the other side, there is an algorithm of community and human behaviour in social sciences. Therefore, all the disciplines are based on mathematics."*

Upon the practice period, all the students were asked to answer again the question "Which disciplines can mathematics be related to?". Mathematics was defined by the participants as related to all the disciplines in 24,66% of the responses, physics in 10,96% of the responses, chemistry in 9,59% of the responses, biology in 6,85% of the responses, philosophy in 4,11% of the responses, art in 6,85% of the responses, engineering in 6,85% of the responses, medicine in 5,48% of the responses, architecture in 9,59% of the responses, geography in 1,37% of the responses, music in 2,74% of the responses, sociology in 4,11% of the responses, anthropology in 2,74% of the responses, and visual arts in 4,11 of the responses. Some examples of the student opinions related to this question are shown in the form of direct quotation below.

S8: *"We can see that mathematics interacts in every event that we encounter. It is therefore associated with all disciplines."*

S9: *"It is possible to see the effects of mathematics from trade to art, from architecture to music."*

S34: *"It is associated with all disciplines because math is life."*

A large part of the students said that mathematics was related to all the disciplines before the practices, but they could not give a detailed explanation about this relationship. According to this, the students know that mathematics is related to many disciplines, but they cannot exemplify this situation. An important part of the students also associate mathematics with science. This indicates that the math perception of the students can be limited to school subjects. After the practices, a large part of the students associated mathematics with all the disciplines and gave examples to explain this relationship. Moreover, there has been a significant increase in the number of the students who associate mathematics with the fields of engineering and architecture. Accordingly, it can be concluded that the practices enable the students to see and define the relationship between mathematics and other disciplines more clearly. Similar results are found in the studies of Bahadır and Hırdıç (2018).

4.3. Findings related to the Third Question

In the interviews conducted before and after the research, the participant students was asked to answer the question "What are your opinions on the place and importance of mathematics in daily life?". The numerical values of the responses by the participants to this question are given in Table 4.

Table 4: Responses to the Third Interview Question*

	Before Practice		After Practice	
Expressions	Number of Response	Percentage	Number of Response	Percentage
Included in all areas	19	48,72	15	41,67
Education Occupation	3	7,69	0	0,00
Other Disciplines	5	12,82	3	8,33
Art	1	2,56	3	8,33
Structures	3	7,69	5	13,89
Computer	1	2,56	0	0,00
Measurement	1	2,56	3	8,33
Social life	5	12,82	3	8,33
In nature	1	2,56	3	8,33
Organization	0	0,00	1	2,78

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

Before the practice, all the students answered the question "What are your opinions on the place and importance of mathematics in daily life?" It was stated that mathematics is included in all areas in 48,72% of the responses, education and occupation in 7,69% of the responses, other disciplines in 12,82% of the responses, art in 2,56% of the responses, structures in 7,69% of the responses, computer in 2,56% of the responses, measurement in 2,56% of the responses, social life in 12,82% of the responses, and nature in 2,56% of the responses. Some examples of the student opinions related to this question are demonstrated in the form of direct quotation below.

> S5: *"Mathematics is everywhere in daily life. All the tools that we use are the result of mathematics."*

> S26: *"The positive sciences are unthinkable without mathematics. They all contain intense mathematics. In addition, mathematics is a must in arts. It is related to all the disciplines."*

> S27: *"I think that mathematics makes a great contribution to comprehending the events that we experience and solving the problems that we encounter through the logical calculations."*

> S35: *"If there was no mathematics in daily life, we would be living in the First Age now. Therefore, mathematics is important."*

Upon the practices, all the students were asked again to answer the question "What are your opinions on the place and importance of mathematics in daily life?" It was stated that mathematics is included in all areas in 41,67% of the responses, other disciplines in 8,33% of the responses, art in 8,33% of the responses, structures in 13,89% of the responses, measurement in 8,33% of the responses, social life in 8,33% of the responses, nature in 8,33% of the responses, and organization in 2,78% of the responses.

Some examples of the student opinions related to this question are given in the form of direct quotation below.

