

The Impact of STEM Applications on Gifted Primary Students¹

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Abstract: The aim of the research is to identify the impact of STEM applications developed by researchers on the basic STEM skills, STEM-oriented attitudes, and problem-solving skills of gifted primary school students. Our research was designed by sequential explanatory design, one of the mixed research designs. For the quantitative part of this study, a pretest-posttest quasi-experimental design was preferred but having a control group. And the qualitative part also was planned as a case study. The study group of the research consists of 20 gifted primary school students in 4th and 3rd grade, each of them has been diagnosed in the field of common talent and benefiting from the Science and Art Centre. The STEM activities applied in this research were designed according to the approach with project-based learning. The STEM activities planned up to the project-based learning approach are planned as 9 activities within the 10-week training plan. In the first week, general explanations and preparations regarding the activities were made. One STEM event is scheduled for each week as a group event, while a single STEM event is scheduled for Weeks 8 and 9. In the education plan, the activities in the first 7 weeks were designed as teamwork, discovering problems from daily life, developing sample solutions to problems, showing the models of their solutions with Legos, while the activities in the last 3 weeks were designed for students to create and present their own original products as a group. The data collection tools in the implementation process were preferred Problem Solving Inventory for Primary School Children; Problem Solving Inventory for Primary School Children ($\alpha=0.85$), STEM Skill Levels Perception Scale ($\alpha=0.940$), STEM Attitude Scale ($\alpha=0.89$) and Semi-Structured Interview Form were used. Dependent Sample t-Test analysis, one of the percentages, frequency, and parametric tests, was utilised in the analysis of the data, and the content analysis method was applied over the analysis of the qualitative data. As a result, it was determined that STEM applications contributed significantly to gifted students' STEM skills, attitudes towards STEM, and problem-solving skills. Up to the students' interviews, it was concluded that gifted students had positive thoughts about STEM applications.”

Keywords: *STEM, Gifted Primary Students, Educational Robot Sets.*

1. INTRODUCTION

It can be said that individuals with special abilities (gifted) and making a difference in the rapidly changing world are at the forefront. It has been aimed, as it was in the past, to benefit from individuals with special talents who attract attention with their special skills and who have come to the forefront with their potential in many fields such as art, science, leadership,

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economy, and sports (Baykoç, 2004). It is stated that individuals with special abilities, expressed as potential; with their creative and innovative ideas take part in the society as leaders, problem solvers and persons who contribute to development. (Akarsu, 2004). The characteristics of individuals with special abilities such as rapid learning, curiosity to learn, creativity, in-depth research and high motivation have higher potential than their peers are highlighted in many scientific papers (Davis, 2006). Although expressed in different ways in various researches, in general, individuals with special abilities are defined as individuals who are beyond of their peers with their characteristics such as intelligence, productivity, problem solving and creativity, who differ significantly and have potential. (Robinson et al., 2014; Davis, 2013). Apart from this definition, it is also remarked that individuals with special abilities are individuals with high levels of language skills. (Clark, 2015). The Ministry of National Education has announced that students with special abilities are "faster learners than their peers; leadership capacity, creativity, art, in the forefront, own special academic ability, comprehends abstract ideas, cares for acting independently in areas of interest and performs at a high level". (Turkish Ministry of National Education 2019). In addition to these characteristics, individuals with special abilities perform some differences compared to other students in the classroom environment with their faster comprehension and productivity skills. (Dağlıoğlu, 2010).

Although students with special abilities own different performance, they must receive education both in the same educational environment and at the same level with the similar teaching techniques and methods as their peers. (Levent and Bakıoğlu, 2013). The educational needs of the gifted, who exhibit differences such as learning faster than their peers and being higher in academic achievement, under these conditions, cannot be met properly (Tomlinson and Alan, 2000). This situation has made it obvious that a differentiated program should be implemented outside the normal curriculum to supply the educational needs of students with special abilities and to perform their abilities. (VanTassel-Baska and Stambaugh, 2005). A differentiated curriculum allows students with special abilities to use their high-level cognitive skills effectively; are expected to develop productivity, creativity, and leadership qualities, as well as to research real-life problems and produce solutions (Tezci and Gürol, 2003). Differentiation of education is only possible with teachers who enrich education and training programs with different methods and who can carry out interdisciplinary studies (Sak, 2011). The purpose of enrichment by Cutts and Moseley (2004) means that is to fully use skills and abilities, to expand knowledge, to deepen understanding, to enhance motivation, to improve thinking, to encourage and to contribute creativity.

In the Science and Art Centres in which specially, high talented students undergo some more supportive education in Türkiye, training programs are enriched, releasing a product and management program are included, and a special emphasis is placed on project-based education in the centres (Turkish Ministry of National Education, 2019). To be able to develop the prominent characteristics of students with special abilities in literature review; teaching and learning with project-based are likely to be possible through the use of methods that allow both individual and group learning, such as collaborative learning, problem-based

learning and STEM (Kazu and Şenol, 2011). STEM is an educational approach that allows students to investigate and question daily life problems with project-based/problem-based learning method and to produce solutions by using their mathematical, scientific, and technological knowledge together (Sanders, 2009). With STEM education, it is aimed that students can use different course jointly such as maths, science, engineering, technology, and develop skills of 21st century such as research, questioning, problem-solving, creativity, productivity, communication, information literacy (Meyrick, 2011). It is also aimed that students can use their existing knowledge, transfer this information to different areas, integrate it and use what they have learned over everyday life with STEM Education. (Akgündüz et al., 2015.)

With the STEM approach, the disciplines of maths, science, technology, and also engineering are handled in a holistic view, an interdisciplinary educational environment is offered, and it is aimed for students to find some solutions for daily life problems by objectives of these disciplines (Moore, Stohlmann, Wang, Tang and Roehring, 2014). STEM Education, which stands out worldwide, is an educational approach first introduced in the United States in order to increase the declining interest in the fields of engineering and technology, to ensure that students are more oriented to these fields, to move the basis of technological and engineering studies to educational environments (Dugger, 2010). STEM education takes its name from the first letters of the English equivalents of the words: science, technology, engineering and maths, while STEM education in Turkey is called as FeTeMM, which is the equivalent of the fields of Science, Technology, Mathematics, Engineering (Çorlu, 2014). STEM is an implementation that allows students to use different disciplinary fields such as mathematics, science, engineering and technology jointly from the first level of education, but in STEM education, all four basic disciplines can be practiced together, or an interdisciplinary approach can be performed with only two disciplinary areas (Hacıömeroğlu and Bulut, 2016). STEM Education, which of the fields of Science, Technology, Maths and Engineering are embraced in a holistic manner, is one of the educational approaches that countries want to implement primarily in today's world due to the skills of this century such as problem solving, high-level thinking, research, questioning and productivity that it provides to individuals (Furner and Kumar, 2007).

