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# STEM ACTIVITIES WITH ROBOTIC CODING; THE EFFECT ON AWARENESS OF TEACHER CANDIDATES REGARDING ITS USE IN SCIENCE LESSONS

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## ABSTRACT

STEM education, which focuses on improving students' 21st century skills, aims to increase interest in engineering professions that have a very important place in the future of the world. Due to continuous innovation in technologies, it is critical to provide STEM and robotics coding training to students. Knowing the content of studies in our country related to STEM is of great importance for awareness of its use in science course. The aim of this study is to investigate the effect of robotics coding STEM activities on teacher candidates ' awareness of their use in science course. 37 science teacher candidates participated in the 12-week study. Qualitative research method was used in this study. Qualitative data was taken from the field notes and semi-structured interview. As part of STEM activities, it is aimed to teach teacher candidates Robotics Coding. In the activities, Arduino IDE, Fritzing programs were taught. Robotics coding STEM activities have had a positive impact on teacher candidates. Teacher candidates reported that activities increased their interest and attitude to science, and that they were instructive, fun, and useful. Teacher candidates expressed that robotics coding activities integrated into education system enabled making learning permanent.

**Keywords:** STEM Activities, Robotics Coding, Science Subjects, Awareness

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## 1. INTRODUTION

Today, individuals must have a number of competencies in order to be successful in both educational and business life. These competencies cover problem solving, critical thinking, using information-communication technologies, accessing information, being open to new ideas and taking initiative. It is aimed that individuals can be educated with the STEM approach that the Ministry of Education has implemented as a draft program in the new education system. Increasing the number of students who have received STEM education and employing these students in industry are among the important goals for countries. To achieve this goal, there is a need for teachers who have received sufficient and qualified STEM education because STEM education can only be meaningful with qualified teachers (Wang (2012)) . In this context, in order to educate individuals who can adapt to the era by acquiring these skills, educational programs should be established with an interdisciplinary approach. The importance of this integration is increasing (Güleryüz et al. (2019); Güleryüz (2020); Wang (2012)). STEM education is a holistic approach integrating interdisciplinary

knowledge (Smith and Karr-Kidwell (2000)). It also helps individuals gain 21st century skills. For all these reasons, STEM education is becoming widespread in the world (Gazibeyoğlu (2018)).

The main goal of STEM education is to raise a new generation who is innovative. STEM education aims to enable students to solve real-world problems, learn knowledge in a more holistic and organized way, and integrate interdisciplinary knowledge (Aydın et al. (2017); Beane (1995); Burrows et al. (1989); Capraro and Slough (2008); Childress (1996); Jacobs (1989); Sweller (1989)).

Programming is an indispensable competence in STEM education, which aims to educate individuals equipped with 21st century skills. Countries that are aware of STEM education are working to ensure that individuals are able to obtain programming skills. Robotics Coding has an importance place in the education of students who are equipped with 21st century skills, able to solve problems they faced, and able to use technology effectively, capable of creating products. Teaching Robotics Coding within STEM education has been one of the most important indispensable subjects of 21st century. Today, investments, resources and research have been increased for the development of robotics, and new job opportunities have emerged for people. With Robotics Coding training, it is aimed to raise generations who are equipped with 21st century skills. Teacher candidates are at the heart of this. Robotics Coding is not only limited to computer science, it is also important in the interdisciplinary interaction (STEM) aspect. Teacher candidates should have 21st century skills and keep up with the digital age (Güleryüz et al. (2020); Güleryüz (2020)).

In our country, changes were made to curriculum in 2017, embracing STEM philosophy (Çepni and Ormancı (2017)). In this context, the specific objectives of the programme of Elementary School Science Teaching implemented in 2018 are to provide basic knowledge in the fields of science and engineering with students, to increase interest in science-related career fields, and to help students find solutions to problems of daily life (Ministry of Education. (2018b)). These goals seem to coincide with the goals of STEM education. In addition, analytical thinking, decision making, creative thinking, entrepreneurship, teamwork, communication and innovative thinking were included in the field-specific skills of this curriculum. STEM education allows students to develop a holistic view of the fields of science, technology, engineering and mathematics, helping find solutions to daily life problems (Berlin and Lee (2005); Daugherty (2013); Kuenzi (2008), Bahar et al. (2018).

In science subjects, many concepts are abstract. In the past, when learning to count in elementary school, beans and walnuts were used. This method used was one of the most convenient tools. In the world, which is moving towards rapid digitalization, there have been new tools to embody abstract objects. The most important of the tools to facilitate learning is the computer and then the Internet. Today, Robotics Coding, a more specialized field, is at the forefront (Cameron (2005); Güleryüz et al. (2020); Güleryüz (2020)).

