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Pre-Service science teachers' experiences with robotic intervention process

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Abstract

In the digital world, where robotics implementations are taking a place in educational processes with increasing acceleration, it is important that pre-service teachers gain competences in this field that addresses the needs of the future. From this point of view, the aim of this study is to design an activity process in which pre-service science teachers will experience robotic implementations and to determine their opinions about this process. In line with this aim, a four-week out-of-school activity process which was implemented with 46 pre-service science teachers was designed. In this process, pre-service teachers were provided iDea software to design. The data of this case study was collected through a structured interview form. According to the results, it was concluded that the awareness and curiosity levels towards robotic implementations of pre-service teachers increased and their confidence in their own competence levels increased through the experiences gained by the participants in the activity process.

Keywords: Robotics, iDea, Teacher education

1. Introduction

During the last decade, robotic interventions have caught interests of teachers and researchers since these interventions are seen as valuable tools to improve cognitive and social skills of students from pre-school to high school and to support learning in science, mathematics, technology, informatics and other school curricula or interdisciplinary learning activities (Alimisis, 2013). The natural admiration of individuals and their identification with robots have made robotics an ideal teaching and learning platform, and the robotic activities used in teaching processes have gained popularity due to the

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natural tendencies of robots to attract the student's attention (Barker, Grandgenett, Hanpton & Nugent, 2008).

The strengths of robotic interventions used for educational purposes in teaching environments stem from the characteristics of robotics in which a student expands the learning environment to include the world around him/her and provide a more meaningful and related learning experience, and this educational process is carried out with the practical, student-oriented and collaborative learning aspects of robotics (Cummings, 2017). Robotic interventions offer students the opportunity to interact with objects and the programming component of the robotics curriculum through the physical structure of a robot. Robotics lessons involve students in challenges involving open-ended practices and the lessons are based on previous knowledge to help the students cope with new challenges. This situation provides an opportunity to see the defects in the thinking processes and to associate the detected defects with new information (Klein, 2009).

When the related literature is examined, it is seen that various contributions of robotic implementations to educational processes are frequently emphasized. For example, Barker and Ansorge (2007) investigated the effect of robotics on the teaching of science, engineering and technology within the scope of the research that was conducted through the post-school program with 32 secondary school students aged 9-11. As a result of the research carried out focused on teamwork, researchers stated that robotic intervention was statistically more beneficial in the acquisition of the learning outcomes in the curriculum. Nugent, Barker, Grandgenett and Adamchuk (2010) designed two different interventions for their study in which they investigated the effect of robotics on the attitudes and STEM learning of secondary school students. The first intervention was an intensive robotics summer camp which consisted of 40 hours. The second was a 3-hour activity that aimed to the introduction of the robotic technologies. Within the scope of the study results, it was stated that there was a statistically significant increase in the learning levels of the students with the long-term intervention process. However, while it was determined that the short-term intervention process was not effective on the learning variable, it was emphasized that this process primarily affects students' attitudes and motivations. Similarly, within the context of an 8-year project carried out by Nugent, Barker, Grandgenett and Welch (2016), it was focused on the knowledge and attitudes of approximately 5000 secondary school students towards science, technology, engineering and mathematics (STEM) and career interests in the field of STEM by means of out-of-school learning environments created through robotic camps and clubs. According to the results obtained from this study, it was explained that robotic activities caused an increase in the content knowledge of STEM, students' problem-solving skills and their interest in engineering career.

The importance of robotic interventions that contribute to STEM education, which is one of the most important approaches that support the development of skills such as critical thinking, communication, collaboration and creativity qualities (Akgündüz, Aydeniz, Çakmakçı, Çavaş, Çorlu, Öner & Özdemir, 2015), which is described by The Partnership for 21st Century Learning (P21, 2019) and defined as the characteristics that 21st century individuals should possess, becomes clear for educational environments. Some of the special effects of robotic interventions on educational processes can be explained in general as follows: Robotic interventions support creativity (Khanlari, 2013; Martin, 2001). They also supported several skills such as problem solving skills (Verner & Ahlgren, 2004), communication skills (Eguchi, 2014; Sklar, Eguchi & Johnson, 2003; Khanlari, 2013), critical thinking skills (Özel, 2018), personal development skills (Sklar, Eguchi & Johnson, 2003) and collaboration skills (Eguchi, 2014; Khanlari, 2013; Özel, 2018; Verner & Ahlgren, 2004). Besides, robotics ensures teamwork (Khanlari, 2013; Sklar, Eguchi & Johnson, 2003). These interventions enhance interest towards STEM field (Eguchi, 2016; Nugent, Barker, Grandgenett & Welch, 2016; Özel, 2018). When effects of robotic interventions on learning processes, it is seen that the interventions improve self-directed learning (Martin, 2001) and provide multidisciplinary learning environment (Johnson, 2003). In addition to these, robotics promotes science learning (Barker & Ansorge, 2007; Mataric, 2004; Nugent, Barker, Grandgenett & Adamchuk, 2010; Nugent, Barker, Grandgenett & Welch, 2016; Özel, 2018).