Today, along with the United States, countries such as China and India attach importance to the development of science, technology, mathematics and engineering skills of persons to prepare for the global market (National Research Council, 2007). Educators, business leaders see STEM education initiatives as a national strategy in education to engage students, increase students' STEM achievement, increase the number of students involved in a STEM education program, the number of graduates in the STEM field, the number of citizens working in STEM-related fields (National Science Board, 2007; Park, 2011). The initiation of STEM education initiatives at the middle grade levels, and the lack of early exposure to STEM education at the primary grade level is seen as a missed opportunity for students to mobilize their interests and achievements (Russell, Hancock and McCullough, 2007). Many studies emphasize the significance of incorporating STEM Education into the primary grades (Brenner, 2009; Bybee and Fuchs, 2006). Initiating STEM education at the primary level

positively which includes student-oriented problem solving affects the self-confidence of primary school students and enables them to gain self-efficacy in STEM courses in the future (DeJarnette, 2012). According to research, it is examined that students may improve a positive attitude towards courses, achieve the desired success in academic courses STEM education influences students positively over the development of skills for 21st century and students' future career choices. (Yıldırım, 2016; Elmalı and Balkan Kıyıcı, 2017). To provide these skills in early ages to students, it seems necessary to design STEM-oriented activities in the courses (Dugger, 2010). According to Donawa (2009), in educational environments where STEM activities are applied, students use the skills of reaching the whole, interpreting, analysing, effective reasoning, correlating the knowledge they have, systematic thinking and evaluation skills by combining the parts according to the problem situation while producing solutions to problems requiring engineering skills. With STEM activities, students conduct research while seeking for effective and innovative solutions to daily life problems, create designs in line with the information they have obtained as a result of research, and perform new learnings both in the design creation process and in the process of testing and evaluating products. (Crismond and Adams, 2012).

Considering the developed countries around the world, it is observed that they mostly include STEM education applications based on science, mathematics, technology, and engineering disciplines in their education systems to increase the number of individuals with today's skills who are able to find some innovative solutions to problems (Tekbıyık and Çakmakçı, 2018). Today, when technology, innovation and science are at the forefront, STEM Education based on the development of 21st century skills come to fore to provide qualified human resources by acting significant role in the development of countries (Banks and Barlex, 2014). According to Clinkenbird (2007), considering the outstanding performance and creativity of gifted individuals in art and science, STEM activities should be included in the education of gifted students to provide high-level benefit from gifted individuals in the increase of qualified manpower and the development of countries. STEM education is an educational practice that offers different and flexible working environments that allow students with special abilities to deepen on a problem, reveal their existing talents, put forward their innovative and creative ideas, conduct research on a subject they are curious about, and produce new and original products (Lee, Baek and Lee, 2013). When the STEM Education Turkey Report is examined, it is seen that there are only schools that provide STEM education, although not in all states of America, and that these schools provide education to students with special abilities (Aydeniz et al., 2015).

STEM Education, which includes different learning opportunities such as acceleration, enrichment strategies, in-depth research, project studies, group studies, use of technology, original product design, presentation, expert interviews, collaboration, which are recommended in the trainings of special gifted students, is useful tool over the education of these specially gifted students (Lee et al, 2012). According to Barış and Ecevit (2019), STEM activities positively affect the use of different disciplines together and participation in scientific studies by students with special abilities who are interested in science and who like to observe research. It is highlighted that the activities for STEM applications provide

opportunities for special gifted students to use skills such as research and inquiry, scientific thinking, producing solutions to problems, designing original products suitable for the solution, collaborating, and positively affecting the STEM skills of special gifted students (Şen, 2018). gifted students want to show what they know, put it into practice, produce, work in the fields of science, experience it in line with their interests, and it is seen, at this point that STEM education, which offers special gifted students the opportunity to participate in scientific studies, show what they know, and experience is useful (NRC, 2011).

It is seen that the development of the prominent characteristics of students with special abilities will be possible by using methods that allow both individual and group learning such as STEM (Kazu and Şenol, 2011). This research is remarkable in point of giving the opportunity to use leadership qualities of students with special abilities who have high leadership qualities compared to their peers while working collaboratively. Activities for STEM applications were implemented to develop engineering, science, mathematics, and technology skills of students with special abilities, to give them the opportunity to use their skills such as problem solving, creativity, collaboration, research inquiry, design, and to enable them to notice and reveal their skills and talents for STEM. The aim of this study in this context, was determined as the impact of STEM applications on the basic STEM skills, attitudes towards STEM and students' problem-solving skills of gifted ones in the primary school.

1.1. Problem

What is the impact of STEM implementations on the basic STEM skills, STEM-oriented manners, and problem-solving skills over gifted primary school students?

1.2. Sub Problem

1. Do STEM practices contribute to students' basic STEM skills?
2. Do STEM practices contribute to students' attitudes towards STEM?
3. Do STEM applications contribute to students' problem-solving skills?
4. What are the students' thoughts on STEM practices?

2. METHODOLOGY

2.1. Research Model

This research was planned as a sequential explanatory design, one of the mixed research designs. Qualitative and quantitative data of the study were collected within this frame, but their analyzes were carried out separately. Quantitative data in the sequential explanatory pattern, takes precedence and qualitative data is collected to strengthen the quantitative data and the correlations of the data to each other is discussed in the discussion part (Creswell, 2003). The pretest-post-test semi-experimental design without control group in the quantitative part of the study was preferred. Although the semi-experimental pattern, which is mostly preferred in educational researches, shows parallel features to the experimental

pattern, the random determination of the participants also distinguishes the semi-experimental pattern from the actual experimental pattern (Balci, 2001). As regards of the qualitative part of the research, the case study was put to work. Researcher collects data, observes, interviews, and makes in-depth investigations in the real research environment, deciding who to meet in the process and how to manage the research process in a case study. (Creswel, 2007).

2.2. Study Group

This study was applied to 20 primary school students who have enrolled to The Science and Art Center affiliated to Samsun Provincial Directorate of National Education within the scope of the support education program in the 2021-2022 academic year. Easy access method was used to determine the study group. Students who receive their education in different primary schools throughout Samsun city, participated in the Individual Assessment Examination in one or more of the fields of general mental ability, visual arts, and music in order to be entitled to register the Science and Art Center. According to the results of the evaluation, all but one of the students in the study group were titled only in the field of general intellectual ability and were included in the Science and Art Center support education program. The one student was identified as having talent in both general intellectual ability and music. Fourteen of the students who attended the support education program and constituted the study group of this research are attending the fourth grade of primary school and each of them is 10 years old. The other 6 students are in the 3rd grade of different primary schools and each of them is nine years old. Twelve of them were male and eight were female.

2.3. Data Collection Tool

Problem Solving Inventory for Children at the Level of Primary Education: The Problem-Solving Inventory for Elementary School Children was performed to test the problem-solving skill levels of the participants. The scale was developed by Serin, Bulut, Serin and Saygılı (2010). Its validity and reliability analyses were carried in line with the data collected from a total of 568 students studying in the 8th grades of primary schools from different regions affiliated to Izmir Directorate of National Education. 50.18% of the study group were female students and 49.82% were male students. The scale is formed on a 5-point Likert scale and consists of 3 factors. To the results of the exploratory and confirmatory factor analyses of the scale, it shows the scale consists of 3 factors and the factors explain 42.26% of the total variance. It was found that the first factor added to the total variance by 19.77%, the second factor contributed to the total variance by 12.99% and the third factor contributed to the total variance by 9.49%. The Cronbach's Alpha reliability coefficient defined to determine the reliability of the scale was calculated as 0.85. It has been seen that the scale, which has a reliability coefficient of more than 0.70 for each factor, is valid and reliable thanks to the internal consistency and stability analyses performed.

Basic STEM Skill Levels Perception Scale: The STEM Skill Levels Perception Scale (SSLS) (SBDÖ) was used to measure the STEM Skill Levels of the participants. The scale was developed by Korkmaz, Çakır and Uğur Erdoğan (2021). The original form consists of 7-

point Likert-type, 3 factors and 43 items. High school and university level achievements items in the item pool in the original scale were removed during the adaptation study of the scale for secondary school students and the STEM Skill Level Scale having of 23 items and 3 factors was formed. As a result of the Exploratory and Confirmatory Factor Analysis of the scale, it is seen that the scale includes of three factors, and the scale items and factors explain 52.23% of the total variance. The first factor, science, contributed 22.067% of the total variance, the second factor, engineering, and technology, contributed 16.30% and the third factor, mathematics, contributed 13.2%. The Cronbach's Alpha reliability coefficient was determined as 0.940.

