ENLIGHTEN THE ROMAN TOMBS WITH YOUR PERISCOPE: A STEM+SOCIAL STUDY

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ABSTRACT

This study reports on the implementation and evaluation of the "Enlighten Roman Tombs with Periscope" activity, one of the STEM + activities in the project named "STEM-ANTIQUE." The project included a science camp with STEM-based scientific studies, field trips, and observations lasting 10 days and 80 hours. The activity that was examined in the current research lasted 4 hours in total, of which 1 hour was theoretical, 1 hour was practice, and 2 hours were the fieldwork activities. The participants of the project were 22 students studying in the 9th grade of the public schools in Karaman, Turkey. As part of the "Enlighten Roman Tombs with Periscope" activity, the participating students explored an artificial tomb that was unearthed through the excavations. In focus group interviews with the students at the end of the study, the participants expressed their opinion that their innovation abilities and problem-solving skills improved.
Keywords: STEM+Social, nature education and science schools, focus group interview.

PERİSKOBUNLA ROMA MEZARLARINI AYDINLAT: STEM + SOSYAL ÇALIŞMASI

ÖZ

Bu çalışma, "STEM-ANTİK" adlı projede gerçekleştirilen STEM+ etkinliklerinden "Periskobunla Roma Mezarlarını Aydınlat" etkinliğinin uygulanmasını ve değerlendirilmesini içermektedir. Proje, 10 gün ve 80 saat süren STEM tabanlı bilimsel çalışmaların, gezi ve gözlemlerin yer aldığı bir bilim kampı özelliği taşımaktadır. Araştırmaya konu olan etkinlik toplamda 4 saat sürmüş; etkinliğin 1 saati teori, 2 saati uygulama ve 1 saati saha çalışması olarak gerçekleştirilmiştir. Projenin çalışma grubunu, Karaman ili merkeze bağlı devlet okullarının 9. sınıflarında öğrenim gören ve pansiyonlarda konaklayan 22 öğrenci oluşturmuştur. Bu kapsamda yapılan STEM+ grup çalışmalarından biri de kazı çalışmaları sonucu ortaya çıkarılan suni mezarın incelenmesi için gerçekleştirilen bu etkinliktir. Çalışma sonunda öğrencilerle gerçekleştirilen odak grup görüşmelerinde katılımcılar inovasyon yeteneklerinin ve problem çözme becerilerinin geliştiği yönünde görüş bildirmişlerdir.
Anahtar kelimeler: STEM+Sosyal, doğa eğitimi ve bilim okulları, odak grup görüşmesi.

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INTRODUCTION

STEM is the acronym for the disciplines of Science, Technology, Engineering, and Mathematics. The STEM education is an integrated educational approach that promotes creative problem-solving skills of students who will be the innovators of the future (Roberts, 2012). The STEM education focuses on an integration of these four disciplines in order to improve students' problem-solving skills through a holistic perspective, to develop their critical thinking skills, and to unleash their creativity to help them design and make a product. Recently, in addition to science, technology, engineering, and mathematics disciplines, the art discipline has also been integrated into the STEM approach due to its important role in engineering designs (Çevik, Şentürk, & Abdioğlu, 2019). STEM education is applied not only with the discipline of art, but also with many other disciplines in recent years. In this context, STEM has been transformed to involve other disciplines to reflect a transdisciplinary approach, such as STEM + S in the field of social sciences, STEM +A in the field of agricultural sciences, and STEM + E in the field of entrepreneurship.