In line with the expressed advantages and increasing popularity of robotic interventions, the accessibility of robotic platforms and programs, which provide easy use opportunity for students of both undergraduate and graduate education levels, as well as school age children, to begin their studies in the field of robotics, is increasing rapidly especially in recent years (Mataric, 2004). However, although educational robotics have been available for several years, many teachers are reluctant to guide students in a robotic intervention curriculum and most teachers do not have any experience with robotics technologies (Cummings, 2017). As a matter of fact, it is emphasized that professional development related to the subject is necessary for teachers and it is important to ensure this development (Cummings, 2017). Indeed, the effect of robotic interventions on the development of 21st century skills, which are expected to be developed by individuals and have an increasing popularity day by day, is frequently emphasized in the related literature. For example, Khanlari (2013) reported that robotics can be used as an effective tool to enhance students' several skills such as creativity, collaboration, team-working, self-direction, communication, social and cross-cultural. In this context, it can be stated that robotics is among the tools that will help students be ready for the 21st century and meet the expectations of the future world. For this reason, it is important that the students of education faculty who are teachers of the future gain experience and knowledge about robotics by having experience in their learning processes to guide their own future students for robotic interventions. From this point of view, the purpose of this study was stated as designing an intervention process in which pre-service science teachers will experience robotic implementations and determining their opinions about this process.

2. Method

This study was designed according to the case study which is one of the qualitative research methods. Case study is a type of research that includes rich descriptions of the situation determined within the scope of the research and aims to determine the perceptions of the participants about the research subject (Hitchcock & Hughes, 1995). In this type of research, the purpose of the research is expressed as a case (Stake, 1995). In this context, the case of this study can be identified as the pre-service science teachers' perceptions about robotic interventions.

2.1. Participant (subject) characteristics

This study was conducted with 46 senior students who were studying in the science education department of an education faculty at a public university in Turkey. The study group consists of volunteer pre-service teachers who are registered to the course termed as "Technology and Design" which is an elective course. 38 of the participants are women (83%) and 8 of them are men (17%). In order to protect the confidentiality of the participants during the presentation of the findings regarding the data obtained, each pre-service teacher was named using the "PST_n" (such as PST_1, PST_2,…, PST_{46}) coding.

2.2. Measures and covariates

The data of this study were collected through a structured interview form. Structured interview method is the type of interview in which content and procedures are organized in advance. Within the scope of this process, the order and expressions of the questions are determined through a plan and this interview method give the interviewer very little freedom to make changes. Some parts where the interviewer is allowed to make modifications may be specified in advance. Therefore, this type of interview is considered a closed situation (Cohen, Manion & Morrison, 2007).

The data collection process was carried out through the pre-interview held at the beginning of the intervention and the post-interview conducted at the end of the intervention process. While the pre-interview form consists of 6 open-ended questions, the post-interview form includes 3 open-ended questions. During the preparation of the interview questions, 5 field experts evaluated the questions, and forms were created in line with the expert opinions. The forms of the interview processes are presented in Table 1 and Table 2.

Table 1. Pre-test form

Interview Phase	Directions	Time
Beginning	Explaining the purpose of the interview Informing about the confidentiality of the interview Asking permission for recording	5-6 min.
Interview Questions	1. If you have participated in any coding or robotic intervention before, please provide information about your experience. 2. Can you explain your opinions on the usability of robotic technologies in educational environments? 3. Explain whether you want to learn more about robotic technologies along with your reasons, please. 4. How would you describe your level of efficacy at a robot programming? 5. Explain how often you follow the studies in the field of robotics, please. 6. Describe the topic that interests you most in the field of robotics, please.	35-40 min.