Students' Attitudes Toward STEM Education Scale: The STEM Attitude Scale was used to identify of the participants' attitudes towards STEM. The scale was developed by Yılmaz, Yiğit Koyunkaya, Güler, Güzey (2017). Up to the results of Exploratory and Confirmatory Factor analysis, the STEM Attitude Scale adapted to Turkish from the scale developed by Guzey, Harwell and Moore (2014) consisted of four factors and all of the factors explained 48.10% of the total variance. The Cronbach's Alpha reliability coefficient of the scale was determined as 0.89.

Semi-structured Interview Form: Researchers preferred a semi-structured interview form with nine questions in the qualitative dimension of the study to determine students' thoughts towards STEM activities that require problem-solving and STEM skills. As creating the interview form, the final version of the form was composed by taking the opinions of a specialist working in the field of STEM, the Science teacher who carried out STEM studies at the Science and Art Center and the thesis advisor. The interview form contains questions to measure the students' attitudes towards STEM activities and their thoughts towards STEM applications when the experimental process is completed. The students were asked some questions in an interview style in a way that the students could easily answer in a flexible class area. The answers for questions and students' opinions were noted.

2.4. Experimental Process

The research titled “The Impact of STEM Applications on Gifted Primary Students” was implemented in the Science and Art Center with gifted students who received support training. While STEM activities were implemented within the scope of support training, students worked in groups and were divided into two groups of three members. The STEM activities applied in the study were designed according to the project-based learning approach. Activities for STEM designed to the learning approach based some projects are planned as 9 activities within the 10-week training plan. A STEM activity is planned as a group activity for each week, while Grades 8 and 9 are being scheduled and a single STEM event is planned in weeks. The activities in the first 7 weeks in the education plan, are designed as students doing teamwork, discovering problems from daily life, developing exemplary solutions to problems, showing the models of their solutions with Legos, on the other hand, the activities in the last 3 weeks are designed for students to create and present their own original solutions/ products as a group. In the process of performing the planned STEM activities, the phases of the project-based learning approach have been taken into account.

The STEM activities applied in the empirical application process were carried out according to the project-based teaching approach. In project-based learning, participants are expected to conduct research on the solution of the problem for a long time individually or in small groups in order to find solutions to the problems they may realize any time in daily life and to produce an original product as a result. It is recommended that the teacher guide the students' work in project-based learning. In this direction, the following project-based learning stages were applied in the empirical application process:

- **Preparation and Planning Stage:** The activity topics were chosen with the help of the teacher. The researches and studies to be carried out by the students during the activities were determined and time scheduled were planned. The required materials and which stakeholders they will benefit from have been adjusted. The activities of the students were planned, and it was decided to make some posters and prepare some presentations as products.
- **Implementation and Monitoring Stage:** Related data was collected about the research topics required for the solution of the problem and the studies planned to be carried out within the framework of the project were formed. The products of the groups are created.
- **Evaluation and Conclusion:** The students performed their project presentations, and shared the information they acquired, the process and the products. Students evaluated the project process themselves via Presentation Evaluation Forms.

Lego Education WeDo 2.0 set was wielded as training material in the process of implementing STEM activities.

Training Material: Leo Education WeDo 2.0 Set: Lego Education WeDo 2.0 set is a robotic coding set produced to attract the interests of primary school students in science, technology, engineering fields and to support students to gain STEM skills. WeDo 2.0 set allows students to acquire basic coding skills with the WeDo program downloaded to a tablet or computer. In addition, thanks to the guided and public projects that can be associated with course achievements such as science and mathematics in the program, students can produce solutions to daily life problems. WeDo 2.0 is a learning tool by living, learning and thinking that is used to create solutions to set problems. With WeDo 2.0, students complete their projects in 3 stages.

1. **Discovery Phase:** Students relate their problems to everyday life, discuss them and suggest possible solutions.
2. **Building Phase:** Students build, program, and test a Lego model of solutions, and make changes if necessary.
3. **Sharing Phase:** Students present and explain Lego models of their solutions.

With the WeDo 2.0 projects, it is seen that students develop many STEM skills such as problem solving, prototyping, research, creativity, analysis, information gathering, numerical thinking in science and engineering fields, and students' interest in science and technology

areas has changed positively (Costa and Fernandes, 2004). WeDo 2.0 set is a learning tool that supports primary school students to gain STEM skills by having fun with Legos and in a gaming environment (Sungur Gül and Marulcu, 2014). WeDo 2.0 kit includes 1 motor / engine, 1 inclination sensor, 1 motion sensor and 1 Smarthub. Apart from these electronic blocks (bricks), there are a total of 280 parts including structural, connection, movement, and decorative bricks.

In the implementation, the training contents consisted of a total of 7 activities, one STEM activity each week for the first 7 weeks, and 2 STEM activities in the last 3 weeks, totaling 9 STEM activities in a 10-week period. The activities worked on weekly are presented in Table 1.

Table 1. *Activities Worked on Weekly*

Week	Activity	Duration	Explanation
1.	-Warm up and Meet -Determination of Teams -Determination of team working rules, core values -Giving information about the theme of the event -Building Lego models in line with the theme -Teamwork, Sharing	40 min + 40 min	Introducing students to their teammates and identifying teamwork core values such as teamwork, discovery, inclusiveness, innovation, impact. Informing the students about the theme of the event and drawing and modeling the design of the buildings in the place where they live as a team.
2.	-Construction Area Preparation -Determination of the materials needed for the construction area -Making Lego models of the construction area -Exploring, sharing	40 min + 40 min	Preparing and researching the construction site for the new building in two teams and modeling it with Legos. Designing a Lego crane for the construction areas. Sharing models.
3.	-Explaining the working areas of architects and engineers -Finding and designing a solution to a problem -Innovation, Sharing	40 min + 40 min	Conducting and presenting research on the working areas of engineers and architects. Designing a two-story building with Legos and programming a Lego crane to transport materials to the second floor. Sharing new ideas and models.
4.	-Exploring the designs of accessible buildings - Elevator and automatic door modeling Inclusiveness, Sharing	40 min + 40 min	Investigating how accessible buildings are designed, demonstrating what is learned with a model. Students transforming a Lego crane into an elevator and designing an automatic door. Sharing models and ideas of inclusion.
5.	-Exploring the design of environmentally friendly buildings -Modeling wind turbines and solar panels -Impact, sharing	40 min + 40 min	Investigating how environmentally friendly buildings are designed, modeling what is learned. Design and programming of wind turbine and solar panel models. Sharing ideas and models
6.	-Exploring how sturdy buildings are designed -Building an earthquake simulator and a robust building model -Share	40 min + 40 min	-Students model the design of a robust earthquake-resistant building where they live. -Sharing the design, drawings and models
7.	-Exploring other topics related to building design -Building Lego models to show what they have learned	40 min + 40 min	Students demonstrate solutions to different problems for building design on their models. Sharing models and ideas.
8.	-Constructing an environmentally		As a team, students design, construct and

9.	friendly, accessible, robust new building. -Working as a team for new building construction -Share -Poster Studies	80 min + 80 min	program new buildings that are environmentally friendly, accessible and robust. Sharing their designs.
10.	-Creating, presenting and sharing posters -Evaluation	40 min + 40 min	Preparation, presentation and evaluation of a poster showing the students' new building design work during the eight-week period.

2.5. Data Analysis

It was, to determine the statistical analysis to be conduct for the analysis of the data obtained, first controlled whether the basic STEM skills, attitudes towards STEM and the students' problem-solving skill scores before and after the experimental application have showed normal distribution. Table 2 summarizes the normality test results of the students' basic STEM skills, attitude towards STEM and problem-solving skills scores.