One of the disciplines that have applications with STEM fields is archeology. Although there are studies in which the archeology is integrated into STEM in the international STEM+ literature, there are no such applications yet in Turkey. In the field of archeology, where technology and science have often been used in recent years, the devices, architectural remains, and other human artifacts from the past have been reconstructed within the scope of experimental archeology since the 1960s. Thus, the descriptive and authoritarian approach of traditional archeology came to an end, and a new, descriptive, testable, and reproducible archeology has been introduced (Duru, 2014). Archeology investigates everything that comes out of human hands and is the product of human thought (Başaran, 1998). Therefore, any experiment to clarify a subject that falls within its scope is covered in this regard (Renfrew & Bahn, 2013). Perhaps the innovation studies in museums can be given as the closest example studies on the integration of technology with archeology. Conferences and practice educations have been organized in numerous archaeological museums in Turkey. These educations aim to develop participants' awareness towards identity and history, to help them understand the importance of historical and cultural values of their city, to create awareness towards the protection of cultural assets, and to contribute to museums through understanding the meaning and importance of museums (Akça, 2015). In his study on these issues, Akmehmet (2008) made recommendations in relation to the educational function of museums, such as the need of in-service seminars, training packages, and presence of museum education experts in order to promote a better comprehension of the science of archeology. Akyürek (2011) stated that students usually do not participate in activities in museums, they are passive, and they do not acknowledge that other civilizations lived on the land they live on now. The researcher reported that at the end of a planned museum event, the participating students expanded their knowledge and views about the museum and historical monuments due to their new experiences. Durmuş (2011) stated that the present visual arts course handbook is inadequate for the teachers, and that museum education-related materials are insufficient to support museum education.

Researchers emphasize that interdisciplinary studies are needed in different fields where the STEM approach is at the center (Ayar & Yalvaç, 2016; Liao, 2016; Sochacka, Guyotte, & Walther, 2016). In their study on the motivations and expectations of geology undergraduates, Lukes and McConnell (2014) found that the STEM approach integrated into geology discipline enhanced the motivations of the students with a higher performance in the course. Barret, Moran, and Woods (2014) found that undergraduates studying in oceanography and mechanical engineering departments significantly increased their achievements in courses taught with a STEM approach. As a result of the study, the authors recommended to conduct similar studies to understand the nature of educational activities that are particularly related to social studies.

The current study includes the implementation and evaluation of the activity “Enlighten Roman Tombs with Your Periscope” developed within the scope of a science camp. The camp was designed and held based on the STEM + Social framework. The study aimed to integrate archeology with STEM fields in order to bring these disciplines together in a common denominator. Within the scope of a Scientific and Technological Research Council of Turkey (TUBITAK) 4004-Nature Education and Science Schools Project, archaeological studies were carried out with 22 students in an artificial Roman villa constructed in Karamanoğlu Mehmetbey University. In this context, aligned with the STEM education approach, "Enlighten Roman Tombs with Your Periscope" activity was designed to include active learning strategies such as excavation, research, examination, observation and design, field work, group work, play, drama, and excursion.

In the activity named "Enlighten Roman Tombs with Your Periscope", the working principle of the periscope, how it can be developed, and how the periscope can be used in a different area were examined in detail. As is known, periscopes have an optical mechanism and provide an outlook through prisms. Although periscopes have various uses today, they are most commonly used in submarines (Gül, 2008 as cited in Merdan, 2018). The use of periscopes ways back to the First World War. The periscopes, which can also be used in different land combat vehicles, were used in submarines during the war. The importance of periscopes was mainly understood in the Second World War. In this war, submarines had significant roles for the countries. Periscopes are still used in submarines today and retain their importance in military power. The periscopes, which have been further developed with the advances in technology, allows taking images from quite a distance in all kinds of environments, both day and night. The periscopes developed nowadays are the product of multidisciplinary research involving the rules of physics, technology, mathematical calculations, and different design studies according to their uses. In this context, designing a periscope with multidisciplinary STEM approach and using it to solve a problem that students encounter was the main purpose of this research. This goal is important because STEM education has two main purposes (Thomasian, 2011). The first of these is to increase the number of students who will make a career choice in the STEM fields at higher education level, and the second is to increase the readiness of students in STEM disciplines to help them propose effective solution methods to overcome the problems they face in their daily lives. One of the characteristics that makes STEM education important and outstanding compared to other approaches is that it develops applied skills (Chang, Ku, Yu, Wu, & Kuo 2015). Nowadays, where technology has an important share in the economic development of countries, it is important to put knowledge into practice in a qualified manner and to draw individuals' attention to these areas regarding career awareness (Hacıömeroğlu & Bulut, 2016).