Table 2. *Post-test form*

Interview Phase	Directions	Time
Beginning	Explaining the purpose of the interview Informing about the confidentiality of the interview Asking permission for recording	5-6 min.
Interview Questions	1. Can you explain your opinions on the usability of robotic technologies in educational environments? 2. How would you describe your level of efficacy at a robot programming? Please justify your answer by evaluating the robotic intervention you attended. 3. Explain how often you follow the studies in the field of robotics, please.	25-30 min.

2.2.1. Intervention Process

This study was carried out through a 4-week out-of-school activity process within the context of two-hour sessions per week. In this process, the program called iDea (http://www.robotsan.com.tr) was used. As a block-based software, iDea offers the opportunity to develop algorithms with its Turkish interface. In this context, it can be stated that the software in question is based on visual programming. Within the scope of this study, iDea is preferred because the software offers the opportunity to develop algorithms with visual programming and provides Turkish language support. The list of materials used within the scope of the intervention process is presented in Table 3.

Table 3. Material list

Material	Count
Computer with internet connectivity	1 for each group
iDea brochure	1 for each student
Wooden design brochure	1 for each student
Content schedule	1 for each student
iDea set	1 for each group
Wooden design set	1 for each group

The process for robotic intervention involves the following steps.

- Introducing the basic concepts of robotics
- Introducing hardware of iDea
- Introducing use of iDea
- Design process
- Associating hardware of iDea set to design
- Coding implementations

In design process, pre-service teachers prepared their own wooden models. At this stage, participants experienced the process of revealing a product by working in the light of learning outcomes of the course subject termed as "Science, Engineering and Entrepreneurship Practices" which is within the scope of each grade level of the secondary school science curriculum. The set offered to students for wooden design has semi-structured content. The content schedule applied during the intervention process is explained in Table 2 and also presented instance photographs (Figure 1-3) of group works.

Table 2. Content schedule

Week	Session	Chapter	Subject Matter
1	1	Chapter 1: Basic Concepts of Robotic Programming	What is Robotics? What is a Robot? Working Principle of Robots
	2	Chapter 1: Basic Concepts of Robotic Programming	Basic Components of Robots Usage Areas of Robots
2	1	Chapter 2: Robotic Project Development	Algorithms and Programs RS iDea
	2	Chapter 2: Robotic Project Development	Implementations with Real Robot Kit (O-bot) RS iDeaSim
3	1	Chapter 3: Robotic Project Implementations	Actuator and Producer Command Applications
	2	Chapter 3: Robotic Project Implementations	Sensor Command Applications
4	1	Chapter 4: Design and Implementation	Preparing Wooden Design
	2	Chapter 4: Design and Implementation	Coding Wood Design with iDea

Figure 1. Editing semi-structured wooden model pieces

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Figure 2. Designed windmill

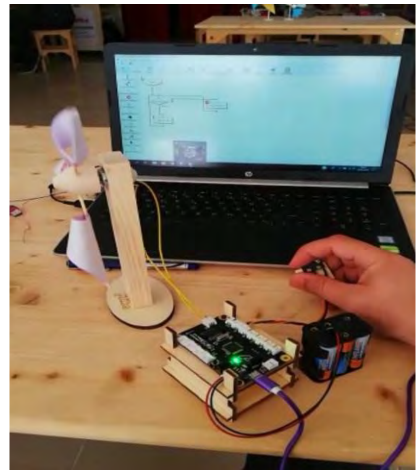

Figure 3. Associating iDea set to design

3. Results

In this section, the findings related to each interview question used in the processes of pre-interview at the beginning of the intervention and the post-interview after the completion of the intervention are presented respectively.

3.1. Statistics and data analysis

In this study, content analysis method was used to analyze qualitative data. This method is defined as the process of summarizing and reporting data written in the context of basic content and messages (Cohen, Manion ve Morrison, 2007). The steps followed in the analysis process were determined as: (1) Coding the data, (2) finding themes, (3) editing the codes and themes obtained, and (4) interpreting the findings (Creswell, 2003). In line with these determined steps, in the process of analyzing the data obtained through the structured interview form, transcription was made first. Then, common descriptions which were mentioned by different participants were determined, and codes were created. By identifying the common points of the codes obtained, similar codes are categorized within the framework of the main idea that they represent. Themes were obtained through this process (Yıldırım & Şimşek, 2011).