Robotics Coding training provides the following benefits;

- It enables teacher candidates to develop cause – and-effect relationship, and skills of algorithms, mathematics, innovative thinking, and teamwork.
- The ability of establishing a cause – and-effect relationship with programming allows them to make more accurate decisions in life.
- Teacher candidates will be able to take precautions. For this reason, these skills, which are especially important in career choices, enable them to thrust themselves forward.

- With programming, teacher candidates learn how to use and access information and to create products.

We see a new technological field in science education. This technological innovation called "Robotics", which is also integrated with various disciplines, has become an indispensable part of the science education process (Cameron (2005)). In Japan, the government made programming courses mandatory at schools for the development of students ' creative abilities. Therefore, Robotics Coding education will be compulsory in primary schools in 2020, secondary schools in 2021 and high schools in 2022 in Japan. With this shift in education policy, the government aims to help students adapt to an era when concepts such as robots and artificial intelligence come to the fore. The media, volunteers and non-governmental organizations significantly support this plan (Murai, 2016; Verma (2016)). China is one step ahead of other countries in teaching programming. In China, programming courses are given to students during preschool period. Parents want their children to have programming courses. Programming courses are given to students in schools all over China. In these programming courses, students are taught the basics of programming, such as coordinate system, directions, as well as the basics of programming (Verma (2015)).

## Importance of Research

It aims to upskill students through collaboration, systematic thinking, creativity and skills to solve the problems optimally by focusing on integrating science, technology, engineering and mathematics within the framework of 21st century skills. Raising students, who have 21st century skills, with STEM and Robotics Coding education has become one of the leading goals of educational systems. Because of this, its importance in education seem to be increasing. Robotics Coding STEM activities contribute to the awareness of teacher candidates in science courses and to teaching science subjects more easily. These issues are currently being promoted in the Ministry of Education and are planned to be spread in schools.

Ministry of National Education, General Directorate of Innovation and Educational Technologies shared views about STEM education and Robotics Coding within the scope of the 2023 education vision;

"….Today, STEM education, which allows students to integrate their knowledge in Science, Technology, Mathematics and Engineering courses, is integrated into education system of many countries…. "

"… "Mobile code" application has been prepared for the purpose of digital content and skill-supported transformation in learning processes. The app, released in Education Information Network as a block-based coding game suitable for fifth and sixth grade Information Technology and software course achievements, was opened to the service of teachers, students and anyone interested in coding via the web, IOS and Android…"(YEĞİTEK (2019)).

## Purpose of Research

In this study, science teacher candidates were taught about Robotics Coding. Teacher candidates conducted Robotics Coding activities. The aim of this study is to examine the awareness of teacher candidates on the effect of Robotics Coding STEM activities on their skills in the science course.

For these purposes, answers to the following sub-problems are sought:

1) Do Robotics Coding STEM activities have an impact on teacher candidates ' awareness levels related to the use of science courses?
2) What are the opinions of teacher candidates about Robotics Coding STEM activities?

### Research Problem

Do Robotics Coding STEM activities have an impact on teacher candidates ' awareness levels related to the use of science courses?

## 2. MATERIALS AND METHODS

Qualitative research method was used in this study. Qualitative research represents the process of holistic examination of events and facts in a realistic environment. The content analysis method was used for the analysis of qualitative data. Content analysis is a systematic, repeatable technique in which some words of a text are summarized with smaller content categories with certain rules-based encodings (Büyüköztürk et al. (2013)).

### Sampling

32 science teacher candidates studying at a State University participated in the study voluntarily.

### Application

In this study, STEM education program covering Robotics Coding activities, which made learning simple and fun for science teacher candidates, were implemented. Robotics Coding activities aim to ensure permanant learning. This program lasted 2 hours a week for 12 weeks (total of 48 hours). For STEM activities, Arduino IDE and Fritzing programs for circuit diagram were taught. A brief summary of the application on STEM activities with Robotics Coding is given below and the work schedule is shown in Table 1.

