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# The Impact of STEM-Based Astronomy Activities on Secondary School Students' Attitudes towards STEM and Astronomy[1]

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## Abstract

STEM (Science, Technology, Engineering and Mathematics) is an educational approach that aims to bring together different disciplines and use the knowledge and skills related to these disciplines to solve the problems encountered in daily life. STEM education supports skills such as creativity, critical thinking, communication skills, problem-solving ability, which we count as important skills for the century we are in. The aim of this study is to determine the effect of STEM-based astronomy activities on astronomy and STEM attitudes of secondary school students. In the study, one group pretest-posttest design was used from experimental designs. In the study, astronomy and STEM attitude scales were applied as pretests to 7th grade students studying at a rural school. The study group consisted of a total of 18 participants, 8 girls and 10 boys, who were determined by convenience sampling method. In the research, which lasted for 4 weeks, preliminary activities were carried out to prepare students for the process before moving on to STEM activities prepared for astronomy subjects. After the preliminary activities, STEM activities related to astronomy subjects were implemented and at the end of the implementation, STEM and astronomy attitude scales were applied to the students again. For STEM activities, knowledge-based life problems were presented to the students, and the students put forward their original ideas about producing solutions to the problem and designing appropriate products. According to the results of the analysis, although there was a positive increase between the STEM attitude scale pretest and post-test scores of the students, there was no statistical difference in their attitudes towards STEM ($p>.05$). According to the pretest-posttest scores of the astronomy attitude scale, a statistically significant difference was found ($p<.05$). According to the results of this research, astronomy activities prepared with STEM-based activities have been effective in developing students' attitude to astronomy.

**Key Words**

STEM education
Astronomy activities
STEM attitude
Astronomy attitude

**About the Article**

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## Introduction

Howard Gardner, the founder of the theory of multiple intelligences, who argued that intelligence consists of various dimensions rather than being a single and dominant character, further argued that it is inevitable to change our current understanding of education with the emergence of new technologies. Gardner said that our children should be equipped with the knowledge and skills to do the jobs that machines cannot do and emphasized that the devices that produce their own energy and make the production they need will not leave work to do to people who have grown up with the educational paradigm of the last 200 years (Gardner, 2004). In this context, the education of generations that adapt to today's changing and developing conditions should focus not only on acquiring knowledge but also on using the acquired knowledge effectively during the solution of the problem they encounter. On the other hand, it is inevitable that the economic development and welfare levels of the nations that keep up with the change of the educational paradigm will increase. The change, transformation and arrangement of new formations in educational sciences to help acquire 21st century skills are related to the need for these skills of the generations of our time. Since the 21st century skills such as critical thinking, collaborating, and leading by making an impact, entrepreneurship and being proactive are regarded as elements universal literacy, the generations that have acquired these skills will be able to shape the future of the world.

It is clearly seen that the traditional education approach's contribution to individuals is limited in gaining universal literacy and acquiring 21st century skills. This situation has led to reforms in educational approaches. Radical changes in the understanding of education have been reflected in the curriculum and therefore, in the teaching methods. Child-centered approaches were preferred to lesson processing methods in which the child's nature, capacity and interest are eliminated, and have become widespread. The STEM education approach has emerged as a contemporary educational approach as a result of the need for individuals who can produce and use knowledge.

STEM education is an educational approach that provides individuals with knowledge and skills by linking the disciplines in it. It has been determined that this approach, which is found to be especially pertinent as a contemporary educational approach for science education classes, increases the interest and motivation of students towards science courses (Yamak, 2014). When we look at the studies carried out in the field of STEM education, which is included in the curriculum of many countries in the world, it is observed that there is a very new field of study and application in our country (Poyraz, 2018). With the spread of STEM education in Türkiye, academic studies in this field have increased with the projects, activities and laboratories established.

Gülhan and Şahin (2016) investigated the effect of the integration of science, technology, engineering and mathematics disciplines on the interests, perceptions, and attitudes of 5th grade students towards STEM fields, and as a result of the research, it was found that the students in the experimental group where STEM activities were applied developed positive attitudes towards these areas. Akgündüz and Özçelik (2017), in their study with students with superior/special abilities, concluded that out-of-school STEM education provided 21st century skills to students in this group and that there was an increase in students' professional orientation towards STEM fields at the end of the activities. Avan, Gülgün, Yılmaz, Doğanay (2017), in their study in which they examined out-of-school learning environments in STEM education, found that the STEM activities applied changed the students' level of using scientific process skills, critical thinking and problem-solving skills, and their interest in astronomy.