S2: *"Mathematics is used in both natural habitats and human structures, and so it is very important."*

S4: *"Mathematics is seen in the architecture of the houses we live in everyday life and in the images of living things in nature."*

S15: *"Although mathematics in general seems to be limited to the lesson, it is actually considered to be within the scope of our needs and is associated with everything. In other words, we use it so as to go on our daily life without any problems even though we are not aware of it."*

S22: *"It is involved in architecture, art, city planning, and technological tools. It is necessary to appeal to the eye or to perform a desired function."*

S26: *"Mathematics exists in daily life where we live from morning to evening. Although we do not symbolize all the events we experience in a day, we actually live in mathematics."*

Whereas the students thought that mathematics was everywhere in daily life before the practice, they gave more detailed answers by mentioning more specific areas instead of generalizations after the practice. Furthermore, no student limited mathematics to a course or a profession after practice. In this respect, it can be concluded that the practice enabled the students to discuss the mathematics in daily life in a more specific and in-depth way.

4.4. Findings related to the Forth Question

In the interviews carried out before and after the research, the participants were asked the fourth question "Do you think that you can express the objects and events you observe in your daily life by means of mathematization?". The numerical values of the answers given to this question are presented in Table 5.

Table 5: Responses to the Forth Interview Question*

	Before Practice		After Practice	
Expressions	Number of Response	Percentage	Number of Response	Percentage
Yes	20	57,14	26	74,29
No	7	20,00	1	2,86
Slightly	8	22,86	8	22,86
Modelling	3	8,33	1	2,13
Architectural	8	22,22	13	27,66
Probability	3	8,33	0	0,00
Nature	4	11,11	1	2,13
Golden Ratio	2	5,56	3	6,38
Other Disciplines	2	5,56	0	0,00
Technology	1	2,78	0	0,00
Daily Routines	9	25,00	6	12,77
Measurement	1	2,78	13	27,66
Ratio	3	8,33	10	21,28

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

All the students answered the question "Do you think that you can express the objects and events you observe in your daily life by means of mathematization?". While 57.14% of the students answered as "Yes", 20% of them answered as "No", and the rest 22.86% answered as "Slightly". It is mentioned that mathematization can be applied in modelling in 8,33% of the responses, architectural in 22,22% of the responses, probability in 8,33% of the responses, nature in 11,11% of the responses, golden ratio in 5,56% of the responses, other disciplines in 5,56% of the responses, technology in 2,78% of the responses, daily routines in 25,00% of the responses, measurement in 2,78% of the responses, and ratio in 8,33% of the responses. Some examples of the student opinions related to this question are shown in the form of direct quotation below.

S4: *"I think that all of the events I have observed around me are of a reason, and mathematics is used to explain these reasons."*

S9: *"We can apply mathematization in scientific experiments."*

S20: *"I don't think I can mathematize. I intend to do this in this project."*

S35: *"Yes, for example, a building consists of millions of shapes. A building can be mathematized by measuring the angles of this shape or etc."*

Upon the practice, all the students were asked again to answer the question "Do you think that you can express the objects and events you observe in your daily life by means of mathematization?". Whereas 71.88% of the students answered as "Yes", 3.13% of them answered as "No", and the rest 25.00% answered as "Slightly". It is expressed by the participants that mathematization can be applied in modelling in 2,13% of the responses, architectural in 27,66% of the responses, nature in 2,13% of the responses, golden ratio in 6,38% of the responses, daily routines in 12,77% of the responses, measurement in 27,66% of the responses, and ratio in 21,28% of the responses. Some examples of the student opinions related to this question are stated in the form of direct quotation below.

> S1: *"For example, when buying a house, it allows us to measure the square meter, the volume and the mass of the objects."*

> S3: *"As in our project, we can even put a situation that does not have much to do with mathematics into mathematics."*

> S6: *"We can mathematize all the objects by finding mathematics in them. For example, we can measure the length of a door thorough the ratio of the shadow lengths."*

> S7: *"After seeing mathematics in nature and historical artefacts, I think everything that is modern can be mathematized."*

> S11: *"I can mathematize the length of a place whose length I don't know by measuring it through the various methods."*

While a significant number of the students thought that they could not mathematically express the events and facts around them before the practice, there was a significant decrease in the number of the students who responded negatively to this question upon the practice. According to this finding, the practices have changed the perceptions of the students about mathematics in a positive way. After the practice, it is observed that the students can diversify the daily life events that they can mathematically explain by giving more examples. In addition, their emphasis on measurement and ratio is particularly noteworthy in these examples. Accordingly, it is seen that there is an increase in the belief that the students can reveal the latent mathematical elements in their daily lives through measurement and rating.