### A Brief Summary of The Application

- Teacher candidates ' readiness levels for STEM education was measured. It was aimed to create awareness by using STEM activities in science science course. Detailed information was given about STEM education.
- For three weeks, teacher candidates were taught the Arduino IDE program, one of Robotics Coding. The download and installation of Arduino İDE was taught.
- For two weeks, teacher candidates were taught the Fritzing program for drawing the circuit diagram in Robotics Coding.
- After five weeks of training, 6 STEM activities related to Robotics Coding were conducted.
- Robotics Coding STEM activities enabled students to embody some abstract concepts in the science course. These activities ensure permanent learning.

| Table 1 Robotics Coding Activity Program | |
|---|---|
| **Week** | **Subject** |
| Week 1 | What is STEM education? |
| Week 2 | Teaching Robotics Coding; Arduino İDE |
| Week 3 | Teaching Robotics Coding; Arduino İDE |
| Week 4 | Teaching Robotics Coding; Arduino İDE |
| Week 5 | Teaching Robotics Coding Circuit Diagram; Fritzing |
| Week 6 | Teaching Robotics Coding Circuit Diagram; Fritzing |
| Week 7 | Robotics Coding Activity; Building Led Lights |
| Week 8 | Robotics Coding Activity; Outside Pressure Measurement |
| Week 9 | Robotics Coding Activity; Temperature Measurement |
| Week 10 | Robotics Coding Activity; Electric Current Measurement |
| Week 11 | Robotics Coding Activity; Soil Moisture Measurement |
| Week 12 | Robotics Coding Activity; Perception of Light |

Robotik Kodlama ile yapılan STEM etkinliklerin elde edilen devre şeması aşağıda etkinlik isimleriyle beraber yer almaktadır.

Activity 1: Building Led Lights

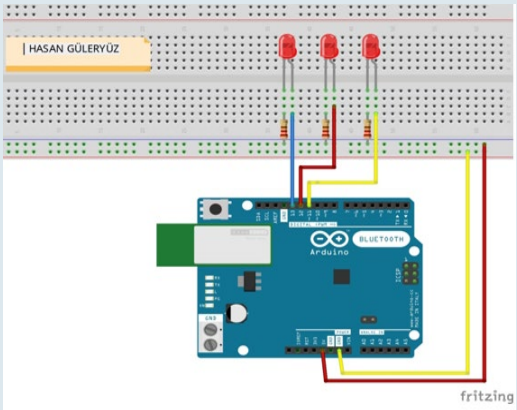
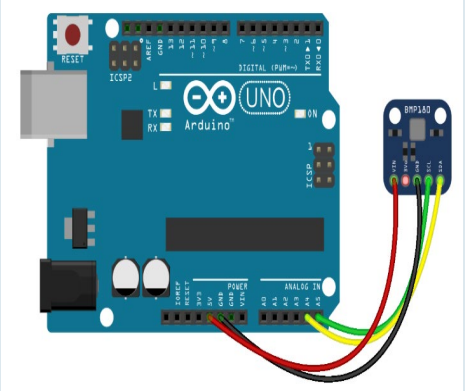
Activity 2: Outside Pressure Measurement