In their study, Kırıktaş and Şahin (2019) examined the career interests and attitudes of high school students towards STEM fields in terms of gender and academic success levels in STEM courses, and after the research, it was seen that the career interest of female students studying in high schools was higher than male students, while it was seen that students' interest in these fields decreased as academic success increased. Bircan and Köksal (2020) applied the STEM attitude scale to the students studying at the Science and Art Centers and found that the STEM attitude scores were at a positive level when they interpreted the data obtained from the scale. It is also one of the findings obtained in the study that STEM attitude scores do not show a significant difference between the genders.

The results of the literature study have shown us that the subject of STEM education has been studied intensively in recent years and has become increasingly popular. The sample groups for the studies were generally science teacher candidates, secondary and pre-school students, and academicians. It has been determined that STEM education activities have a positive effect on students' interests and attitudes towards this field. In addition, in the studies conducted with teacher candidates and academicians, it has been stated that there are deficiencies in theoretical and practical training for STEM education during the training process of teachers. On the other hand, it is one of the findings obtained as a result of the literature review that STEM activities with secondary school students are relatively rare in terms of astronomy. STEM education, which is an approach that was put forward under the influence of this race in the 1950s and 60s, when the space race started, is closely related to the field of astronomy (Wissehr, Concannon & Barrow, 2011). It has been statistically determined that STEM education increases professional interests in this field (Alıcı, 2018). From this point of view, it can be deduced that supporting astronomy subject gains with STEM education activities can increase students' interest in STEM professions such as physics engineering, aerospace engineering, and astronaut.

Within the specific objectives of the science curriculum, to provide basic information about astronomy, biology, physics, chemistry, earth and environmental sciences, and science and engineering applications, and to use scientific process skills and scientific research approach in the process of understanding the relationship between nature and human-environment. and producing solutions to the problems encountered in these areas (Ministry of National Education [MoNE], 2018). Astronomy subjects, which are included in the earth and universe subject area of the science course curriculum, have taken their place at every level and students are expected to acquire knowledge and skills in this direction. As mentioned in the curriculum, astronomy is indispensable for science literacy. Astronomy subjects are available at all 3rd ,4th ,5th ,6th ,7th, and 8th grade levels in the curriculum. The first unit of each grade level directly or indirectly consists of astronomy subjects. On the other hand, while the subject area of "Earth and Universe", which includes astronomy subjects, was the place in 2013, it was seen that it was first in the 2018 curriculum (Deveci, 2018). This shows that astronomy education has been given more importance by the Ministry of National Education in recent years.

"Let's Get to Know Our Planet" unit in the 3rd grade science course, "The Earth's Crust and the Movements of Our Earth" in the 4th grade science course, and the "Sun, Earth and the Moon" unit in the 5th grade science course unit, the "Solar System and Eclipses" unit in the 6th grade science course, the "Solar System and Beyond" unit in the 7th grade science course are direct astronomy subjects in the curriculum. The "Seasons and Climate" unit, which is available at the 8th grade level, can be indirectly counted as one of the subjects of astronomy. The existence of astronomy subjects in a total of 32 learning outcomes is an indication that this branch of science cannot be considered separately from the science course (MoNE, 2018). The extensive inclusion of astronomy subjects in the science curriculum has led course teachers and academics studying in this field to seek appropriate methods and techniques in terms of retention in astronomy achievements. STEM applications in the field of astronomy are frequently encountered all over the world from pre-school to high school age, and these applications are also the subject of academic research.

In the study conducted by Styliani, Dratsiou, Panagiotis and Panagiotis (2020), it was assumed that the learning and success of students in this field will be strengthened by enriching with technology integration in STEM disciplines. In the study, first, the students were informed about the subject of the lesson, then an easy-to-apply technological solution was put forward by the teacher, which would enable the subject to be explored creatively, and then the students were expected to produce creative content about the lesson on their own. According to the qualitative findings of the study, the participants welcomed the course topics with enthusiasm and remained engaged in the process. In addition, it has been determined that education enriched with technology leads to successful educational experiences. Kalkan (2018) conducted a trip to Erciyes University Astronomy and Space Sciences department with 24 2nd grade students in order to introduce STEM education and career interest in this field to children in early childhood with field trips. Güngen (2019) argued that camps with STEM education approach could be a solution to the problems encountered in astronomy and space science education, and in this context, he created alternative teaching environments for teachers, students and individuals interested in astronomy, and supported these environments with the website they prepared on the Internet. The