Another aim of this study is to offer teachers an exemplary STEM + Social activity. Throughout the article, there are guidelines for teachers regarding how to effectively implement the activity in their schools. The participants' opinions about the activities are also shared. At the end of the project, a focus group interview was conducted with the students to determine their perceptions about how the activities contributed to their knowledge and development.

ACTIVITY IMPLEMENTATION

Preparation for the Activity

The science camp was held as part of "STEM-ANTIQUE" project which was supported by grant from TUBITAK. The project was conducted with 22 ninth-graders studying at public schools in the province of Karaman and staying at school hostels. Also, 12 instructors, 10 guides, two project experts, and one coordinator worked in the project as project staff. The students who participated in the project were selected through interviews and by administering a general knowledge test, prepared by a mathematics, a science, and an archeology expert. Since the students staying at the hostels are from families with low socio-economic level, priority was given to these students as they would be less likely to participate in such activities, projects, trips, and observations. The project was grounded and shaped accordingly, considering that the successful students among these students should participate in the project. In the selection of these students, the test developed by the experts of the project was applied in order to act fairly, to maintain objectivity, and to give priority to those who have never participated in such projects before. The test consists of two parts. The first part is the biographical part in which the participants were asked about where they live, whether they had been to the excavation sites, their High School Entrance exam scores, and whether they had been involved in a TUBITAK project before. The second part of the test is a 10-item section with general knowledge questions. In this section, multiple choice questions were asked about science, technology, general culture, and history. For example, questions such as “Who is the first Turkish scientist to receive the Nobel Prize in chemistry?”, “What is the definition of technology?”, “Which of the following is one of the historical sites in the province Karaman?” were asked. The test was conducted in a classroom setting for 15 minutes with the permission letter received from the Provincial Directorate of National Education and the ethics approval received from the university. After the interviews with the students whose test scores were ranked from high to low, consent was obtained from the parents of the students who were deemed eligible to participate in the project, and the required legal permits were obtained from the school administrations and the Provincial Directorate of National Education in order for these students to be placed on leave during the project. In addition, ethical approval was obtained from the university ethics committee regarding carrying out the project according to ethical principles. The project lasted for 10 days. Fourteen STEM+S activities that took 80 hours in total were carried out and two science-oriented field trips were organized. The “Enlighten the Roman Tombs with Your Periscope” activity, which is the subject of the current research, lasted a total of 4 hours. Through a semi-structured interview form prepared in line with the expert opinions, the views of the participants were obtained on how the activities in the project contributed to their understanding of STEM+ fields.

The theoretical part and the development of the products took place in the workshop room of the Faculty of Education, and testing of the developed STEM products and putting them into practice to solve a problem was carried out in an artificial ancient Roman villa constructed in Karamanoğlu Mehmetbey University campus. A picture of the ancient villa is given in Photograph 1.

All project activities were planned by the project researchers. Aligned with a STEM+Archeology education approach, the activities were designed to include science, technology, engineering, mathematics, and archeology aspects. In this context, STEM+Archeology activity templates were created in the course plan suitable for the ninth grade of high school (Appendix 1). The participants were given these activity worksheets and informed about the process. Details about the activity process are presented in the following sections.

Photograph 1. Artificial Ancient Roman Villa

STEM+Archeology Objectives

The objectives, which are targeted by the “Enlighten Roman Tombs with Your Periscope” activity, are presented in Table 1. The standards included in the curriculum of the Ministry of National Education (MoNE) secondary school science, mathematics, technology-design, visual arts, and history courses related to these objectives are given in Table 2.