Activity 3: Temperature Measurement

Activity 4: Electric Current Measurement

Activity 5: Soil Moisture Measurement

Activity 6: Perception of Light

| Activity 1 | Activity 2 |
|---|---|
|  |  |

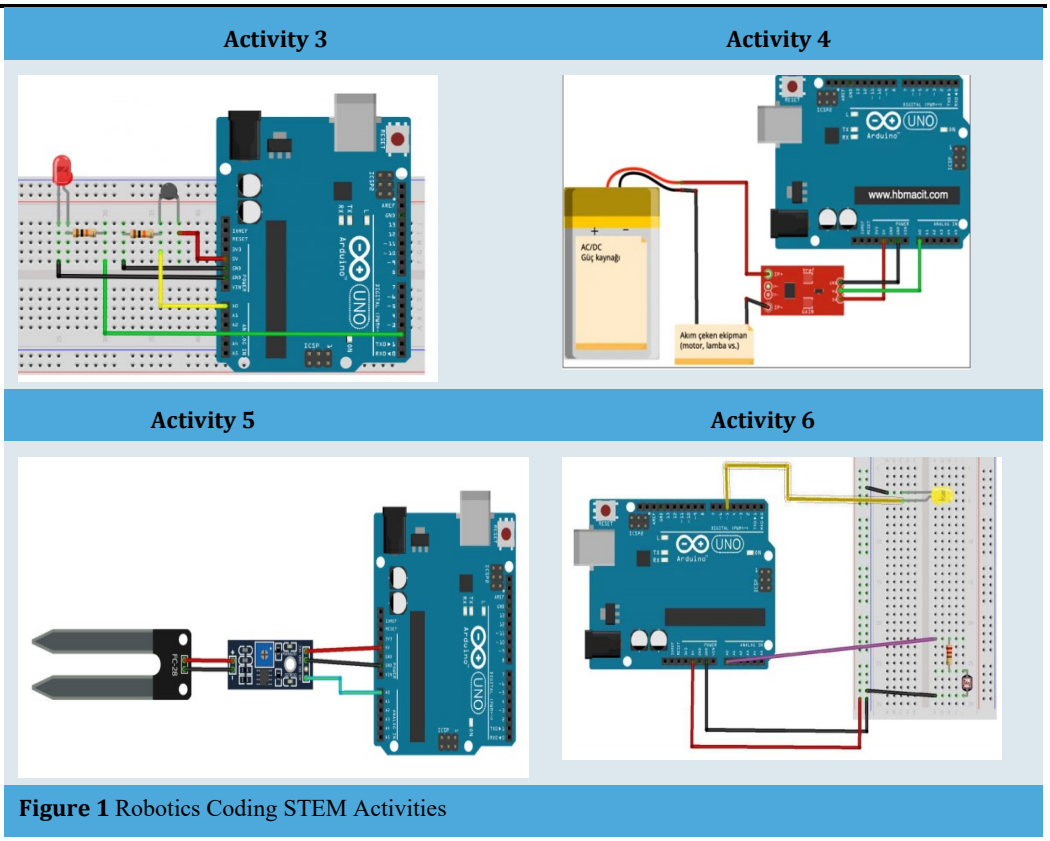



**Figure 1** Robotics Coding STEM Activities

### Data Collection Tools

For qualitative data, field notes and semi-structured teacher candidate interview forms were used. The researcher helped students whenever they needed to. Throughout the study, the researcher took field notes related to the activities. Field notes recorded by the researcher were given to teacher candidates at the end of the course, confirming the accuracy of the notes. Field notes were used in the analysis of qualitative data and the interpretation of events.

### Semi-Structured Questions

1) What are the benefits of STEM activities in science course?
2) What are the contributions of STEM activities to the science course?
3) How did Robotics Coding activities change your perception of science learning?
4) What are the advantages of Robotics Coding training in science course?
5) How did you experience a change in your learning life after Robotics Coding activities?
6) What are your suggestions for STEM activities in science course?
7) What are the limitations of giving Robotics Coding training in science course?

### Analysis of The Data

After completing STEM activities, a semi-structured interview form prepared with expert opinions was given to teacher candidates. It was declared that this form would not be used for academic evaluation, but would only be used in the study. Students were also asked not to write their names. In this way, an environment was

provided for teacher candidates to express their ideas in a more comfortable and neutral way.

By analyzing qualitative data, the awareness of teacher candidates on the use of STEM activities in science course was revealed. Opinions of teacher candidates were taken about the activities.

The data was first organized by the researcher and evaluated by two experts. The necessary changes were made as a result of evaluations by experts. Categories were created by the researcher. The categories were determined after taking of expert opinions.

## 3. RESULTS AND DISCUSSIONS

The answers of teacher candidates are given in tables below.

The answers of teacher candidates to the question of "What are the benefits of STEM activities in a science course? " are given in Table 2.

**Table 2** What are the benefits of STEM activities in science course?

| | F | % |
|---|---|---|
| Having problem solving skills | 17 | 45.9 |
| Benefitting from different disciplines | 14 | 37.8 |
| Learning engineering design processes | 9 | 24.3 |
| Having 21st century skills | 7 | 18.9 |
| Increasing interest in courses | 4 | 10.8 |

Examining Table 2, having problem solving skills stood at % 33.3, representing the highest rate, benefitting from different disciplines stood at % 18.4, increasing interest in courses stood at %7.8, representing the lowest rate.

STEM education is a curriculum based on the idea of educating students as producers and inventors through an interdisciplinary approach. STEM education integrates these four disciplines with a harmonious learning paradigm based on real-world production-oriented practices, rather than teaching them as separate subjects. It is an interdisciplinary project-based training model created by integrating STEM disciplines. In the project-based STEM education model, students think, design and produce. Thus, the student's position in education is changed. Thanks to STEM education, students have become individuals who wonder, ask questions and produce solutions. Thanks to these activities, interest and motivation of teacher candidates concerning science course increased.

Some answers of teacher candidates to the question of "What are the benefits of STEM education?" are given below:

TC (Teacher Candidate)3 "… I can transfer information through STEM activities. I combine my knowledge with different disciplines…"

TC14 "…. I learned engineering design processes with STEM activities. As a teacher candidate, it will be very useful to me in the future…"

The answers of teacher candidates to the question of "What are the contributions of STEM practices to science learning?" are given in Table 3.