researcher observed that the activities carried out within the scope of these camps prevented students from misconceptions and had a positive effect on their understanding of the concepts of astronomy and space sciences. Okulu (2019), at the end of the study on the development and support of astronomy-based STEM education activities during the education of gifted individuals and teacher candidates, astronomy activities support the science and art center students and science teacher candidates' astronomy knowledge, attitudes and interests towards STEM fields and that observed that it contributes to the permanence of knowledge, attitudes and interests.

Bampasidis, Galani and Koutromanos (2019) investigated the achievements of high school students by participating in a study simulating the Astro Pi competition organized by the European Space Agency. In this context, students were expected to develop a software that would detect the possible effects of the sun on the interior of the International Space Station. The teachers who guided the students throughout the project reported that the students approached the project with enthusiasm, and also stated that the project significantly increased the students' interest in astronomy. The coordinators of the study also stated that the project made the students familiar with scientific knowledge and experiment processes, improved the quality of teaching and resources, had a multidisciplinary content in accordance with the STEM understanding, and developed the skills of students such as teamwork, communication, and presentation.

In his study, Danaia (2006) examined the effect of an astronomy education program, which includes the use of a telescope that can be controlled remotely over the Internet and applied in 30 secondary school schools in different regions of Australia, on students' science perceptions and general knowledge outputs. For this study, qualitative pre-test and post-test tools were developed to measure student attitudes and perceptions before, during and after the program. According to the results obtained from the analysis of the tests, the program implemented had a significant positive effect on both the perception of astronomy and the level of knowledge about astronomy-related subjects. However, the level of effect was not found to be equal between schools. The researcher stated that this difference may be due to variables such as how the program was initially introduced to students and students' access to technological equipment.

When the relevant literature is examined, it has been determined that astronomy-based STEM education applications can be increased, and it is foreseen that a study to be carried out in this direction will contribute to the literature. The fact that it is the only study that measures the attitude of STEM-based activities towards the field of astronomy among other studies on astronomy education published in Türkiye has revealed the originality of the research. In this context, it is aimed that the activities prepared with the STEM approach in this study improve students' attitudes towards astronomy and STEM fields, develop solutions to problems related to astronomy and apply the solution. In line with the acquired purpose, the sub-problems of the study are listed as follows:

1. Is there a significant difference between the pre-test and post-test results of the students who experienced Astronomy-Based STEM Activities in the "Attitude Towards STEM" scale before and after participating in STEM applications?
2. Is there a significant difference between the pre-test and post-test results of the students who experienced Astronomy-Based STEM Activities in the "Attitude towards Astronomy" scale before and after participating in STEM applications?

## Method

In the research, one-group pre-test-post-test design, one of the experimental designs, was used. In this design, the effect of the process on the group is tested with a study on a group. Unlike one group post-test model, in this model, the group is administered both before and after the procedure (Büyüköztürk, 2013). During the research process, the STEM Attitude Scale and the Astronomy Attitude Scale were applied to the students twice, at the beginning and at the end of the study. During the application, the students filled out the knowledge acquisition diaries, activity diaries and the product development diaries, so that their activities were carried out more systematically and in a planned manner. According to the pretest-posttest results obtained from the application, the sub-problems of the research were evaluated. The students were not informed about the details of the research before the application. Thus, it is aimed that the research results do not affect the student performance and the

research results. A four-week break between the pre-test and post-test was given to prevent students from becoming familiar with the test questions.

***The Study Group***

The study group of the research consists of 7th grade students studying at a Secondary School affiliated to the Midyat District Directorate of National Education in the Fall semester of the 2019-2020 Academic Year. The group consists of 8 girls and 10 boys. The parents of the students constituting the study group are primary school graduates and the number of siblings is 4 or more. The study group was selected by convenient sampling method. Convenient sampling method may be preferred in cases where it is difficult to select the study group with random or systematic non-random techniques (Fraenkel et al., 2012). This method is economical and fast. It is easier for the researcher to access the sample than other sample selection methods. Considering the general demographic characteristics of the students in the study group, it can be said that they are from the families with low socio-economic status in general. In addition, it can be said that students' reading and reading comprehension skills are weak.