4.5. Findings related to the Fifth Question

Before the practice, the students were asked the question "What are your thoughts about mathematics education provided in the classroom?". The numerical values of the answers by the students to this question are shown in Table 6a.

Table 6a: Responses to the Fifth Interview Question Before Practice*

Expressions	Number of Response	Percentage
Insufficient	16	39,02
Rote-learning	7	17,07
Boring	5	12,20
Sufficient	4	9,76
Unqualified	2	4,88
Insufficient practice	2	4,88
Does not reflect real mathematics	2	4,88
Entertaining	1	2,44
Difficult	1	2,44
Technology should be enhanced	1	2,44

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

The thoughts about the mathematics education provided in the classroom were stated as insufficient in 39,02% of the responses, rote-learning in 17,07% of the responses, boring in 12,20% of the responses, sufficient in 9,76% of the responses, unqualified in 4,88% of the responses, insufficient practice in 4,88% of the responses, not reflecting real mathematics in 4,88% of the responses, entertaining in 2,44% of the responses, difficult in 2,44% of the responses, and that technology should be enhanced in 2,44% of the responses. Some examples of the student opinions related to this question are presented in the form of direct quotation below.

S4: *"I think that the mathematics that we were taught or memorized in the classroom environment and the formulas that we used were just memorized without explaining the reasons. For this reason, we cannot think mathematically, just memorize."*

S5: *"Basic mathematics education is generally being done. Instead of teaching the students to benefit from the environment, they are taught in a simple way."*

S25: *"Mathematics education in the classroom environment can be carried out in a more compelling form. It can be reinforced with mind games and logic questions. It can be made more entertaining and practice-based."*

After the practices, the students were asked to answer the question "What are your thoughts about mathematics education provided in outdoor areas (in nature, in historical areas)?". The numerical values of the answers by the participants to this question are given in Table 6b.

Table 6b: Responses to the Fifth Interview Question After Practice*

Expressions	Number of Response	Percentage
More effective than classroom environment	7	20,00
Permanent learning	7	20,00
I learned the relationship between mathematics and daily life	5	14,29
I noticed mathematics hidden in nature	5	14,29
Entertaining and enjoyable	5	14,29
It is used in Seljuk and Ottoman architecture	2	5,71
I had the opportunity to practice - learning by doing	2	5,71
My perspective on mathematics has changed	1	2,86
Tiring	1	2,86

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

The thoughts about mathematics education provided in outdoor areas (in nature and historical areas) were expressed as more effective than classroom environment in 20,00% of the responses, permanent learning in 20,00% of the responses, that I learned the relationship between mathematics and daily life in 14,29% of the responses, that I noticed mathematics hidden in nature in 14,29% of the responses, entertaining and enjoyable in 14,29% of the responses, that it is used in Seljuk and Ottoman architecture in 5,71% of the responses, that I had the opportunity to practice - learning by doing in 5,71% of the responses, that my point of view towards mathematics has changed in 2,86% of the responses, and tiring in 2,86% of the responses. Some examples of the student opinions related to this question are shown in the form of direct quotation below.

S2: *"We learned the importance of mathematics in daily life. I think it was very useful."*

S5: *"This education changed my perspective on mathematics."*

S20: *"I think it's necessary because something does not fit well before learning by doing and experiencing."*

S35: *"Mixing mathematics and culture worked very well."*

A significant part of the students mentioned that the education in classroom environment were insufficient and boring. They found the activities carried out in the project more entertaining and efficient than the activities carried out at school. In his study, Çığrık (2016) emphasized that the traditional education approaches are insufficient in associating the school program with out-of-school areas, and that new education and event programs should be prepared in order to associate educational programs with out-of-school learning areas. In addition, the students stated that they learned by experiencing and doing the activities in the project themselves and that they did not do such activities in their schools. The students who participated in the study demonstrated that the activities carried out in outdoor learning environments (in nature and historical areas) had important outputs in terms of discovering the relationship between scientific knowledge and daily life, facilitating learning, and permanent knowledge. These opinions support the results of some research conducted outside the school (Sontay, Tutar and Karamustafaoğlu, 2016; Balkan Kıyıcı and Atabek Yigit, 2010).