**Table 3 What are the contributions of STEM activities to science learning?**

| | f | % |
|---|---|---|
| Increase of permanent learning | 24 | 64.8 |
| Embodying concepts | 20 | 54 |
| Practice-oriented rather than theory-oriented | 14 | 37.8 |
| Increasing curiosity and interest | 9 | 24.3 |
| Improvement of craft skills | 6 | 16.2 |

Examining Table 3, increase of permanent learning stood at % 64.8, representing the highest rate, embodying concepts stood at % 54, and improvement of craft skills stood at %16.2, representing the lowest rate.

STEM activities, which are widely used in education, cover multiple disciplines. STEM, which is used in the field of education especially in developed countries, is applied in schools as a lifestyle, not as a model. The main purpose of this approach is to make students successful.Therefore, students are offered an approach that they learn by living, doing, producing, and embodying what they have learned. With the increase of interest and curiosity in science through STEM activities, they expressed that embodying concepts enabled them to learn. The statements of teacher candidates support this.

The answers of science teacher candidates to the question of "What are the contributions of STEM activities to learning science?" are given below:

TC21: "…I realized that it increased my interest, curiosity, and desire to learn science subjects..."

TC 2: "…STEM activities helped ensure that learning became permenant…"

TC23: "…I enjoy STEM activities so much that I don't even understand how time passes…"

The answers of science teacher candidates to the question of "How has Robotics Coding activities changed your perception of learning in science subjects?" are given in Table 4.

**Table 4 How did Robotics Coding activities change your perception of science learning?**

| | f | % |
|---|---|---|
| Improvement of cognitive skills | 24 | 64.8 |
| Keeping up with the digital age | 18 | 48.6 |
| Ensuring permanant learning | 13 | 35.1 |
| Learning the working principle of many mechanisms | 9 | 24.3 |
| Ensuring the development of handcraft | 7 | 18.9 |
| Learning the programming language | 6 | 16.2 |

Examining Table 4, improvement of cognitive skills stood at % 64.8, representing the highest rate, keeping up with the digital age stood at % 48.6, and learning the programming language stood at %16.2, representing the lowest rate.

Robotics Coding activities significantly increase permanent learning by addressing more than one sense organ. With Robotics Coding activities, teacher candidates keep up with the digital age and have the necessary cognitive skills. The statements of teacher candidates support this.

The answers of science teacher candidates to the question of "How did Robotics Coding activities cause a change in your perception of science learning?" are given below:

TC28: "… I became aware that my cognitive skills were improving. I feel like an engineer…"

TC19: "… In order to be more useful to students, all teacher and teacher candidates should keep up with the digital age…"

The answers of science teacher candidates to the question of "What are the advantages of Robotics Coding training in science course?" are given in Table 5.

**Table 5 What are the advantages of Robotics Coding training in science course?**

| | f | % |
|---|---|---|
| Helping find solutions to problems | 26 | 70.2 |
| Ensuring awareness of many digital tools used in daily life | 18 | 48.6 |
| Increasing interest and curiosity | 12 | 32.4 |
| Boosting self-confidence | 9 | 24.3 |
| Enhancing creativity | 5 | 13.5 |
| Enhancing productivity | 4 | 10.8 |

Examining Table 5, helping find solutions to problems stood at % 70.2, representing the highest rate, ensuring awareness of many digital tools used in daily lifestood at % 48.6, and enhancing productivity stood at %10.8, representing the lowest rate.

Robotics Coding activities, which enable students to establish a cause-and-effect relationship and allow them to deal with problems that they are likely to encounter, are both instructive and fun. Due to Robotics Coding trainings, students can make logical decisions, learn to think critically, and evaluate all alternatives. Robotics Coding trainings open the doors of programming, software and design to students. All these allow students to have a vivid imagination. Robotics Coding helps students solve problems by breaking them into small pieces. It allows them to cope with the difficulties and find solutions. Robotics Coding activities provide the opportunity to embody concepts in science course. In this way, students ' interest in science subjects increases. The statements of teacher candidates support this.

Some answers of science teacher candidates to the question of "What are advantages of Robotics Coding training in science course?" are given below:

TC32: "… Robotics Coding activities in the science course has increased my interest and curiosity in science subjects…"

TC17: "… It enabled permanent learning by embodying some abstract concepts in science subjects…."

The answers of science teacher candidates to the question of "How did you experience a change in your learning life after Robotics Coding activities?" are given in Table 6.