Students in the study group are subject to the Science Curriculum prepared by the Ministry of National Education. The age group of students, secondary school level is one of the most appropriate age levels for developing interests and attitudes towards STEM fields and making professional orientation in this direction (George, Stevenson, Thomason & Beane, 1992). The applications for the students took place in the classroom environment during the class hours. Before starting the research, the students and parents who will participate in the research were informed about the research and the "Voluntary Participation Form" was filled. The applications were conducted by the researcher himself. The researcher was responsible for all the processes related to the courses for 4 weeks.

***Data Collection Tool***

In this study, the "STEM Attitude Scale" developed by Lin and Williams in 2015 and adapted to Turkish by Hacıömeroğlu and Bulut in 2016 for validity and reliability studies was applied to determine students' attitudes towards STEM. The scale is a 37-item and 5-factor Likert-type scale consisting of Science, Mathematics, Engineering and 21st Century Skills sections. 7 points were determined in the evaluation of the answers given by the students regarding the scale. These points were used as strongly disagree, disagree, partially disagree, undecided, partially agree, agree and strongly agree. The scale was applied both at the beginning and at the end of the process. The reliability of this scale, which was adapted into Turkish, was calculated as .94 (Hacıömeroğlu & Bulut, 2016).

The "Astronomy Attitude Scale" was used to determine students' attitudes towards astronomy. The scale indicates 10 negative, 5 positive statements and 15 judgments in a five-point Likert type. Each item is numbered from 1 to 5, from negative to positive attitudes of students towards astronomy. They are 1; strongly disagree, 2; disagree, 3; undecided, 4; agree, 5; I strongly agree. The astronomy scale was 75 points in total. It was developed by Zeilik, Schau and Mattern (1999) and adapted into Turkish by Bilici, Armağan, Çakır, and Yuruk (2012). In the study, the coefficients of the internal consistency and sub-factors of the scale were determined. The reliability coefficient was found as α=.80. Considering the reliability coefficient, since this value is well above .70, it was decided that the measurement tool had sufficient reliability and was used to collect data (Büyüköztürk, 2011). When the reliability levels of the sub-factors were examined, it was determined that the sub-factors were quite reliable (α=.71 and α= .77) (Alpar, 2003)

***Research Plan and Implementation Steps***

In the study, which was carried out as a group study, the data collection tools "STEM Attitude Scale" and "Astronomy Attitude Scale" were applied to the 7th grade students at the beginning of the process. Students were given forty minutes to complete the scales. The scales were applied in the classroom. After the scales were collected, the experimental applications part of the research started. Before the activities, the students were informed by the researcher about the basic features of the planets and their satellites in the Solar System, their sizes and distances to be compared with each other by scaling, and about other small celestial bodies in the Solar System (dwarf planets, meteorites, asteroids, comets, etc.). Before moving on to STEM-based activities, several preliminary activities were carried out to motivate students, engage them in astronomy subjects and attract their attention. As a result of the

preliminary astronomy activities carried out before the implementation of the activities prepared with the STEM education approach, the students became aware of what task they could undertake in the other activities in the group, and it was observed that the students were motivated for other activities.

In the experimental applications part of the study, after the preliminary activities, the STEM-based activities part started. In this part of the study, theoretical information was given to the students and videos related to the subject were watched. Afterwards, the students were presented with scenarios, and they were asked to consider the information they learned in astronomy lessons while solving the current problem in the given scenario. Students were asked to choose a profession and a task for each group. The groups were asked to do research to find a solution to the problem, to fill in the knowledge acquisition diaries, and after the necessary information was gathered, they were asked to create their products by making a group discussion, using the materials provided and considering the limitations. Afterwards, the product development diaries were distributed to the students, and the students were provided to draw the product they designed, test it in the process and report it. The materials were distributed to the groups by the researcher, and under the supervision of the researcher, the groups were enabled to design products using STEM disciplines. Student Activity Diaries were distributed to the students at the end of the activity and students were asked to fill them in individually. Thus, STEM-based activities finished. After four weeks, "Astronomy Attitude Scale" and "STEM Attitude Scale" were applied to the study group and the application process of the study was completed.