At the beginning of the activity, a total of four cooperative learning groups of four or five members were formed. Capraro, Capraro, and Morgan (2013) stated that the interdisciplinary work of students in STEM activities is similar to the collaboration of STEM field experts in real life. Accordingly, cooperative learning method was adopted in the activities. Expert trainers provided training related to their areas of expertise for each STEM field.

Table 1. STEM+Archeology Objectives

Science	Designs an imaging tool by considering the principle that light emanating from a source is radiated linearly, using mirrors or lenses.
Technology	Performs the installation of a simple electrical circuit.
Engineering	Performs three-dimensional works using different materials by adding, removing parts and applying force from the inside and outside.
Mathematics	Understands where a right angle can be used in daily life. Recognizes the rectangular prism and its basic elements.
Archeology	Examines the human beings' life style, relationship with nature, and struggle for survival (eating and drinking, dressing and sheltering) with modern approaches by analyzing the material cultural remains from the old settlements.

Table 2. Curriculum Standards

Science F.7.5.3.1.	Correlates the cause of refraction with the change of medium by observing the path followed by the light (MoNE, 2018a).
Technology F.8.7.3.2	Designs a model based on the conversion of electrical energy to heat, light, or motion energy (MoNE, 2018a).
Engineering TT.8.D.1.4.	Builds an original design model or a prototype (MoNE, 2018b).
Visual Arts G.8.1.8.	Makes three-dimensional work using a combination of different techniques and materials (MoNE, 2018c).
Mathematics M.8.3.4.1.	Recognizes the perpendicular prisms, identifies their basic elements, builds and draws their nets (MoNE, 2018d).
Archeology T.9.2.3.	Knows the major civilization basins on earth in the First Age (MoNE, 2018e).

Tools and Materials Used

Tools and materials used in the activity were provided by the project team. These tools and materials are as follows: wood materials (slat, plywood), mirrors (flat mirror), lenses, led lights, battery, cardboard, hot silicon gun, silicone, scissors, quick adhesive, pickaxe, shovel, trowel, storage box (multibox), imitation pitos tomb, imitation wood tomb, imitation artifacts (metal objects, ceramics, coins, etc.), and artificial skeleton.

Introduction to the Activity

This part took 1 hour and was implemented in three stages. Firstly, a physics expert introduced the concept of flat mirrors to the participants and provided information about the use and importance of these mirrors (Photograph 2).

Photograph 2. Briefing by the Physics Instructor

Secondly, the participants explored the path of light. It was discussed that light coming from a source follows a linear path in all directions (Figure 1). Examples were used to scaffold the participants' understanding.

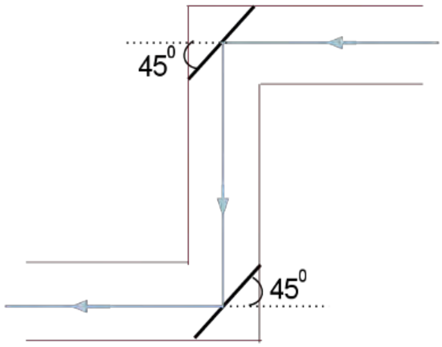


Figure 1. Representation of Light's Linear Path

At this stage, the instructor made a connection between flat mirrors and periscope. The instructor said "The periscopes with mirrors have a working mechanism based on the principle of reflection of light in flat mirrors." He explained that adjusting the tilt angles of the mirrors, allowing light to follow a path in the pipe, and eventually capturing the image are the main elements in the functionality of the periscope.