**Table 6 How did you experience a change in your learning life after Robotics Coding activities?**

| | f | % |
|---|---|---|
| Increasing my interest and curiosity in programming | 30 | 81.3 |
| Increasing my motivation in programming | 27 | 72.9 |
| Enhancing my attitude toward Robotics Coding | 22 | 59.4 |
| Increasing my awareness about Robotics Coding | 18 | 48.6 |
| Increasing my productivity and creativity | 12 | 32.4 |
| Making learning easy | 11 | 29.7 |

Examining Table 6, increasing my interest and curiosity in programming stood at %81.3, representing the highest rate, increasing my motivation stood at %72.9, making learning easy stood at %29.7, representing the lowest rate.

Robotics Coding has become the focus of attention over time. Millions of students around the world participate in a series of competitions in which they have to design and program their own real robots. That's how it gained momentum. The statements of teacher candidates support this.

Some answers of science teacher candidates to the question of "How did you experience a change in your learning life after Robotics Coding activities?" are given below:

TC30: "…My self-confidence has increased with Robotics Coding activities conducted within the scope of STEM education…"

TC9 "…. Robotics Coding activities are so enjoyable that I am not aware of how time passes…"

The question of "What are your suggestions for teachers who will conduct STEM activities in science course as teacher candidates?" was asked to science teacher candidates and the answers are given in Table 7.

**Table 7 As teacher candidates, What are your suggestions for teachers who will conduct STEM activities in science course?**

| | f | % |
|---|---|---|
| Knowing the interdisciplinary approach | 26 | 70.2 |
| Knowing the engineering process | 23 | 62.1 |
| Having sufficient knowledge about STEM | 22 | 59.4 |
| Having full knowledge of science subjects | 15 | 40.5 |
| Using time effectively | 9 | 24.3 |
| Preparing the designs that students can do in advance | 4 | 10.8 |

Examining Table 7, knowing the interdisciplinary approach stood at %70.2, representing the highest rate, knowing the engineering process stood at %62.1, preparing the designs that students can do in advance stood at %10.8, representing the lowest rate.

It is very important for science teacher candidates to have positive thoughts toward STEM and its activities in terms of science education. It is also very important for science teachers to have a positive attitude toward activities that will ensure effective learning in students. Science teachers who are open to innovation are wanted to educate their students as students who can also research, question, have scientific curiosity, and are open to innovation. In order to have STEM literacy, first of all, teachers should be able to master their field, know the interdisciplinary approach and easily transfer the knowledge they have. In order to be an equipped teacher in STEM activities, he should trainned in this field. The statements of teacher candidates support this.

Some answers of science teacher candidates to the question of "What are your suggestions for STEM activities in science course?" are given below:

TC 8: "…I think that the STEM education approach should be learned from people who are experts on this issue and studies should be examined…"

TC19: "… In order for STEM education to be successfully applied in classrooms, it is absolutely necessary for teachers to be trained within the scope of a program in the form of in-service training…"

The answers of science teacher candidates to the question of "What are the limitations of giving Robotics Coding training in science course?" are given in Table 8

**Table 8 What Are The Limitations Of Giving Robotics Coding Training In Science Course?**

| | f | % |
|---|---|---|
| The lack of teacher who can give programing training | 35 | 94.5 |
| The lack of equipment in classrooms | 28 | 75.6 |
| The lack of equipment | 28 | 75.6 |
| Less lesson hours | 15 | 40.5 |
| Level of readiness of students | 10 | 27.2 |
| The lack of self-confidence of students | 4 | 5.4 |

Examining Table 8, the lack of teacher who can give programing training stood at %94.5, representing the highest rate, the lack of equipment in classrooms stood at %75.6, the lack of self-confidence of students stood at %5.4, representing the lowest rate.

Thanks to Robotics Coding, students can use robotic technologies, create new products, search for solutions to the problems of daily life, solve the problems they face more easily, work in cooperation, take responsibilities, comprehend the working mechanism of technological tools, and evaluate events critically. Thanks to Robotics Coding, students can get acquainted with coding and start writing code more permanently, effectively and easily. To achieve this, there should be sufficient and equipped teachers and necessary Robotics Coding workshops. As part of STEM training, there is lack of teachers in the field of Robotics Coding, and STEM

labs/workshops are not equipped enough. The statements of teacher candidates support this.