***Analysis of Data***

In order to determine whether parametric tests or non-parametric tests will be used in the analysis of the data, the normality of the data was checked. While analyzing the normality of the data, "Kolmogorov-Smirnov" and "Shapiro-Wilk" test values are examined. It is appropriate to use the "Shapiro-Wilk" test if the number of data used in these tests is 50 or less, and the "Kolmogorov-Smirnov" test if the number of data is 50 or more (Büyüköztürk, 2018). Since the study group of this study was less than 50 people, the homogeneity of the data was examined according to the results of the "Shapiro-Wilk" test. According to the results obtained, non-parametric tests were used within the scope of the study. The difference between the total score of the astronomy scale and the sub-dimension scores of the STEM scale and the pre-test and post-test means of the total scores were determined with the Wilcoxon Signed-Rank Test. W-statistics are used to estimate the normal distribution for dependent measures (paired samples) in large groups of more than 10. W-statistics is a non-parametric alternative to the t-test, and multivariate normality conditions are not required in this method. In the study, the limit of statistical significance was accepted as $p<0.05$. All statistical analyzes were performed using the SPSS package program.

## Results

In this section, the findings of the statistical analysis of the sub-problems put forward for the purpose of the research are given and interpreted in the form of tables. This way is more reader-friendly.

**Table 1.** Pretest-posttest scores of the participants' attitude towards STEM scale

| | N | Mean | Standard deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|
| STEM Math pre-test | 18 | 29.78 | 7.62 | 30.00 | 16.00 | 40.00 |
| STEM Math post-test | 18 | 30.72 | 4.85 | 29.00 | 25.00 | 40.00 |
| STEM Science pre-test | 18 | 35.72 | 8.33 | 36.50 | 14.00 | 45.00 |
| STEM Science post-test | 18 | 39.39 | 5.27 | 40.50 | 25.00 | 45.00 |
| STEM Engineering pre-test | 18 | 33.06 | 8.63 | 33.50 | 13.00 | 45.00 |
| STEM Engineering post-test | 18 | 38.06 | 4.56 | 37.50 | 29.00 | 45.00 |
| STEM 21st Century Skills pre-test | 18 | 44.17 | 9.18 | 45.50 | 19.00 | 55.00 |
| STEM 21st Century Skills post-test | 18 | 47.17 | 6.16 | 47.50 | 28.00 | 55.00 |
| STEM total pre-test | 18 | 133.89 | 27.82 | 139.00 | 50.00 | 167.00 |
| STEM total post-test | 18 | 147.78 | 16.18 | 150.50 | 106.00 | 171.00 |

To give the answer to the sub-problem "Is there a significant difference between the pre-test and post-test results of the students who experienced Astronomy-Based STEM Activities in the "Attitude Towards STEM" scale before and after participating in STEM applications?", Attitude towards STEM scale was applied at the end of the activities and the data were given in the Table 3. The mean, standard deviation, minimum and maximum values of the total scores taken from the scale of attitude to the disciplines of the students are included.

The Wilcoxon Signed-Rank Test results, which were conducted to determine whether the attitudes of the students in the study group regarding Science, Mathematics, Engineering and 21st century skills disciplines show a statistically significant difference before and after participating in STEM-based astronomy activities are given in Table 2. According to the results obtained from the test, the p value calculated for the mathematics discipline is 0.48, d for the science discipline is 0.15, for the engineering discipline is 0.05, and for the 21st century skills is 0.36. If the p value found in a test result is less than 0.05, it means that there is a significant difference in the comparison result. Statistical analysis at the end of the study showed that there was no significant difference between the pre-test and post-test in STEM fields. The significance trend (borderline significance) can be interpreted for the p value calculated for the engineering discipline (Kul, 2014).

**Table 2.** The Wilcoxon Signed-Rank test results of secondary school students' attitude towards STEM scale pretest and post-test scores