Table 2. *Normality Test of Students' Basic STEM Skills, Attitude towards STEM and Problem-Solving Skills Point Totals*

	Shapiro-Wilk				
	Z	df	p	Skewness	Kurtosis
STEM Skills pre-test	.103	20	.678	-0.552	0.277
STEM Skills post-test	.126	20	.296	-0.569	0.384
STEM Skills pre-test	.154	20	.401	0.672	0.060
STEM Skills post-test	.146	20	.650	0.114	-0.359
Problem Solving pre-test	.123	20	.525	0.038	-0.919
Problem Solving post-test	.116	20	.850	0.162	0.016

We may express that the test showed a normal distribution when examined, the Table 2 according to the results of the Shapiro-Wilk test applied to the STEM Skill pre-test and STEM Skill post-test, STEM Attitude pre-test and STEM Attitude post-test, Problem Solving pre-test and Problem-Solving post-test, the test was not significant ($p > .05$). However, when we look at the Shapiro-Wilk results applied to the STEM Skill Post-test and STEM Attitude Pre-test, it is understood that the test is significant ($p < .05$) and isn't a normal distribution. On the other hand, when the kurtosis and skewness values of the STEM Skills in post-test were examined, the Kurtosis value was found 0.384 and Skewness value was found to be -0.569. Since the skewness and kurtosis values are between +1.5 and -1.5, it is possible to say that the data of the STEM Skills Test show a normal distribution (Tabachnick and Fidell, 2013). Similarly, the Skewness and Kurtosis values of the STEM Attitude pretest were 0.672 and 0.060, respectively. Since the kurtosis and skewness values of the STEM Attitude pretest were between +1.5 and -1.5, it is assumed that the STEM Attitude pretest data have also showed a normal distribution and the analyzes continued accordingly. A group must have at

least 30 participants for parametric statistics to be available. However, it is stated in the literature that parametric statistics can be used if it shows a normal distribution in groups up to 20 (Büyüköztürk, 2017). So, we have decided to use parametric tests for the analysis of the data based on the normal distribution of the obtained data. The Dependent Sample t-Test was used from parametric tests to determine whether the difference between pretest and post-test scores was significant in the students' basic STEM skills, STEM-facing attitudes, and problem-solving skills. For the analysis of qualitative data, it was preferred to use content analysis method.

3. FINDINGS

The results of the Dependent Sample T-Test on whether STEM practices contribute to students' basic STEM skills are revealed in Table 3.

Table 3. *The Impact of Experimental Practice on STEM Skills*

		N	X	S	df	t	p
STEM Skills	Pre-test	20	80.55	17.35	19	-7.030	.000
	Post-test		112.40	16.58			
F1: Science	Pre-test	20	41.70	9.097	19	6.544	.000
	Post-test		55.90	7.587			
F2: Engineering and Technology	Pre-test	20	18.10	4.266	19	6.397	.000
	Post-test		26.70	5.732			
F3: Mathematics	Pre-test	20	20.75	5.684	19	5.891	.000
	Post-test		29.80	4.432			

As the data in Table 3 are discussed, the STEM Skill score totals of the students are $X=80.55$ and the STEM Skill final test score totals are $X=112.40$ before STEM applications. It is possible in line with these data, to say that there is an increase in the sums of students' STEM Skill scores after the application of STEM activities. When STEM Skill sub-factors are examined, it is found that the sum of the last test score after the experimental application is $X=55.90$ while the sum of the pretest score of the science subfactor is $X = 41.70$. The pretest score total of the Engineering and Technology sub-factor was $X=18.10$, as the last test score total was $X=26.70$ and the pretest score total of the Math sub-factor was $X=20.75$, while the final test score total was $X=29.80$.

When the STEM skill score totals are dealt, it is understood that the difference of the pretest final test scores of the students for the Science, Engineering-Technology and Mathematics sub-dimensions is positive. In other words, after the application of STEM activities, we may say that there is an increase in the scores of the students' skills for the Science, Engineering-Technology and Mathematics sub-dimensions. That STEM applications have a favorable impact over students' STEM Skill scores may be concluded in line with these data.

Also, when examined at whether the positive change between the STEM Skill pre-test and post-test scores of the students may be outstanding in accordance with the data obtained in Table 3, that shows there is some difference between the STEM Skill pre-test and post-test scores of the students in favor of the post-test ($t(19) = -7.030$; $p < 0.05$). Similarly, it is understood there was a significant difference between the pretest posttest scores of the students' skills for the Science, Engineering-Technology and Mathematics sub-factors ($t(19) = 6.544$ for science; $p < 0.05$; $t(19) = 6.397$, $p < 0.05$ for engineering-technology; $t(19) = 5.891$, $p < 0.05$) for mathematics. In this direction, it is possible to say that STEM applications contribute significantly to the basic STEM skills of gifted primary school students. The results of the Dependent Sample T-Test on whether STEM practices contribute to students' manners for STEM education are placed in Table 4.

Table 4. *The Impact of Experimental Practice on Attitudes towards STEM*

		N	X	S	df	t	p
STEM Attitude	Pre-test	20	90.65	10.52	19	8.357	.000
	Post-test		104.85	8.405			
F1: Personal Social Inference	Pre-test	20	30.70	4.305	19	6.290	.000
	Post-test		35.75	2.989			
F2: Math and Science Learning	Pre-test	20	24.10	3.024	19	4.482	.002
	Post-test		26.35	2.720			
F3: Engineering Learning	Pre-test	20	20.85	2.852	19	6.712	.000
	Post-test		24.95	3.187			
F4: Technology Learning and Usage	Pre-test	20	15.00	1.892	19	7.782	.000
	Post-test		17.80	1.542			

It is seen when Table 4 is examined, that the STEM attitude pretest score totals of the students before the STEM applications are $X=90.65$, while the STEM attitude score totals after the application are $X=104.85$. It is possible to say that students have an increase in STEM attitude scores after STEM applications. When the sub-factors of STEM Attitude are examined; the final test score total was determined as $X=35.75$ after the application of STEM activities while the personal Social Inference sub-factor pretest score total was $X=30.70$. While the pretest score total for the Mathematics and Science Learning dimension was $X=24.10$, the final test score totals were $X=26.35$, the pretest score total for the Engineering Learning sub-factor was $X=20.85$, and the final test score total was $X=24.95$. The sum of the pretest attitude scores of the Technology Learning and Usage sub-dimension was $X=15.00$, while the final test score totals were determined as $X=17.80$. In line with the obtained STEM attitude scores, it is possible to say that there is an increase in the attitude scores of the students regarding the sub-factors Personal Social Inference, Mathematics and Science Learning, Engineering Learning, Technology Learning and Usage in favor of the last test. In

other words, it is seen that STEM activities practices positively affect students' STEM Attitudes.

When the STEM Attitude pretest and posttest scores are compared, and when it is examined whether the increase in favor of the last test is significant or not, it is possible to say that there is an increase in the STEM Attitude scores of the students after STEM applications and that this increase differs significantly ($t(19) = -8.357$; $p < 0.05$). Students' Attitudes towards the sub-factors of Personal Social Inference, Mathematics and Science Learning, Engineering Learning, Technology Learning and Use were also found to be significantly different between the pretest posttest scores ($t(19) = 6.290$, $p < 0.05$ for personal social inference; $t(19) = 4.482$, $p < 0.05$ for mathematics and science learning; $t(19) = 6.712$, $p < 0.05$ for engineering learning; $t(19) = 7.782$, $p < 0.05$ for technology learning and use). It can be in line with these data, said that STEM activities applications contribute significantly to the attitudes of special gifted primary school students towards STEM. It was used Dependent Sample T-Test to test whether there was a significant difference between the students' problem-solving skills before and after the STEM activities applied to the students and the results were given in Table 5.