Thirdly, in an attempt to increase students' motivation, the instructor asked students some questions such as “Has anyone seen or used an actual periscope before? In your opinion, for what purposes can periscopes be used?” Then, the class brainstormed different ideas about the use of periscopes. First, those who had seen a periscope before took the floor. Statements of those who said “I saw the periscope in the museum, it was used in the war.”, “I saw it on a submarine.” were noted on the board. The answers to instructor's question “So, what could be the purpose of the periscope's use in a combat or in submarines?”, such as “To secretly watch the enemy in a battle.”, “To see the surface of the water in the submarine.”, and “To see things that are hard to see.” were also noted. Answers to the instructor's question “Can a periscope be used in dark?”, such as “We can if we add a lamp to light up the space”, “We can, with a flashlight”, “It's possible with the use of batteries and a lamp circuit.” were also noted on the board. Instructor's follow-up question, “So can we design a periscope that will allow us to see objects in a dark, hard-to-reach place?”, was responded by the students “Yes!”, indicating they could do this task. Thus, the participants were motivated and agreed to be part of this study.

The Teaching Process

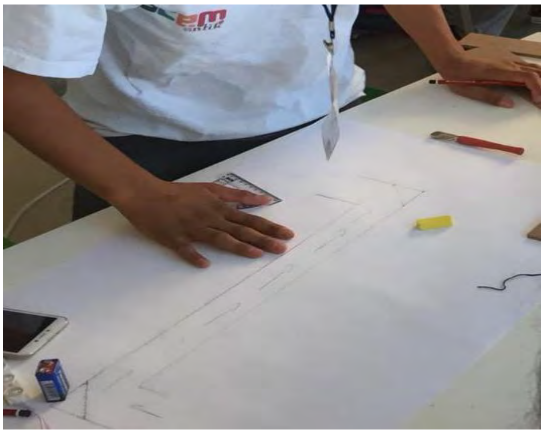
This part took 1 hour and was applied in two stages. In the first step, instructors and students comprehensively discussed how the periscope should have a design in accordance with its intended use. The class agreed that the periscope to be used at the excavation site should be designed in accordance with the conditions of the land. The instructor invited students to share their ideas about the materials that will be used for making a periscope. One of the participants said “We can make it out of cardboard because it's lighter and easier to shape.” and, the instructor's question “So, will a cardboard periscope be durable enough to be used in the field?” was answered by another participant, saying “Let's make it from thin wood, which is both durable and lightweight and easy to shape.” Upon this, the instructor said: “The periscopes will be used to view the interior of the Roman tombs that you will find at the site of the excavation. So, what should be the shape of the wooden periscope to be inserted into the Roman tomb?” Upon this, one of the participants responded, “We can make it cylindrical, the periscopes I saw were all cylindrical.” Another participant said, “It would be difficult to make a cylindrical periscope using wood material, I think we should make it rectangular.” The instructor said “It may be easier to square off a wooden periscope. So before going into design, would you like to see where exactly to use your periscopes, which will be made of wood in the form of a rectangular prism?” The site was then surveyed and the Roman tombs, where the periscopes would be used, were examined (Photograph 3).

Photograph 3. Examination of Roman Tombs for Proper Periscope Selection

Then the instructor said, “As you can see, it's dark inside and the periscope will enter the tomb from an opening of 10*10 cm. I want you to develop your periscopes with that in mind.” Each group was asked to draw periscope schemes, after instructor's statement “Before you start making your designs, I want you to draw the periscope on the paper in front of you.” (Photograph 4).

In the second stage of the teaching process, the drawings were evaluated. The drawing that was most suitable for the land condition (tomb entrance, mirror angles, integration of the circuit to the periscope) was adopted and each group was asked to suggest a model suitable for this drawing (Photograph 5).