| | | N | Rank average | Rank total | Z | p |
|---|---|---|---|---|---|---|
| STEM Mathematics Field | Negative Ranks | 9 | 7.72 | 69.50 | -0.69 | 0.48 |
| | Positive Ranks | 9 | 11.28 | 101.50 | | |
| | Equal | 0 | | | | |
| | Total | 18 | | | | |
| STEM Science Field | Negative Ranks | 4 | 8.75 | 35.00 | -1.42 | 0.15 |
| | Positive Ranks | 11 | 7.73 | 85.00 | | |
| | Equal | 3 | | | | |
| | Total | 18 | | | | |
| STEM Engineering Field | Negative Ranks | 4 | 8.88 | 35.50 | -1.94 | 0.05 |
| | Positive Ranks | 13 | 9.04 | 117.50 | | |
| | Equal | 1 | | | | |
| | Total | 18 | | | | |
| STEM 21st Century Skills Field | Negative Ranks | 7 | 7.21 | 50.50 | -0.90 | 0.36 |
| | Positive Ranks | 9 | 9.50 | 85.50 | | |
| | Equal | 2 | | | | |
| | Total | 18 | | | | |
| STEM Total | Negative Ranks | 6 | 8.08 | 48.50 | -1.61 | 0.10 |
| | Positive Ranks | 12 | 10.21 | 122.50 | | |
| | Equal | 0 | | | | |
| | Total | 18 | | | | |

*p <.05

To give the answer to the sub-problem "Is there a significant difference between the pre-test and post-test results of the students who experienced Astronomy-Based STEM Activities in the "Attitude towards Astronomy" scale before and after participating in STEM applications?", the Astronomy Attitude Scale was applied at the end of the activities and the data were results in the Table 3 and Table 4.

**Table 3.** The participants' pre-test post-test scores of astronomy attitude scale

| | N | Mean | Standard deviation | Median | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Astronomy pre-Test | 18 | 66.06 | 13.27 | 67.50 | 43.00 | 87.00 |
| Astronomy post-Test | 18 | 78.17 | 8.97 | 80.50 | 53.00 | 89.00 |

The findings obtained as a result of the Wilcoxon Signed-Rank Test are given in Table 4. When the table was examined, the obtained p value was found to be 0.02. A statistically significant increase was observed in the mean score of the astronomy scale before and after implementation. After showing the statistically significant significance with the P value, whether the difference between the two test results was significant or not was examined by effect size analysis. The Cohen d value was taken into account in the calculation of the effect size. In the calculation, the d value was found to be 1.06. If this value is 0.80 and above, it is considered a big effect and expresses the strength of the relationship between the variables. With the effect size analysis, it was once again determined that the difference in score values on the astronomy attitude scale was not accidental and could be attributed to STEM education.

**Table 4.** Wilcoxon Signed-Ranks Test results of secondary school students' astronomy attitude scale scores after pre-test and post-test

| | | N | Rank average | Rank total | Z | p |
|---|---|---|---|---|---|---|
| Astronomy | Negative Ranks | 6 | 5.33 | 32.00 | -2.33 | 0.02* |
| | Positive Ranks | 12 | 11.58 | 139.00 | | |
| | Equal | 0 | | | | |
| | Total | 18 | | | | |

## Discussion, Conclusion and Recommendations

The history of astronomy began when human began to wonder, dream and think, and has continued to exist from primitive times to the present day. The subjects of interest of the science of astronomy have always been interesting for humanity, and the interest of humanity has always continued to develop in the end. It is also associated with other disciplines such as astronomy, mathematics, engineering, technology, which help us to better understand the functioning of the Earth and the universe. The accumulation of many technologies, coding, knowledge, and skills developed for astronomy and space exploration has fed and even formed the basis of other fields in most developed countries. For example, fields such as medicine, industry, communication, energy, defense industry are among the fields that have developed thanks to the developments in astronomy and space research (Aslan, 2020).

The fact that astronomy science is so important has led to the need for astronomy education to be included in the curriculum, and in this direction, astronomy science has found its place in national and international education programs. When the TÜBİTAK (The Scientific and Technological Research Council of Türkiye) 2018-2022 strategic plan is examined in our country, it is emphasized that projects for the rapid development and promotion of astronomy, space sciences and aviation technologies should be supported. The Ministry of National Education has increased the number of achievements related to astronomy in the curriculum by becoming the units related to astronomy and space sciences bearing the subject name "Earth and Universe" in the Science Curriculum into the first units of the science course. It is known that questioning-based, activity-based or applied teaching and learning activities are more effective in terms of providing students with the subjects in the curriculum in contrast to traditional methods. STEM education, which is one of the educational approaches that is increasing in popularity today and actively involving students in the learning process, is one of the methods used to make astronomy education meaningful.