Table 5. *The Effect of Experimental Practice on Problem-Solving Skills*

		N	X	S	df	t	p
Problem Solving	Pre-test	20	89.75	8.747	19	-7.395	.000
	Post-test		104.25	6.290			
F1: Self-confidence	Pre-test	20	42.10	4.315	19	6.786	.000
	Post-test		51.05	3.859			
F2: Self-control	Pre-test	20	26.85	4.017	19	5.225	.000
	Post-test		30.60	2.542			
F3: Avoidance	Pre-test	20	20.80	2.966	19	3.454	.003
	Post-test		22.60	1.729			

When the data mentioned in Table 5 are considered, the sum of the problem-solving skills scores of the students before STEM activities is $X=89.75$ and the sum of the last test scores of problem-solving skills is $X=104.25$. Based on these data, it is possible to say that there is a raise over the total of scores of the students' problem-solving skill after the application of STEM activities. When the sub-dimensions of them are investigated; While the sum of the Trust sub-dimension pretest scores was $X= 42.10$, it shows us that the sum of the last test scores of the Self-confidence sub-dimension after STEM applications was $X=51.05$. While the sum of the pretest scores for the self-control sub-dimension was $X=26.85$, the sum of the final test scores was $X=30.60$ and the sum of the pretest scores for the Avoidance sub-dimension was $X=20.80$, while the sum of the final test scores was determined as $X=22.60$.

When the Dependent Sample T-test results given in Table 5 are tested, the difference in the final test and pretest scores of the students for the Self-Confidence, Self-Control and

Avoidance sub-factors is positive based on the data. In a similar statement, it is possible to say that after STEM applications, there was a rise over the whole skills scores of the students in respect to the Self-Confidence, Self-Control and Avoidance sub-dimensions in favor of the last test. Based on these data, it was determined that STEM applications had a positive impact over all the participant students' problem-solving skill scores.

When the problem-solving skill pretest and posttest scores are compared, it is understood that there is some difference between the pretest on problem-solving skill and the last test scores in favor of the last test ($t(19) = -7.395$; $p < 0.05$) in line with the data in Table 5. It is understood that there is a important difference between the pretest final test scores of the skills of the students belonging to the Self-Confidence, Self-Control and Avoidance sub-factors in favor of the final test ($t(19) = 6.786$, $p < 0.05$ for self-confidence; $t(19) = 5.225$, $p < 0.05$ for self-control; $t(19) = 3.454$, $p < 0.05$ for avoidance). Based on these data, we may say that STEM activities applications put significantly up to the problem-solving skills of gifted students in primary schools. In the qualitative dimension of the study in order to determine their views on the applied STEM activities, the answers of the students to the questions can be listed below.

1. Did you enjoy joining in STEM activities work? Why? Answers to the question:

a. In terms of engineering skills and use of technology,

S1: "Attending STEM events is a lot of fun, a lot of fun because it was so nice to code on the tablet and do designs like engineers."

S8: "I felt like I had a talent for engineering skills and the use of technology, and I loved that."

S12: "Yes, I like it because engineering is my favorite profession and I was like an engineer at these events and I love to use technology."

S3: "Yes, because I like measurements, coding and designing."

S14: "I liked it because it was fun to do research from the tablet and create mock-ups."

S17: "I liked it because I loved building design and improved my engineering skills."

b. In terms of the use of science skills and math skills,

S1: "It is very enjoyable because we learn science and mathematics by having fun."

S5: "I liked it because we worked with fun, so math and science are a fun lesson."

S8: "I liked that as we did math calculations at the events."

S11: "We watched videos about science and did calculations with math, so I liked it."

S12: "I like it because we did research by using science skills, and I love doing research, and I also like to do calculations in math."

S14: "It was nice to use mathematics, take measurements with the ruler and calculate the intervals."

S13: "Yes, using mathematics while designing made me feel happy and I imagined myself as a person who had accomplished important things."

When the answers of the students to the first question in the interview form are examined; It is seen that they like to participate in STEM activities, feel like an engineer while designing

and are happy. It can also be said that they enjoy doing research and mathematical calculations, using technology, acquiring new knowledge, and are aware of their own skills and abilities. Accordingly, it is possible to say that students enjoy participating in STEM activities and find STEM activities useful and fun.

2. What was it like studying with your friends as a group at STEM events, creating designs? Evaluate it in terms of collaborative work and product creation, please. Answers to the question:

S13: "I felt very strong because if I had worked alone, I would not have been able to do this work and I would not have been able to produce such a product."

S6: "It was good, I like to collaborate with my friends and create a new product."

S9 "I loved working with my friends, I saw that they had different ideas and tastes, and when our different ideas were combined, it was a very nice product."

S11: "It was a lot of fun, both working and creating products. While working collaboratively, sometimes we were serious and sometimes we joked, which I liked very much."

S12: "I think we work well with our friends, but there are times when we contradict each other. When we conflicted, we made the right decisions because we looked at it from different dimensions, not from one perspective."

S20. "It was nice to plan our work with friends, to decide together, so we worked tirelessly with fun."

S7. "Sometimes we can discuss, but we can still work together and complete each other's shortcomings, so I think it's great to work with the group."

When the answers of the students to the second question in the interview form are examined; it is possible to say that they like to work collaboratively, that they feel stronger together, that they can make the right decision even if they sometimes contradict each other, that they can create a more beautiful product when different ideas combine, that they complete each other's shortcomings and that they find it fun to work collaboratively. Accordingly, in STEM activities, it is seen that students find it useful to work with their friends as a group.

3. If you had to design a product at a new STEM event, what would you pay more attention to? Answers to the question:

S3: "I would be careful to plan ahead according to the details of the product."

S5: "I would be careful to design a brand-new product that would solve an important problem today, and I would place more emphasis on collaboration."

S11: "I would do more research to make the design more beautiful and closer to reality, and I would try to design nicer."

S13. "Before designing the product, I would have made the drafting drawings more carefully and meticulously, and I would have done the checks more."

S14: "I would pay more attention to the distribution of duties of my group mates, I would give importance to giving the right tasks to the right people. When designing the products, I would pay more attention to their size."

S15. "I would have done more research on my design from different sources and used my time more effectively."

S17: I would more consider the usefulness of the product I was going to design and to design a product with an innovative aspect."

S16: "When designing products, I used to pay special attention to measurements and the number and type of materials because we had problems with these issues."

When the answers of the students to the third question in the interview form are examined "If they were to design a product in a new STEM event"... it is possible to say that they would do more research from different sources, pay attention to the usefulness and innovation of their products, and give more importance to the distribution of duties within the group, planning their work, measurements and controls. According to the opinions of the students, it can be said that STEM activities contribute to them in terms of preparing, planning, product creation and evaluation skills.

4. What are your thoughts on whether STEM activities are contributing to you? Explain. Answers to the question:

S1: "I learned to study in groups, code and make new designs through STEM activities. I think STEM activities have helped me."

S2: "I think they have contributed especially in terms of being able to work collaboratively and do teamwork."

S4: "To me, STEM activities have helped us learn new knowledge in science, math, and technology."

S8. "It helped me improve my technology skills, engineering and problem-solving skills."

S11: "It helped me because I learned a lot of things I didn't know, I understood the importance of working with the group, and I saw that I could solve the problems we faced."

S13: "STEM activities have contributed to me, so my dexterity has improved, I have learned to use technology more effectively, my group work and engineering skills have improved."