3.2. Pre-interview process

With the pre-interview process, it was aimed to determine the pre-service teachers' existing experiences and opinions regarding robotics and coding. For this purpose, participant responses for 6 open-ended questions in the form are included in this section.

Question 1. If you have participated in any coding or robotic intervention before, please provide information about your experience.

When the answers given to this question were analyzed, it was seen that 25 pre-service teachers stated that they had not participated in any robotic intervention before or had no such experience. 21 pre-service teachers identified that they were involved in robotic interventions through various lessons or courses. The answers of the pre-service teachers who experience these practices are presented in the following table.

Table 5. Robotic experiences of pre-service teachers

Category	Code	n
Software	Arduino	13
	Mblock	3
	iDea	3
	C++	1
Implementation	LED circuit	7
	Buzzer	1
	Sound	1

12 of the pre-service teachers who stated that they participated in robotic intervention determined that they could not remember the details about the software they used or the implementations they did. These participants could not make any explanation about the steps they followed in their studies and the usage of the software which they experienced. 1 pre-service teacher reported that he could not even remember the name of the software he used in that process. Examples of participant responses are presented below:

PST_{24}: "I've done a study about Arduino before. I do not remember the program used. But our work was mainly on understanding how robotic objects work… But as I said, I don't remember much…"

PST_{25}: "I participated in a robotic intervention that lasted for 2-hours session in theory. Unfortunately, I can't remember what was told..."

PST_{27}: "We coded with the Arduino, but I cannot remember in detail..."

PST_{30}: "I received robotics education in special teaching methods course. We made coding with mBlock software. We used Arduino, breadboard, sensors and many other materials. We prepared and presented a project at the end of the term."

PST_{31}: "We did Arduino study with mBlock. We created a series of codes by making sounds at various intervals and lights together with the sound…"

Question 2. Can you explain your opinions on the usability of robotic technologies in educational environments?

When the answers given to this question were investigated, it was seen that 1 participant stated that he could not be sure about the usability of these implementations in the classroom. Also, it was determined that 4 participants expressed negative opinions that activities based on robotics were not practicable for learning processes. The reasons for these opinions of these participants in reference to this situation are presented in the following table.

Table 6. Negative participant views on the usability of robotic technologies

Code	n
High cost	2
Physical conditions of the school	2
Curriculum	1

PST_{39}: "It can be used in city centers, metropolitans, but in poor community, that is, if the possibilities are limited, it will not be available. Because it can be expensive. For this reason, I think use of robotics in the classroom cannot be generalized…"

PST_{46}: "It is difficult to use due to the school facilities and curricula in our country. But I think it would be good if it could be used. But of course, as I said, I think the availability is low in these conditions…"

When the responses of the participants who present positive opinions about the usability of the robotics were examined, it was seen that 1 participant stated that these activities could be practicable under the condition of "correct and appropriate use". It was also seen that 39 participants expressed their opinions about usability of these technologies within the framework of various focus points. In this context, participant responses are gathered under 6 categories termed as learning process, individual development, individual desire, needs of implementation, conditions of implementation and needs of the age. While participant responses about the advantages of robotic technologies to the educational environments composed the category termed as learning process, the qualifications and skills that are stated to be gained to the students through the environments supported by the mentioned technologies are brought together under the category of individual development. In addition, participants' opinions that the courses containing robotic technologies will increase the interest and willingness towards the lesson by encouraging the student shaped the category termed as individual desire. Participant responses which list the requirements that will be needed for performing activities based on robotic technologies and stated that these technologies will be practicable through the provision of these requirements constituted the needs of implementation category. Similarly, some participants based on the factor of interest in the availability of these technologies, and a category termed as conditions of implementation was created in line with these responses. In addition, in the light of participant responses focusing on the opinions of individuals existing in the digital world to gain familiarity with robotic technologies in order to be ready for their expectations and future lives, the category called the needs of the age has been structured. The categories obtained and their codes are presented in Table 7.