The main purpose of this study is to determine the effect of astronomy-based STEM activities on students' attitudes towards astronomy and STEM. For this purpose, knowledge-based life problems related to the learning outcome of "Students will be able to describe the causes of space pollution and determines the possible consequences that this pollution may cause." In "Solar System and Beyond"

unit and STEM-based activities related to these achievements were applied. In order to test the effectiveness of the activities, attitude scales were applied to the students before and after the process, and during the activity process, the students were asked to fill out the knowledge acquisition diaries, the product development diaries and student diaries. Students used their own creativity to put forward solutions and products in the face of a given problem and at the end of the process, original products produced by STEM-based activities were revealed.

In the research, "Attitude Scale Towards STEM" was applied to the students before the activity and thus the students' prior knowledge against STEM disciplines was checked. Later, STEM activities prepared in relation to astronomy subjects were carried out by the students. While the activities were carried out, the students were expected to find solutions to the knowledge-based life problem given and to create their designs in this direction. At the end of the activities, the Attitude Scale towards STEM was re-applied to the students and subjected to statistical analysis together with the test at the beginning of the research.

When the findings obtained as a result of the study were examined, although there was a significant difference between the pretest and posttest score means in favor of the post-tests, there was no statistically significant difference in the attitudes of the students towards STEM. For the difference between pre-test and post-test in the field of Engineering from STEM disciplines, it was interpreted as a statistically significant trend. In their study, Selvi and Yıldırım (2017) found that there was no difference between the STEM attitude scale post-test scores of the group subject to the research. The reason why there is no significant difference between students' STEM attitude scores may be that the students' academic achievement levels in science and mathematics courses are moderate. In previous studies, it has been revealed that the attitudes of students with high academic success in mathematics course towards this course are also at a high level (Kalın, 2010; Kutluca, 2017; Sezgin, 2013 as cited in Tabuk, 2019). Baş and Şentürk (2016) revealed that there is a significant relationship between students' science attitudes and academic achievements in science courses. In the studies conducted with especially talented children studying in Science and Art Centers, it was seen that these students' academic success in Science and Mathematics fields was high and their attitudes towards STEM were also at a high level (Bircan and Köksal 2020; Yazar, 2019).

The data obtained as a result of the Astronomy Attitude Scale applied to the students at the beginning and end of the activity were interpreted as a result of statistical analyzes and a significant difference was determined between the pretest and posttest scores. The activities positively increased the students' attitudes towards astronomy. The statistically significant change in the Astronomy Attitude Section is in line with expectations. The activities were carried out with limited time and facilities and were limited to the field of astronomy in accordance with the purpose of the study. Therefore, it can be said that similar activities should be multiplied in order to identify a significant change in other attitude scales. However, activities focusing on the field of subordinate astronomy quickly had a positive effect in the study group and a statistically significant and positive change was observed in the group's attitude towards astronomy. At the same time, in astronomy courses taught through presentation, students thought of astronomy as a field that they could never learn and experienced that space was not actually a difficult area to access with the concrete products they produced as a result of the activities. In previous studies, the attitude of astronomy has been measured by different activities. It has been seen that authentic learning activities have a great impact on students' attitudes towards astronomy (Arslan et al., 2020). In another study, it was seen that the method of learning by doing and experiencing increased the attitude of astronomy in 5th grade students (Doğaç and Gök, 2020). Taşcan (2019) found that science activities developed on astronomy had a positive effect on the spatial skills and academic achievements of 5th grade students. Güngen (2019) stated that STEM activities prepared with astronomy and space sciences-based applications, together with their implementation in astronomy camps and workshops, encourage individuals to develop innovative ideas for astronomy. Considering the results, our recommendations to obtained from researchers who want to conduct studies on the research subject are as follows;

- The study was limited to the 7th grade Science "Solar System and Beyond" unit. Taking into account the data obtained as a result of the study, STEM lesson plans for other astronomy subjects can be prepared and applied to improve students' attitudes towards astronomy.

- The number of the study group remained limited, so the study group could not be divided into experimental and control groups. The sample size may be increased in future studies.
- While designing STEM activities, considering that the living space of the students is a village and that the study is carried out in a village school without a laboratory, the students are expected to carry out the activities with easy-to-reach materials. Researchers can use coding and robotics for STEM-based activities to implement.
- The inclusion of an academician, astronomer or aerospace engineer specialized in astronomy in the research environment can make the process more interesting and enjoyable for students.
- The researcher can expand the scope of the study by adding a descriptive analysis dimension to the study by using the statements in the student activity journals to be filled out by the students in the study.

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