S16: "I think STEM activities have contributed a lot to us. For example, all contributed to many issues such as teamwork, research."

When the answers of the students to the fourth question in the interview form are examined; STEM activities provide students with; teamwork, collaboration, research, problem solving, revealing talents and skills, designing, learning new information and time management can be said to contribute to many areas. According to the opinions of the students, it is seen that STEM activities have positive effects in terms of providing students with 21st century skills such as collaborative work, designing, producing, using technology and engineering skills.

5. Would you like to participate in new STEM activities as a group? Why? Answers to the question:

- S4: “Yes, I would like to participate because it is very difficult for me to do this work alone, but it is easier when I do the activities as a group. Also, group work is a lot of fun.”
- S8: “I want to participate because working as a group adds new things to me and my friends. It's so much fun because my friends and I work together, it wouldn't be fun if I worked alone.”
- S12: “Of course, I would like to participate. Working as a group is a lot of fun and instructive, and I'd love to rejoin because we do the work as students.”
- S13: “Yes, I would like to participate again because I feel very happy in group work. Within the group, I feel like a puzzle piece that complements my group mates.”
- S18: “If I'm going to work with a small number of people, yes, but if the group is more than three people, no, I don't want to participate. Cause I don't like working with a crowded team.”

When the answers of the students to the fifth question in the interview form are examined; it is possible to say that they want to participate in a new STEM activity to be held as a group. Among the reasons why they want to participate in a new STEM event to be held as a group; that working as a group is fun and instructive, that students feel happy, that they mingle more quickly with their friends, and that it is easier to work as a group. A student stated that he did not want to participate in group work when the number of students in group work was crowded. However, in general, it is seen that students find STEM activities as a group fun, useful and instructive.

6. What were the most challenging parts of your STEM activities? Why are you struggling?
Answers to the question:

- S4: “If I had worked alone and not as a group doing the activities, it would have been difficult, but since we worked as a group, I didn't have any difficulty at all, and it was even a lot of fun.”
- S6: “In general, I did not have difficulty, but sometimes I had difficulty in the coding part because the codes can be mixed and it may take a lot of effort to find the right code.”
- S8: “While looking for solutions to problems in STEM activities, I had difficulty thinking and finding different ideas.”
- S9: “In STEM activities, I had a hard time installing parts during the product creation phase.”
- S13: “I think I had a hard time drawing the product we were going to design before I designed the product because it was hard to imagine and think before we did something.”
- S18: “The most challenging part was when we couldn't agree on a common decision on an issue because there were situations where we couldn't decide for a long time because everyone's tastes were different.”
- S20: “I think the difficult part was to design and implement it, because some things do not happen while designing, sometimes there are problems and it may be necessary to do the same work many times.”

When the answers of the students to the sixth question in the interview form are examined; it can be said that students have difficulty from time to time, especially in the product creation

phase, writing the appropriate codes, sometimes compromising as a group, looking for solutions to the problem and drawing the design as having STEM activities. To the student opinions in general, although they have difficulty at some points in STEM activities, it is possible to say that they do not have much difficulty because they find the activities and working as a group fun.

7. What were the most challenging parts of collaborative learning? Why? Answers to the question:

S2: "I didn't have much difficulty, just when we had a hard time making plans together as a group."

S12: "It's hard to get along with our girls in the group because we often contradict each other."

S13: "Having opposing thoughts. Because two or more people oppose an idea, other people say different opinions, and it is sometimes difficult to make a common decision."

S14: "It wasn't the part I had any difficulty with because I like to work as a team, to collaborate. If I did it alone, such a beautiful product might not have come out."

S15: "There was a distribution of tasks in the group, and sometimes when my other friend finished the task before me, I could speed up and made mistakes in my own work."

S20: "...the fact that we have different ideas and can't agree when we decide on something because everyone has different ideas and wants their opinion to be accepted."

When the answers of the students to the seventh question in the interview form are examined; Fort his cooperative learning, it can be said that students have difficulty in disagreeing especially during the study, in the formation of the plan of the study and in the joint decision-making phase. However, when the student opinions are reviewed in general, it is seen that although they have difficulty in some points in collaborative work, they like to work as a group in cooperation and have fun in collaborative learning.

8. What was the most important contribution/advantage that STEM activities made you? Explain them with the reasons. Answers to the question:

S1: "STEM activities have nurtured me to be patient because we need to be patient to get along with our friends and create products."

S2: "STEM activities taught me to work collaboratively, to be a team, to think together and make decisions because we did everything together as a group."

S5: "The most important contribution that STEM activities provide to me is to be able to turn the designs we have in mind into reality and to make innovative designs because we can create brand new different products with our own common decision."

S7: "It has improved my engineering skills, and I have also learned to be planned and think fast because it is necessary to think like an engineer when designing products in STEM activities."

S12: “STEM activities have taught us to think like an engineer, to use our science skills and math skills skillfully, to code and to make the most of technology because we have done research, created new designs with Legos and coded with tablets.”

S15: “Actually, I felt like an engineer because there are so many problems in everyday life and I learned to find solutions to these problems and create new products.”

S16: “I think it gains habits like working together, doing research, sharing, finding solutions to problems in daily life because we did all of these things throughout the event.”

S20: “With STEM activities, I learned to look at situations from different perspectives, generate new ideas, find solutions to problems and think more.”

When the answers of the students to the eighth question in the interview form are examined; STEM activities provide students with, from this point of view it is possible to say that it adds many skills such as thinking like an engineer, doing research, finding solutions to problems, creating new designs, using technology correctly, making decisions, being a team, sharing, producing different ideas, thinking, being planned. In general, as to student opinions, it can be said that students acquire new knowledge and skills through STEM activities, except for one student, and STEM activities are beneficial to students.

9. Were there any issues that bored or made you unhappy while performing STEM activities? If so, what were they? Write with the reasons. Answers to the question:

S1: “In general, there was nothing that made me unhappy, but sometimes there were disagreements within the group and that bothered me.”

S5: “There was nothing that was a problem at all, everything was very nice and I had a lot of fun.”

S8: “I had a lot of fun in the activities, but sometimes we could not use our time properly as a group and we could not design the product we wanted, which made me sad because it did not grow.”

S11: “Yes, there were situations that bothered me because some of my groupmates humiliated me by saying that I couldn't do the event and I was upset.”

S14: “There was nothing that made me unhappy, on the contrary, it made me very happy.”

S16: “There were no issues that bored me or made me unhappy while performing STEM activities.”

S19: “There was a situation that bored and made me unhappy in STEM activities. In the group, my friends gave me very few tasks and I felt like I was not part of the group, which made me unhappy.”

When the students' answers to the ninth question in the interview form were analyzed; It can be said while performing STEM activities that students sometimes feel unhappy in time management, in the distribution of tasks within the group, when there are conflicts of opinion and disagreements. However, when we consider the student opinions in general, it is seen that there were no issues that bored and made students unhappy, and that they even had fun and were happy during the activities. According to this, it can be inferred that students' thoughts towards STEM activities are positive.

When the answers given by the students to the questions in the interview form about STEM activities were examined; It can be concluded that student opinions towards STEM activities were positive, students enjoyed participating in STEM activities, developed their engineering and mathematics skills, learned how to use technology and coding correctly, were able to produce solutions to problems in the activity, design, work collaboratively and learn by having fun during STEM activities. In addition, it can be stated that students gained 21st century skills such as research, planning, time management, decision-making, cooperation, questioning, productivity and leadership while practicing STEM activities. Considering to teacher observations in the classroom, it is possible to say that the students participated in STEM activities with interest, were curious and eager to learn new information, learned how to conduct research, learned what it means to be a team, learned to be patient and respect different ideas, even if they had disagreements from time to time, and reflected their creative and innovative ideas on their products and actively participated in the activities.