4.6. Findings related to the Sixth Question

As a sixth question, the students were asked "What are your reasons for participating in the project?" before the practice. The numerical values of the answers given to this question by the participants are presented in Table 7a.

Table 7a: Responses to the Sixth Interview Question Before Practice*

Expressions	Number of Response	Percentage
Advice by teacher	3	6,82
To improve myself	10	22,73
Being free	1	2,27
Being interesting in mathematics	10	22,73
For a different perspective	2	4,55
To create a product	2	4,55
My interest in architecture	4	9,09
To see a different city	1	2,27
Being a wonderful project	1	2,27
Group work and opportunity for communication	2	4,55
Wonder	2	4,55
Desire to examine	2	4,55
Wish to spend entertaining time	3	6,82
Contribution to career choice	1	2,27

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

The reasons for participating in the project were stated as advice by teacher in 6,82% of the responses, to improve myself in 22,73% of the responses, being free in 2,27% of the responses, being interested in mathematics in 22,73% of the responses, for a different perspective in 4,55% of the responses, to create a product in 4,55% of the responses, my interest in architecture in 9,09% of the responses, to see a different city in 2,27% of the responses, being a wonderful project in 2,27% of the responses, group work and opportunity for communication in 4,55% of the responses, wonder in 4,55% of the responses, desire to examine in 4,55% of the responses, wish to spend entertaining time in 6,82% of the responses, and contribution to career choice in 2,27% of the responses. Some examples of the student opinions related to this question are given in the form of direct quotation below.

S4: *"I participated in so as to understand how people discovering mathematics were doing by looking at nature."*

S12: *"I wanted to see how comprehensive the use of mathematics was in nature."*

S20: *"I attended to learn how to analyse my environment through mathematics."*

The majority of the students stated that they participated in the project since they were interested in mathematics and wanted to improve themselves. The reasons for the participation of the gifted students to the project and their willingness to participate in the project are due to the fact that they will spend time together with their peers who are like each other and who have common interests. Associations in informal learning environments of the special talented students who have similar socio-cognitive and emotional characteristics and want to carry out studies in the same fields are also important for their cognitive and social development (Davaslıgil, 2004; Sak, 2011; Öztürk and Ayvaz, 2018). Öztürk and Ayvaz (2018) stated that performing activities in informal learning environments through group work facilitated and accelerated the acquisition of not only cognitive outcomes but also social gains of the gifted students. After the practices, the students were asked the question "What kind of contributions did the project provide to you?". The numerical values of the answers to this question are shown in Table 7b.

Table 7b: Responses to the Sixth Interview Question After Practice*

Expressions	Number of Response	Percentage
Ability to observe-think-plan	25	30,12
Affecting career choice	1	1,20
Developing practical intelligence	9	10,84
Being aware of the importance of mathematics	20	24,10
Ability for group work	10	12,05
My perspective on architecture	5	6,02
Handicraft	7	8,43
Communication ability	6	7,23

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

The contributions of the project to the participants were defined as ability to observe, think, and plan in 30,12% of the responses, affecting career choice in 1,20% of the responses, developing practical intelligence in 10,84% of the responses, being aware of the importance of mathematics in 24,10% of the responses, ability for group work in 12,05% of the responses, my perspective on architecture in 6,02% of the responses, handicraft in 8,43% of the responses, and communication ability in 7,23% of the responses. Some examples of the student opinions related to this question are presented in the form of direct quotation below.