Table 7. Positive participant views on the usability of robotic technologies

Category	Code	n
Learning Process	Supporting learning	15
	Permanent learning	3
	Easy learning	2
	Supporting clarity	2
	Applied learning	2
	Creating an easy activity	2
	Saving on time	1
	Creating STEM activities	1
	Embodying abstract concepts	1
	Efficient learning	1
Individual Development	Creativity	2
	Sense of discovery	1
	Problem solving skills	1
	Innovative thinking	1
	Scientific literacy	1
	Supporting mental activity	1
Individual Desire	Interesting	7
	Remarkable	2
	Increasing willingness	1
	Experiencing a sense of success	1
Needs of Implementation	Preparation of the appropriate environment	8
	Increasing teacher education	2
	Cost reduction	1
	Establishing interdisciplinary relationship	1
	Low class size	1
Conditions of Implementation	Student interest	2
	Teacher interest	1
	School interest	1
Needs of The Age	In compliance with the needs of the future	4
	In compliance with student expectations	2

When Table 7 is examined, it was seen that pre-service teachers present opinions about the possible effects of robotic technologies on the learning process in general. At this point, it was determined that the most common opinion (n = 15) is that an educational environment which includes these technologies will support the learning process. However, it was seen that the number of participants who expressed their opinions on the category of individual development was quite low. Pre-service teachers stated that an interesting process will be prepared for students by using robotic technologies in classroom environments. It is the opinion that the most emphasized point (n = 7) under the category of individual desire is that these technologies are interesting. In addition, pre-service teachers formed the most frequently expressed topic in the needs of implementation category with their views (n = 8) on the preparation of a classroom environment that contains the necessary equipment for robotic technologies and has appropriate physical conditions. Also, 4 pre-service teachers came together in the conditions of implementation category with their opinions regarding the necessity to have individual interest in these technologies in order to use robotics. Participant responses collected within the scope of the code termed as in compliance with student expectation (n = 4) which is the most expressed code in the needs of the age category is that technology based activities are in line with student expectations by stating that the new generation has grown up with technology. Examples of participant responses for these views are presented below:

PST_1: "I think that it will create and develop innovative and creative thinking skills for the problem situation in the educational environment. In this way, students will be able to easily solve their daily problems.…"

PST_4: "… I think a reduction in costs will increase usability. Of course, the education given to teachers should also be increased."

PST_{22}: "In this way, our students, our next generation, will become a society that produces from being a consumer society. In other words, students will be trained in accordance with future times. Because technology has increased a lot and I think robots are spreading every day."

PST_{25}: "It would be a positive practice to motivate students to discover. But our educational environment must be arranged accordingly. In other words, the way of sitting in classrooms, computer labs, etc. should all be adjusted accordingly. Materials must be purchased. If these are provided, that is to the benefit of the students. I think we will provide permanent learning because our students will learn by practicing."

PST_{26}: "When the robot is used, we draw the attention of the students more. Thus, the subject is better understood …"

PST_{31}: "I think it would be beneficial if used properly. Because I think it is hard to meet the expectations of the new generation and they want to see different things…"

PST_{37}: "I believe that the mistake of robotics perception will be overcome and the prejudices against these technologies will be destroyed. So, I think it can be used in the classroom, it would be nice. Because the students will start the next step with the happiness of the sense of accomplishment with the use of robots. I believe that they will develop their own techniques and, ultimately, their level of reading science will go up with practice."

Question 3. Explain whether you want to learn more about robotic technologies along with your reasons, please.

Answers to this question showed that all participants were willing to improve themselves on this issue. However, 1 participant added that he wanted to get a certificate about robotics. While pre-service teachers were expressing their opinions about this issue, they made evaluations within the framework of various main ideas. In this context, 4 categories termed as professional goal, professional perception, individual perception and the needs of the age have been obtained. Opinions that generated the professional goal category touched upon the participants' goals for their future professional lives. The category of professional perception includes the responses of pre-service teachers focused on the place of teaching processes supported by robotic technologies in education. When the individual perception category is investigated, it is seen that the mentioned category is shaped within the framework of the participants' own perspectives on robotic implementations. The needs of the age category was determined to be composed of pre-service teachers' views on the relationship between future and robotic technologies. Mentioned categories and the codes that constitute these categories are presented in Table 8.