Photograph 4. Drawing Stage of Periscopes



Photograph 5. The Periscope Model Deemed Appropriate

Photograph 6. Construction Phase of the Periscopes

In this context, each group combined the pieces of wood they measured and cut, using hot-silicone with the help of trainers and guides (Photograph 6). The participants then adjusted the angles of the mirrors of their periscope, in the shape of two rectangular prisms that passed into each other, together with their group mates. The participating groups tried to design the most appropriate periscope model (length-width-mirror angles-integration of the light circuit) and tested it with the guidance of the instructors. In the instructor's evaluation, the following criteria for the periscopes were taken into consideration: the smoothness of the frame of the periscope (the shape of the rectangular prisms), the angles of the mirrors, the imaging power of the periscope, the mobility of the nested parts, and accurate configuration of the electrical circuit. The periscopes that met the criteria were deemed suitable to be taken to the field. Periscopes that did not meet these criteria were returned to the group and the group was asked to revise their periscope (Photograph 7).

Photograph 7. Evaluation of the Periscopes

Testing

The periscopes developed by the students were taken to Roman tombs for testing. The testing stage took an hour. Without opening the tombs, the periscopes were descended into the tombs from a small opening to identify the findings inside. The group that identified the artifacts in the most accurate way was authorized to open the tomb (Photograph 8).

Photograph 8. Testing the Periscopes

Other groups worked to improve their periscopes, came back to the field, and tested them again. The data on the findings in the artificial Roman tombs observed by the groups with their periscopes are given in Table 3. As shown in Table 3, Group 4 identified the most accurate remains found in the Roman tomb with the periscope they developed. The lighting and mirror angle of the periscope as well as the size of the periscope developed by the group were very effective in identifying the remains in the tomb.

Table 3. Artifacts Identified with the Periscopes

Groups	Skeleton	Tear bottle	Totem	Coin	Ring	Gas lamp	Vase	Total
1	X	-	X			X	X	4
2	X	-	X	X		X	X	5
3	X	-				X	X	3
4	X	-	X	X	X	X	X	6

Evaluation

A focus group interview was conducted with the students who participated in the activities to evaluate the STEM+ Archeology activities. The purpose of the focus group interviews is to obtain in-depth, detailed, and multi-dimensional qualitative information about the views of participants on a particular subject, their experiences, interests, experiences, tendencies, thoughts, perceptions, feelings, attitudes, and habits (Bowling, 2002; Gibbs, 1997). The interviews of the current study were held in two sessions; the first and second groups participated in the first session, and the third and fourth groups participated in the second session. In both sessions, three separate questions developed by the project researchers were asked to the groups using a semi-structured interview form.

The analysis of the focus group interviews is similar to other data collection methods used in qualitative research (Britten, 1995). In other words, analyses are less structured and are more explanatory compared to quantitative studies (Edmunds, 2000). Content analysis is an appropriate method in analyzing the data (Kitzinger & Farquhar, 1999). During the data analysis process, key themes are identified under certain topics when analyzing the data during or after recording (Çokluk, Yılmaz, & Oğuz, 2011). The aim of this type of analysis is to present the findings to the reader in an organized and interpreted form (Yıldırım & Şimşek, 2016). Two researchers coded the data (i.e., the participants' responses to the interview questions) collected in the current study separately. Then, they discussed each code whether there is agreement or disagreement. The reliability formula proposed by Miles and Huberman (1994) was used for the intercoder reliability calculation. According to the Reliability = Consensus / (Consensus + Dissidence) method, the reliability between researchers was found as 0.92 = (66/(66+5)). A consensus for all codes was built through discussion and reflection. Similar codes were put together to form themes. The themes and codes emerged from the analysis of the responses given by the participants are shown in Table 4.

Table 4. Themes and Codes

Themes	Codes	*f*
Contribution of the activity	Permanent knowledge	10
	Usage in different places	12
Challenges encountered	Tiring	9
	Testing stage	13
Opinions about STEM activity	Interesting	8
	Fun	8
	Instructive	6
Total		66

The findings from the analysis of the responses to the interview question "What were some of the contributions of the activity titled Enlighten Roman Tombs with Your Periscope?" are given in Table 4 under the theme "Contribution of the activity." As shown in the table, 10 (45.4%) participants said that the activity provided permanent knowledge about STEM topics, while 12 (54.6%) participants expressed that through participating in this activity they learned that the periscopes could be used in different places.