It can be also said that the students were enthusiastic, happy and had fun both during the STEM activities and during the product presentation phase. Although it was observed by the teacher that two students had difficulties in collaborative activities, wanted their own ideas to be accepted, had difficulty in making joint decisions, sometimes did not want to participate in the activities, and sometimes wanted to leave the group in the first weeks, it can be said that in the following weeks, they were more harmonious in group work, respected joint decisions, and were willing and happy, especially during the product design phase. In the 10-week-long STEM activities, even though some students sometimes had problems due to differences of opinion while working collaboratively, the fact that all of the students wanted to participate in STEM activities again as a group supports the idea that students enjoyed STEM activities, had fun, were happy and learned by having fun in STEM activities. When the answers given to the interview questions are examined, otherwise; the results of the dependent variables measured in the research support the results of the dependent variables measured in the research, as the student's developed science, mathematics, technology, and engineering skills, produced solutions to problems in the activities and developed positive attitudes towards STEM studies.

4. DISCUSSION

“The results of the research reveal that after the STEM programs implemented to gifted primary school students, there was an advance in the STEM skill points of the students. It is seen that the STEM activities applied in the study put significantly to the basic STEM skills of the students up and this contribution was statistically significant. When the sub-factors of the STEM Skill Level Perception scale were investigated, it showed that after the STEM activities were implemented, there was an increase scores of the students to in the skill the science, engineering, technology and mathematics sub-factors and this increase was statistically significant. This result displays that the STEM skills of gifted primary school students who have joined the STEM activities can improve positively. When the students' opinions on STEM activities obtained in the qualitative dimension of the research are

examined, it is understood that STEM activities not only improve students' engineering, mathematics," science "and technology skills, but also contribute to the development of decision-making, cooperation, inquiry, productivity, time management and leadership skills. It can in respect to this study, be said that the preparation of the STEM activity programs designed to be applied to the students according to the project-based learning approach, the planning/ preparation of the activities implemented within this frame of the research within a 10-week long training plan and their implementation in a flexible setting had an effect on the positive development of the students' STEM skills. When the literature sources are reviewed, it is possible to find many numbers of studies on gifted students and STEM applications, but it is realized that there is a limited number of studies in which the effects of STEM applications on talented students' STEM skills, attitudes and problem-solving skills are discussed together."

Considering the literature, we may find similar studies supporting the results of our study. Özçelik and Akgündüz (2018) who worked with 25 gifted students and were diagnosed as gifted in their study aiming to evaluate out-of-school STEM education with gifted students and observed that the students gained mathematics, architecture, and engineering gains up to the results of the study. In addition, as a result of the research, it was determined that STEM applications improved the 21st century skills of gifted students such as critical thinking, creativity, communication and cooperative works. Similarly, Kulegel and Topsakal (2021) examined how the perceptions and skills of gifted middle school students changed with STEM education practices and found that STEM education practices improved the technological inquiry, creative thinking, scientific inquiry and argumentation skills of gifted students, enabled their career choices, and STEM education was important in exploring their perceptions and skills. Ridlo et al. (2020) also found that STEM activities carried out with the based-on project learning approach positively increased students' creative thinking skills. Students' opinions in the qualitative dimension of the study at the same time, showed that STEM activities positively affected students' creative thinking skills. This situation also supports the results obtained in the qualitative dimension of this research. Another study revealed that STEM practices have positive effects on students' problem solving, research skills, focusing on real world problems, perseverance, academic skills, and building mentoring relationships. (Wu, Pease and Maker, 2019). Moreno et al. (2016) proved that STEM programs potentially help contribute for increasing students' STEM-related skill and content knowledge in this direction. In addition, Apaivatin's (2021) study similarly revealed that STEM education is important for the development of students' scientific process skills. It was revealed in another study, that STEM implementations made a statistically significant contribution to the science process skills, scientific concepts, and scientific content knowledge of gifted students. (Robinson et al., 2014)."

In the research by Özçelik and Akgündüz (2018), they found that as a result of STEM applications, gifted students gained 21st century skills such as critical thinking, creativity, communication, and cooperative study students gained mathematics, architecture and engineering gains and their STEM skills increased. Similarly, Rasul, Halim, and Iksan (2016) reported that with STEM applications, in which he examined the changes in students' 21st

century skills, he found that STEM implementations were the most effective way to improve students' 21st century skills development. Barış and Ecevit's (2019) study also supports these findings. These studies show that the implementation of STEM activities to gifted students in educational environments improves students' STEM skills such as technology, engineering, mathematics and science provide the students with 21st century skills such as collaborative study, critical thinking, creativity and communication. The research results obtained in the qualitative dimension of similar researches in the literature also prove the results of our study in terms of the fact that STEM programs have developed for students' 21st century skills such as research, time management, decision making, cooperation, inquiry, productivity, leadership, engineering and mathematics skills.”

However, a limited number of studies were taken part in the literature review that differed the results of these studies. Gülhan and Şahin (2018) who measured the impact of STEM programs on the scientific creativity of middle school students in science course concluded that the effect of STEM activities on students' scientific creativity levels was limited. This situation was interpreted as the lack of planning and time management skills of the students joining for the research rather than the time limitation of the 12-week study. As a result of different research, the ideas of primary school students about STEM activities were determined and that exhibited that STEM activities during the program positively affected the communication skills and lessons of primary school students and gave an idea about which profession they would prefer, but it was revealed that problems such as lack of time, deficiency of material and information were encountered during the implementation of STEM activities in primary schools (Karakaya et al., 2019).”

It is seen that the STEM activities during the program conducted over the research contribute significantly to the STEM attitudes of the students and this contribution is at a statistically important level. Similarly, from the sub-factors of the STEM Attitude Scale; When the pretest posttest scores of personal social inference, mathematics and science training, engineering, technology training and use sub-factors are reviewed, it is found that there is a significant difference in favor of the final test. In line with that result, it may be said that the STEM manners of gifted primary students who are applied STEM activities can develop positively. It is seen that the student opinions about STEM activities are positive, that students like to participate in STEM studies, that they want to participate in STEM activities again, that they have fun during the application, that they learn by having fun in STEM programs when the student opinions on STEM activities obtained in the qualitative extent of our research are examined. The data from the qualitative dimension of the study show that STEM activities contribute to the development of STEM attitudes of especially gifted primary school students.”

When the related literature is reviewed, we may possibly come across researches showing that activities for STEM programs contribute to the improvement of students' attitudes towards STEM. Barış and Ecevit (2019) tested the impact of STEM practices on the education of gifted students and found that students developed a positive attitude towards scientific studies, interdisciplinary work, and cooperative learning up to the results of the

research. Similarly, Şen (2018) examined the STEM skills used by students with special abilities in activities appropriate to the STEM approach and the students' ideas on activities for STEM programs in his study, and in the qualitative dimension of the study, and emphasized that STEM education contributes positively to students' motivations, that students are happy during practice, and that students develop a positive attitude towards STEM.

In another research, the opinions of the students about FeTeMM based activities were examined and as a result of the research, it was found that the students exhibited a positive attitude towards FeTeMM activities, that they wanted to include more FeTeMM activities in the courses, and that the students found FeTeMM activities useful (Gökbayrak and Karışan, 2017). Similarly, in the study of Kalkan and Eroğlu (2017), it was found that students with special abilities actively participated in STEM applications, that the motivation of students was high in applications and that students improved a positive view towards STEM. Ceylan (2017)'s study is also remarkable at this point in terms of students improving a positive manner towards STEM activities. The effect of STEM research experience on the creative problem-solving tendencies of gifted students and their attitudes towards engineering was examined and according to the results of the research, it was revealed that there was a positive increase in the attitudes of gifted students towards engineering after STEM applications in another study (Kang and Nam, 2017).”