Some answers of science teacher candidates to the question of "What are the limitations of giving Robotics Coding training in science course?" are given below:

TC14: "…As a science teacher candidate, we need to improve ourselves in the field of Robotics Coding for our students…"

TC25: "… For Robotics Coding activities conducted within STEM education, much more time should be allocated in the weekly course curriculum and a programming workshop should be established in each school for activities…"

**Providing 21st Century Skills**

The aim of early Robotics Coding training is to provide 21st century skills with students. Programming is not only limited to computer science, but is also very important in terms of interdisciplinary (STEM) interaction. By gaining algorithmic thinking skills at an early age, students will be able to solve problems in different areas by thinking creatively (Güleryüz et al. (2019); Güleryüz (2020)).

Robotics Coding is not just the coding of the given material. Creating a product that works is also part of Robotics Coding. The first step is to imagine. Then, the product is designed and made functional with programming. Thus, it is aimed to provide creativity out of 21st century skills with students. Obviously, Robotics Coding training is effective in providing creativity, problem solving, and responsibility skills with students, but not limited to them. It also provides information literacy, critical thinking and teamwork skills with students. Students are expected to have 21st century skills and integrate them into their life in order to be individuals who are useful for their country. It is one of our duties to provide the necessary opportunities for children to gain these skills. STEM provides the best solution to the problem statement with science, technology, engineering and mathematics tools (Beswick and Fraser (2019); Stehle and Peters-Burton (2019),; Walan (2019)). Some answers of teacher candidates are given below:

TC26: "… Thanks to Robotics Coding activities, I feel myself as a 21st century student…"

TC12: "… All teachers should have full knowledge of 21st century skills…"

**Keeping Up With Digital Age**

The world is changing fast. Teachers have to adapt to this rapid pace of change and innovation. This rapid change lays a burden on everyone, especially teachers, in the process of adapting to life and society. From education to health, from production to economy, we are in a new era. In Industry 4.0, education needs to keep up with this change and even guide it. Industry 4.0 means the digitalization of the industry, its automation, and its equipping with high technology.Our age is the age of technology, the way we prepare for competition in this age is to give our students opportunities and provide them with such environments. In order to keep up with the digital age, we see that different technological projects have emerged with these opportunities that we offer to our students. Thanks to Robotics Coding activities within the scope of STEM education, our students improve their 21st century skills and and keep up with the digital age. Within the STEM education, our aim is to allow students to find the best solution by themselves. We encourage our students to find their own solutions to the problems they face, using their imagination, which has the biggest differences, through simple and limited materials, by providing different scenarios for the problems they may encounter in daily life. We want our students to understand the basis of teamworking and find new solutions for problems (Berlin

and Lee (2005); Daugherty (2013)). Some answers of teacher candidates are given below:

TC30: "… It is necessary to break away from rote learning... We also need to keep up with the digital age…".

TC18: "…. When I learn science subjects through Robotics Coding activities, I realize that I keep up with the technological age…".

**Embodying Concepts Related To Science**

In rapidly digitalizing world, we now have new tools to embody abstract concepts. The most important of the tools to facilitate learning is the computer and then the Internet. Today, a more specialized field, Robotics Coding, has come to the fore. We need to embody abstract concepts for learning and teaching easily. Therefore, the use of programming in education makes learning more effective. But this time, what we code is a concrete object that we can touch. For students, it is very important that what they code is come back to earth.Robotics provide the opportunity to plan real-world activities that help understand the abstract concepts of distance, speed, time, environment, diameter, heat, angle, light and so on. Robotics Coding activities can be planned in accordance with the achievements that need to be acquired in the fields of mathematics and science. But due to the nature of Robotics Coding, a concept in the field of mathematics covers the fields of science, technology, engineering and mathematics. At this point, a targeted gain in mathematics is achieved, while at the same time, the ability to think systematically, solve problems, and see the relationships between events develop simultaneously in the stages of Robotics Coding (Cameron (2005); Wang (2012)). Some answers of teacher candidates are given below:

TC1: "… I had the opportunity to embody some abstract science subjects with Robotics Coding activities…"

TC13: "… The embodied information is easier to learn…".

**Integration Of Robotics Coding Into Science Course**

The activities focuse on maximizing students ' skills in all fields and especially their skills in the field of science. The aim of this research is to enable science teachers to integrate Robotics Coding activities into their courses. In addition, teachers will be able to develop science projects with Robotics Coding. The integration of Robotics Coding activities within STEM education helps students to learn effectively. In the integration of STEM disciplines, teachers ' perspectives on Robotics Coding, their knowledge of other disciplines, and their field knowledge are important (Ministry of Education. (2018b); Ríordáin et al. (2016)). Some answers of teacher candidates are given below:

TC22: "… I find that I learn effectively and more easily with the activities conducted... The activities are very enjoyable…".