S5: *"It provided me a different perspective. I started to see whether there was any mathematical game on every object or not."*

S24: *"The project made me realize that nothing was randomly constructed, that there was a pattern in all of them, and that mathematics was in every aspect of our daily life."*

S25: *"Thanks to the project, my handicraft increased. I learned what to do to make a nice organization in group work. I have made new friends, and my culture has increased, and my perspective on social events has changed."*

As a result of the research, it was concluded that the schools of nature and science contributed to the students to develop a positive attitude towards science. This result supports the literature (Konur et al., 2011; Tekbıyık et al., 2013; Erten and Taşcı, 2016; Öztürk and Ayvaz, 2018). Randler, Baumgartner, Eisele and Kienzle (2007) stated that the existing learning will be reinforced by supporting the educational activities carried out in formal education by means of out-of-school learning environments, and that the scientific process skills and affective characteristics of the students will also improve positively. Erten and Taşcı (2016) indicated that out-of-school learning environments contributed to the development of scientific process skills such as observing, classifying, measuring, recording data, using data and creating models. Considering the opinions of the students obtained after the study, it can be stated that the activities carried out in nature in relation to daily life have developed the observation, thinking and planning, working with group, and hand skills of the students.

4.7. Findings related to the Seventh Question

Before the practice, as a seventh question, the participants were asked "What are your expectations from the project?". The numerical values of the answers to this question are given in Table 8.

Table 8: Responses to the Seventh Interview Question Before Practice*

Expressions	Number of Response	Percentage
Improving my skills	3	9,38
Discovering mathematics in nature	10	31,25
3D design through GeoGebra	1	3,13
Having fun	10	31,25
Having knowledge about architecture	2	6,25
Developing communication skills	2	6,25
Using drone	4	12,50

* Since some of the student responses fit into more than one category, such responses are reflected in the response numbers in each category.

The expectations of the participants from the project were stated as improving my skills in 9,38% of the responses, discovering mathematics in nature in 32,25% of the responses, 3D design through GeoGebra in 3,13% of the responses, having fun in 31,25% of the responses, having knowledge about architecture in 6,25% of the responses, developing communication skills in 6,25% of the responses, and using drone in 12,50% of the responses. Some examples of the student opinions related to this question are shown in the form of direct quotation below.

S21: *"To be able to use web-based applications effectively and use such tools as drone."*

S25: *"I would like to acquire knowledge about past lifestyles."*

S26: *"I expect to observe the relationship between nature and mathematics in a concrete way."*

In line with the feedback received from the students, it can be said that the purposes of the project and the reasons for participating in the project overlap. When we evaluate the frequency of positive evaluations of the students, it can be said that the expectations of the students are satisfied. Considering the opinions obtained at the end of the study, it is thought that the perspective on the scientific projects that provide informal learning environments to be organized for gifted students will be positive and that the participation in these projects will be at a high level. It is also concluded that the attitudes of the students attending the science camp towards the science have increased significantly after the camp when compared to the level before the camp and that the students have a change in their perspectives on science, scientific knowledge, and scientific environment. Therefore, it can be mentioned that the scientific activities and the scientific environment in the camp have a big role in the emergence of this result. For this reason, increasing the number of similar projects is important for science education. These opinions also support the results of some research conducted in out-of-school settings (Braund and Reiss, 2006; Eshach, 2007; Sontay, Tutar and Karamustafaoğlu, 2016).

5. Recommendations

In the study, an educational environment where realistic mathematics problems can be solved through an interdisciplinary approach and inductive methods by taking the educational needs of specially gifted students into account was generated, and it has been observed that this environment has been found to lead to positive developments in the views and perspectives of students about mathematics discipline. Based on the results of this research, some recommendations for practitioners and researchers are stated below.

In particular, the teachers who work with specially gifted students can use mathematization activities in their classes to ensure that their students use their potential at the highest level. In addition, this kind of activities is in the form of teaching mathematics discipline and the importance of this discipline in daily life. By integrating mathematical activities into the courses, it can be predicted that they can contribute to mathematical thinking of the students. The fact that all these activities are carried out in informal settings outside the classroom will positively affect the attitude of the students towards the course.

The effects of mathematization activities performed in informal settings on problem solving or mathematical skills of the special talented students can be examined in the researches that can be carried out upon this research.

The study group is composed of the high school students with similar socio-economic features. The effect of similar activities with the students with different socio-economic features can be examined. It can also be examined how differentiation of the age group can change the results of the study.

An important part of the activities carried out within the scope of the research was performed on computer. How this situation affects the results of the study may also be a subject for a different study.

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