It was proved in another study in which students' positions to STEM were examined in terms of different perspectives / variables, that students moved from primary school to secondary school with a high STEM attitude and that boys towards engineering and technology and female students had higher attitudes towards mathematics (Karalar, Sidekli and Yıldırım, 2021). In a similar study, it was highlighted that STEM programs have a positive impact over the students' positions about STEM and that it is important to implement more STEM programs in educational environments at the primary school grades (Zeng, Zhou, Chen, Xu, and Xiao, 2019). As seen in the results of similar researches in the related literature, it is understood that STEM applications contribute to the development of attitudes towards STEM of especially gifted primary school students. The results obtained in the qualitative dimension of the studies in the literature are resemblance with the results of this study in terms of the positive student opinions on STEM activities, the active participation of students with interest in the activities, and the desire to participate in STEM activities again.”

It is seen that the applied STEM activities contribute significantly to the problem-solving skills of especially gifted primary school students and this contribution is statistically significant. The sub-factors of the Problem-Solving Scale for Children at the Primary Education Level similarly; When the sub-factors of confidence, self-control, avoidance are compared with the pretest final test scores, there is a significant difference in favor of the final test. These results obtained in the research show that a positive development will be achieved in the problem-solving skills of specially gifted primary school students who are applied to STEM activities. When the student opinions on STEM applications obtained in the qualitative part of the research are examined, it can be said that STEM applications contribute

to the development of students' problem solving, teamwork, collaboration, research, presenting their talents and skills, and designing. At the same time, to student views, with STEM activities, it is noteworthy that students have difficulty in thinking and finding different ideas while looking for solutions to problems by looking at situations from different perspectives.”

When the literature is examined, it is possible to come across similar studies showing that STEM activities contribute to the development of students' problem-solving skills. Wu, Pease and Maker (2019) who aimed to measure the application of creative problem-solving and conceptual understandings of students in their research, and as a result of the research, found that STEM applications have positive effects on students' problem solving, research skills, focus on real-world problems, perseverance, academic skills, and building mentoring relationships. In another study which aimed to measure the creative problem-solving tendencies and attitudes towards engineering of gifted students after STEM education and according to the results of the study, determined that there was a positive increase in the creative problem-solving tendencies and attitudes towards engineering of gifted students after STEM applications. When the same research was evaluated in terms of gender, it was found that STEM education had a more positive effect on female students in terms of the development of engineering design ability (Kang and Nam, 2017).”

Similarly, in the research done by Ceylan (2014), they found that activities about STEM positively contributed to persons' academic achievements, problem-solving skills and that students had positive thoughts about STEM practices. In this study, it is remarkable that students have good ideas about STEM activities contributing to the improvement of skills related to problem-solving. In the research of Çalışıcı and Benzer (2021), it is emphasized that STEM implementations contribute positively to the attitudes for environment, scientific achievements, and problem-solving skills of students in the 8th grade. In the research of Asigigan and Samur (2021), which highlighted the impact of activities about STEM on intrinsic motivations, perceptions of problem-solving skills and critical thinking tendencies of 3rd and 4th grade students, it was concluded that there was a raise in students' perceptions of problem-solving skills after STEM activities were implemented. Another study found that learning via the STEM approaches could develop participants' abilities of problem-solving (Astuti, Rusilowati and Subali, 2021). Another research examining the impact of STEM activities on students' problem-solving skills similarly revealed that STEM activities contributed significantly to students' problem-solving skills (Purwaningsih, Sari, Sari and Suryadi, 2020). In a similar study, the impact of STEM activities on the students' perceptions at the secondary school towards skills over problem-solving was examined and as a result of the research, has showed that STEM activities contributed positively to students' perceptions of problem-solving skills (Doğan, Aydın and Kahraman,2020). Erden and Yalçın (2021) who examined the effect of STEM activities on the problem-solving skills of preschool students in their research tested that the STEM activities acquired as a result of the research increased the problem-solving skills of the students and that supports the findings obtained as a result of this research. In addition, according to the teacher observations obtained during the conducting part of activities for STEM, the students who participated in STEM activities with

interest were able to find real solutions to problems and were able to create innovative and creative designs were witnessed, and this underpins the results of the research. As seen in the studies in the literature, we may possibly say that STEM practices in the study contributed to the improvement of students' problem-solving skills.”

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

1. Activities for STEM programs contributed to increasing of STEM skills of gifted students who are ahead of their friends in terms of problem solving, intelligence, productivity, and creativity. Likewise, from the sub-factors of the STEM Skill Level Perception scale; It was concluded that there was a raise over the skill points of Science, Engineering-Technology and Mathematics sub-factors and this increase was statistically significant. Thus, it may be said that the applied STEM activities have positive impact over the STEM skills of gifted primary school students.
2. After the STEM practices, it may be said that we have witnessed an increase between the pre-test and post-test scores of the attitudes of gifted students towards STEM in favor of the post-test and this increase was found to be significant. Similarly, it was found that there was an important difference between the pre-test and post-test points of the STEM Attitude Scale sub-factors of personal social inference, mathematics and science learning, engineering learning, technology learning and use in favor of the post-test. Thus, it may be concluded that STEM activities supported by applications have contributed to the STEM attitudes of gifted primary school students.
3. The applied STEM activities provided a contribution over the problem solving skills of gifted students learning faster among their friends and have high potential, and it was concluded that this increase was statistically significant. It is also one of the sub-factors of the Problem Solving Scale for Elementary School Children; when the scores of self-confidence, self-control and avoidance sub-factors in the pre-test and post-test were compared, it was seen that there was an important increasing in favor of the post-test. Thus, it was understood that STEM activities positively contributed to the problem-solving skills of gifted primary school students.
4. We may conclude that the students liked to participate in STEM studies, developed their engineering and mathematics skills, produced solutions to problems in the activity, could design and learned by having fun during STEM activities and found STEM activities useful considering student opinions about the applied STEM applications were examined. In addition, according to the teacher observations found during STEM applications, it was obtained that the students gained 21st century skills such as research, planning, time management, decision making, cooperation, questioning, productivity, leadership.

In the research, the impact of STEM activities for the STEM skills, attitudes over the STEM and problem-solving skills of gifted students were handled and some suggestions are listed in line with the results obtained below.

5.2. Recommendations

1. With the activities implemented according to the STEM Education approach, an interdisciplinary educational environment is offered to the students and students use the disciplines of mathematics, science, technology, and engineering together. The application of the method used in this research can be useful for teachers in mathematics, science and technology design courses from the disciplines based on the STEM approach.
2. Implementing STEM programs up to the approach on project-based learning, using multiple disciplines together in activities, adopting a student-centered approach, including problems from daily life, design and production-oriented studies can be recommended over the training of gifted students being faster learners, curious and have high mental capacity.
3. STEM activities can be recommended to teachers owing gifted students in their classes where they can transfer the knowledge they have learned to other fields, produce solutions to problems, make original designs, and use technology effectively for gifted students who love to research, produce, have creative and innovative ideas, and show leadership characteristics,
4. The study group of this research work consists of gifted primary school students. The results of the study had better be compared by applying it to gifted students studying at different grades of education.
5. Studies investigating the role of teachers in associating STEM practices with the educational curriculum and disseminating them in educational environments can be carried out.
6. More activities in the research, were implemented over the basis of science, engineering and technology fields. Research can be conducted to test the extent to which such STEM practices have impact on the career tendencies of gifted students.

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