One of the codes that emerged in the analysis of the answers given to the first question is *permanent knowledge*. For example, the student coded as S2 drew attention to the integration of different disciplines in the "Enlighten the Roman Tombs with Your Periscope" activity and expressed his opinion as "I have gained new experiences with this activity, and learning different courses in an interconnected manner helped me obtain more permanent knowledge." Another student, S6, highlighted *permanent learning* as follows: "We tested our periscope in the excavation area and so we were able to learn by experimenting…What we have learned has become more permanent thanks to using mathematics, physics, technology, engineering, and archeology together while making the periscopes." As seen in these examples, the students stated that they thought that what they learned in the STEM+S activity they attended, was permanent.

Another code that emerged in the answers given to the first question is *usage in different places* and is about learning the different uses of the periscope. In this regard, the student coded as S16 expressed the following views: "Periscope activity taught us the usage areas of a periscope, as well as teaching us how to use a periscope and how to use different branches of science together." Similarly, the participant coded as S8 stated that "We learned that a periscope doesn't just have to be used in submarines or in wars." and S17 said that "It can also be used in archeology through STEM. We can also use it for different purposes."

The frequency distribution of the responses received from the participants to the question "What challenges did you face during the activity?" is shown in Table 4. As seen in Table 4, 9 (40.9%) participants stated that the activity was tiring, and 13 (59.1%) participants said that the process in which the periscope was tested was challenging. Some of the answers given by the participants to this question are given below.

Emphasizing the *tiring* aspect of the activity, the participant coded as S3 stated that "The activity was appropriate for our level but completing STEM activities was exhausting." The participant coded as S10, who emphasized the difficulty of the testing phase of the activity, explained that "We did not have any problems during the periscope construction, it was difficult to view the Roman tombs in the excavation area to test the periscope." The participant coded as S22 shared a similar view by saying "Everything was okay during the activity, we have gained many things, the only thing we had difficulty was having the periscope we developed passed the test."

Another question posed to the participants is "What is your opinions about the STEM activities (considering also the periscope activity)?" The frequency distribution of the responses received from the participants is given in Table 4. As shown in the table, STEM activities were interesting according to 8 (36.4%) participants, were entertaining according to 8 (36.4%) participants, and were instructive according to 6 (27.2%) participants. Some of the answers given by the participants to this question are given below.

The participant coded as S7 stated that the activities are *interesting* and said that "The STEM activities were quite interesting, and the interconnectedness of science, technology, engineering, and mathematics was very educative." As an example of expressions emphasizing the *fun* side of the activities, the statement of the participant coded as S9 can be given. The participant expressed his opinion as "STEM education is very fun and effective, I hope this education would be provided in our schools, too." Among the participants emphasizing the *instructive aspect* of the activities, S17 responded as "We learned by doing and experiencing, it was beneficial. It was instructive. Our view towards the problems has changed." Similarly, S21 explained that "Engineering/design-based activities have contributed to our dexterity. It taught a lot of things. I felt like an engineer." The participant coded as S22 also stated his opinion such as "I acquired interesting information, especially about archeology and engineering."

CONCLUSIONS and SUGGESTIONS

This study examined the "Enlighten the Roman Tombs with Your Periscope" activity, one of the activities in the STEM-ANTIQUE project. The participating students received an integrated STEM+S education in which they designed, made, and tested a periscope to solve an authentic problem related to determining the artifacts in an artificial tomb.