Table 8. Reasons for wish of knowledge acquisition about robotics

Category	Code	n
Professional Goal	Teaching their students	10
	Being the teacher of the new generation	5
	Contributing to the future	4
	Raising creative individual	3
	Raising innovative individual	2
	STEM studies	1
	Project development	1
Professional Perception	Popularity in education	7
	Useful for student	4
	Student interest	4
Individual Perception	Interest	7
	Funny	2
	Riveting	2
	Making daily life easier	2
	Concern	1
Needs of The Age	Supplying the needs of the future	14
	Consonant with the age	5

It is seen that 7 different codes were formed within the scope of the professional goal category. It was determined that the most emphasized point (n = 10) within the scope of this category is the desire of the participants to teach robotic technologies to their future students. Besides, their views are remarkable that they want to develop themselves by learning new strategies such as robotics in order to teach the new generation, and that they aim to enable their students to develop themselves in this field in order to contribute to the future by supporting the development of the country. The category called professional perception contains the responses of the participants (n = 7) which expresses that robotic implementations should be learned because they are an area of interest in today's education and are increasing in popularity every day. In addition, it was observed that the participants who thought that the students were interested in this field and that robotic technologies would be useful for their future students arrived at a consensus in this category. It was determined that the most emphasized point (n = 7) within the framework of the individual perception category was the responses of the participants who expressed their individual interest in the studies in the field of robotics. One participant stated that he thinks that he has little knowledge about robotic technologies and therefore wants to improve himself to overcome his anxiety for making implementation. In the needs of the age category, it was determined that the most emphasized common opinion of the participants (n = 14) which stated that it is necessary to obtain information in the field of robotics in order to meet the needs of the future, since robotic technologies will become more important in the future and these technologies will confront human beings in all areas of life. Examples of participant responses to this question are presented below.

PST_1: "We need individuals who are open to innovative and creative thinking in order not to miss the technological age in the future. In order to meet this need, I want to be among the science teachers who can support these achievements."

PST_3: "I want it because I think the future is the robotic coding period."

PST_{10}: "In the future, these implementations will gain more importance and I will be able to offer my students a useful learning environment. Therefore, I want to improve myself in this area."

PST_{18}: "I want to exist in the future, so I want to learn more…"

PST_{28}: "I would like to learn more. Because I think that it is very interesting in today's education, beneficial for students and improving students' creativity and skills..."

PST_{33}: "I would love to have more information in this field. Because I think robots will be at the center of our lives in the future and I think this is necessary in order to teach new generation students."

PST_{35}: "With the developing world order, technology has entered each area of our lives. In order to keep up with this world, we need to follow this information. Robotics and coding have become a course in which even very young children play an active role. Considering that we will provide education to these children, it is important for us to have an accumulation of knowledge on this subject…"

PST_{36}: "I want to learn more about robotics. I am interested in this subject. I am curious about the technological devices and their working principles. I want to work on it because of these reasons…"

PST_{43}: "I want to be a good and ideal teacher and show my students what has changed and what can be done with the development of technology. I want to learn more about robotics in order to improve myself in this field…"

PST_{46}: "I would like to learn more. Because especially in countries such as Canada, robotics is a compulsory course. These countries use robots in every field from construction to industry. these countries are developed countries. We would like to be so…"

Question 4. How would you describe your level of efficacy at a robot programming?

When the individual evaluations of the participants for programming within the scope of robotics were examined, it was seen that 4 codes which were named as sufficient, medium, beginner and inadequate were obtained. Participant distributions for these codes are presented in the following table.

Table 9. Individual evaluation opinions for programming

Code	n
Sufficient	3
Medium	2
Beginner	1
Inadequate	40

4 of the participants who defined their own efficacy assessment as “inadequate” in programming stated that they found this level insufficient by stating that they are still at the beginning level. However, most of the participants (n = 25) who created this code also determined that they have not received any training in programming before.

PST_{9}: “I have never used a program. I have never done any robotics study before. So, I have no qualifications.”

PST_{15}: “I'm zero right now. I've never done anything like this...”

PST_{46}: “I can easily code a robot via a ready-made interface. I need a few tries in very, very complex situations. But I'll handle it later… So, I think my efficacy level in this regard is extremely good… I am enough…”

Question 5. Explain how often you follow the studies in the field of robotics, please.

When the answers given to this question were investigated, it was seen that 17 participants made explanations that they have never followed the studies in robotic technologies. 1 participant stated that he started to follow the works in this field "newly". At the same time, in the light of the participants' responses which stated that they were following robotic technologies, two categories were named as periodic follow-up and random follow-up. The codes in these categories and their components are presented in the following table.