TC3: "… In the integration of Robotics Coding with science, my field-related skills are enhanced... I feel like an engineer…".

TC13: "… If there were not Robotics Coding STEM activities, we, as science teacher candidates, would not have learned Robotics Coding …".

It can be said that the training given in this study, which aims to determine the views of teacher candidates who receive robotic coding training within the scope of STEM activities, has given positive results. Structured interview and activities with teacher candidates gave positive feedbacks. Teacher candidates conducted 6

activities related to Robotics Coding. At these activities, the Arduino Ide program and the Fritzing program for the circuit scheme were taught to teacher candidates. Two of the objectives of the research are to teach teacher candidates Arduino Ide program and Fritzing programs, and to enable them to learn some abstract science concepts. At the end of the study, with the Robotics Coding training, they were able to use Arduino Ide and fritzing programs on their own and use them in projects.

The results of this study support the results of Güleryüz et al. (2020)'s study on teacher candidates' views on Robotics Coding training. Güleryüz, et al. In this study, they emphasized the need for teacher candidates to have 21st century skills and to keep up with the digital age. According to Güleryüz et al. (2020), Robotics Coding activities have increased motivation of teacher candidates for science courses. As part of STEM education, integrating science and programming, it is believed that learning can be permanent and more meaningful by embodying some abstract science concepts that are difficult to understand.

In addition, the results of this study support the study of Sayın and Seferoğlu (2016), which examined the place of programming training in education policies. Khanlari (2013) determined that Robotics Coding activity is an effective tool for developing 21st century skills such as collaboration, communication and social responsibility. Examining the literature, in the studies on robotics and programming training, similar results were obtained (Benitti, 2008; Datteri (2013); Güleryüz et al. (2020); Güleryüz (2020); Gültepe (2018); Sullıvan (2008); Şenolm and Büyük (2015); Şenol and Demirer (2017); Welch and Huffman (2011)).

On the other hand, it has been found that there are very few national academic studies related to Robotics Coding. This indicates that this study contributes to the literature.

Based on the results of studies on programming education, it seems that programming is becoming a very important requirement in teaching science. The activities conducted within the scope of the study supported this. In 2018 the updated framework of qualifications in the teaching of sciences in the context of Turkey, life skills, engineering, and design skills were regarded andthroughout the program, the importance of Science, Engineering and Entrepreneurship practices and interdisciplinary practices in solving the problems faced in daily life were emphasized. Therefore, it is understood that the new science course curriculum also includes interdisciplinary practices emphasized by STEM. This has brought to the forefront the knowledge, skills and attitudes of teachers who are practitioners of the program towards STEM activities. Therefore, teachers ' perspectives on STEM, their knowledge of other disciplines, and their knowledge of the field are important in the integration of STEM disciplines (Ríordáin et al. (2016)).

## 4. CONCLUSIONS AND RECOMMENDATIONS

Teacher candidates expressed that STEM Robotics Coding activities integrated into education system enabled making learning permanent. On the other hand, teacher candidates expressed that they had fun and increased motivation in relation to the education they received. The need to keep up with the digital age and have 21st century skills is frequently emphasized both by the Ministry of education and in scientific studies. Giving Robotics Coding as a course is important in terms of keeping up with the developing and rapidly changing technology. Robotics Coding positively contributes to obtaining 21st century skills such as problem solving, creativity, critical thinking skills and cooperation-communication. Robotics Coding training has enabled teacher candidates to see, experiment and measure the results

of their projects in the real world in many subjects. Thus, thanks to coding, they have used an important tool such as robot in education in order to teach abstract concepts by concretizing them. Robotics Coding provides the opportunity to teach concepts in science, mathematics, chemistry, and many other fields. In addition, programming activities have attracted a lot of attention from students, making lessons more enjoyable. Thanks to Robotics Coding activities in science course, teacher candidates have increased their awareness of and motivation. A teacher candidate's opinion on this issue is as follows: "I can design any activity related to Robotics Coding. I have the self-sufficiency to take part in a project." In addition, the activities provided a high motivation with teacher candidates for lessons and projects. A teacher candidate expressed this situation as follows: "I had a lot of fun in training and my interest and motivation for the lesson increased". This has a leverage effect on learning. Robotics Coding activities significantly increase permanent learning by addressing more than one sense organ.

According to these results, it is believed that there will be no difficulties in ensuring the integration of Robotics Coding with science course within the framework of STEM.

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