Analysis of the data from the focus group interviews showed that the students were largely satisfied with the activity and considered it interesting and educative. This result is in accordance with many studies reported in the literature (Birinci-Konur, Şeyihoğlu, Sezen, & Tekbıyık, 2011; Keleş, Uzun, & Uzun, 2010; Markowitz, 2004). Based on the responses the students gave to the questions in the focus group interview, it can be argued that learning by doing-experiencing and making connections between different disciplines is an effective approach for students' learning and motivation. We should note that this result is probably not only due to the activity completed, but also due to other project activities such as STEM+ social tasks, field trips, observations, and competitions. It has been reported in some of the studies in the literature that educational camps are fun and that students are in constant communication with each other, thus having a positive effect on their personal and social development (Çelik, 2012; Smith, Steel & Gidlow, 2010; Tatar & Bağrıyanık, 2012).

Data analysis pointed to some aspects of the activity that needs improvement in future implementations. These aspects include the testing phase of the periscope at the excavation site, and the fast-paced work to carry out the test in the time allocated for it. This challenge was also explained by the participants in the focus interview. In future implementations of the activity, students may be given more time to use their periscopes in the excavation site and teachers may scaffold students' work during this testing phase. In multidisciplinary studies such as STEM, instructors, guides, and especially engineers or technicians from different fields should be included since STEM activities are based on engineering and design. In this way, students can work more effectively and efficiently in a more comfortable learning environment during the activities.

Some suggestions can be made in the light of the study findings. The first suggestion is to spend more time on the activity. The activity lasted about 4 hours. Allowing a longer period of time for a multi-disciplinary study such as the activity examined in this paper can make the learning process more effective for the participating students. The second suggestion is to design, implement, and evaluate similar activities for the same age group. The third suggestion is to use the same activity with different age groups and make a comparison with the current implementation. Finally, similar activities can be developed by integrating a different field (e.g., agriculture) into the STEM approach other than archeology.

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Appendix 1

Activity - Enlighten the Roman Tombs with Your Periscope

Part 1		
STEM+Archeology Objectives		***At the end of this course, students***
		Can design an imaging tool using mirrors or lenses based on the fact that light emanating from a source is radiated linearly.
		Can perform the installation of a simple electrical circuit.
		Can perform three-dimensional works using different materials by adding, removing parts and applying force from the inside and outside.
		Understands where a right angle can be used in daily life. Recognizes the rectangular prism and its basic elements.
		Examines the human beings' life style, relationship with nature, and struggle for survival (eating and drinking, dressing and sheltering) with modern approaches by analyzing the material cultural remains from the old settlements.

Part 2	
Basic Tools and Materials Used	• Wood materials (Slat, plywood) • Mirrors (Flat Mirrors) • Lenses • LEDs • Battery • Cardboard • Hot silicone gun • Silicone • Scissors • Quick adhesive • Pickaxe • Shovel • Trowel • Storage box (multibox) • Imitation pitos tomb • Imitation wood tomb • Imitation artifacts (metal objects, ceramics, coins, etc.) • Artificial Skeleton
Implementation of the Activity	
Introduction: 1. A physics expert instructor informs the participants about the basic operating principle of the periscope and the flat mirrors. 2. The instructor asks participants high-level thinking questions related to periscopes in order to increase their curiosity and motivation.	

3. The participants brainstorm on the design of the periscope and the tools and equipment that can be used for making a periscope.

Teaching Process:

1. Each group is asked to draw their own periscope model.

2. The sketches are examined and the instructors and participants determine the most appropriate model for making an effective periscope.

3. All groups create a model with the determined basic characteristics.

Testing:

The periscopes created by the participants are evaluated by the instructors and the appropriate ones are used for observation. The evaluation criteria are as follows:

1. Smoothness of the frame of the developed periscope (shape of the rectangular prism).

2. Angles of the mirrors.

3. The image capturing power of the periscope.

4. Movement flexibility of intertwined parts.

5. And, accurate configuration of the electrical circuit.

The groups take their periscopes to the excavation site to observe the Roman tombs. They test their designs on field.

Evaluation:

Assessment of the created material and activities is done through various measurement tools (such as focus group interview) with students.