Table 10. Robotic studies follow-up levels of participants

Category	Code	n
Periodic Follow-up	Sometimes	10
	Regular on social media	7
	Internet-based video follow-up	1
	Often	1
Random Follow-up	If it catches my attention	4
	If I come across	3
	If I see it on social media	2

PST_7: "I try to follow it regularly. I read foreign news sources and science magazines."

PST_{17}: "I read in the monthly scientific and technical magazines..."

PST_{19}: "I'm as much as I can follow on the internet and social networking sites."

PST_{39}: "I don't follow much. Magazines, newspapers, etc. I sometimes come across while reading the sources."

Question 6. Describe the topic that interests you most in the field of robotics, please.

When the participants' explanations regarding this question were evaluated, it was seen that 7 participants declared that they did not have any ideas about this issue. Responses from other participants are collected in 5 categories as basic principle, function, discipline, daily life and future situation. The mentioned categories and codes in their contents are explained in the following table.

Table 11. Robotics that Engage Participants

Category	Code	n
Basic Principle	Working principles	11
	Coding	6
	Production stages	2
	Sensors	1
Function	Movements	1
	Making decisions	1
	Speeches	1
Discipline	Science field	2
	Medical robots	1
	Engineering	1
Daily Life	Making life easier	3
	Manpower reduction	1
Future Situation	Being emotions	2
	Robot-human	2
	Replacing humanity	2
	Domination levels over society	2
	Human interactions	1

PST_5: "It is a very interesting event that some machines have very different jobs, that is, robotization by just entering a code."

PST_{14}: "The idea that robots can completely replace human beings and be able to do something without command both attracts my attention and scares me."

PST_{24}: "The thing I was most interested in was the construction of robots that were very close to humans, and now replacing real people, such as anchorperson, with their own programmed robots."

PST_{32}: "It is interesting for me that cars and planes are used by robots."

PST_{36}: "I am interested in practicing, that is combining theory and practice, and coding. The fact that many devices around us work with parts in the robotics field, that is, associating them with daily life encourages me."

3.3. Post-interview process

After the completion of the intervention process, post-interview process was carried out to re-examine the opinions of pre-service science teachers. Findings related to this process carried out with 3 open-ended questions are presented in this section, respectively.

Question 1. Can you explain your opinions on the usability of robotic technologies in educational environments?

When the answers related to this question were examined, it was found that all participants expressed positive opinions about supporting educational processes with robotic technologies. Besides, it was determined that pre-service teachers who gave negative opinions in the pre-interview process showed a positive tendency regarding the robotics. Examples of participant responses which are showing this change are presented below:

PST_{39}: "I think these technologies provide permanent learning. Providing and its price made me think, but I saw that it could be affordable. In other words, mass purchase can be done by group work. If there is a cost problem, I think it can be solved like this."

PST_{46}: "I think that activities based on robotics will be advantageous in classrooms. In other words, it encourages students to think in different ways, their creativity develops… Therefore, I think these technologies should be used. It is especially useful in science education. It can be associated with many subject matters."

It was found that pre-service teachers (n = 36) stated that they could offer an interesting learning environment through robotic technologies especially in the teaching of science subjects. Also, it was seen that 17 participants identified that experiments on science subjects could be supported by robotics and that examples of various situations that could be encountered in daily life could easily be moved to the classroom environment. At this point, the categories and codes obtained in line with the reasons used by the participants in explaining their positive opinions about the integration of robotic technologies into educational environments are presented in Table 12.

Table 12. Participant opinions on the usability of robotics

Category	Code	n
Individual Development	Problem solving skills	39
	Analytical thinking skills	32
	Associating new information with daily life	28
	Creativity	28
	productivity	24
	A sense of wonder	23
	Research sense	19
	Design skills	19
	Understanding new technologies	9
Learning Process	Liking course	41
	Interesting	37
	Funny	34
	Active participation in the course	31
	Focusing	25
	Motivation	22
	Brainstorming	13
Learning	Permanent learning	44
	Concrete learning	40
	Active learning	32
	Learning by doing	31
	Applied learning	27
	Easy learning	26
	Free learning	4
Activity	STEM	24
	Efficient use of time	19
	Project development	6
iDea	Turkish language support	33
	Easier to use	25
	Free	7

When Table 12 is examined, it is seen that the responses of the participants are shaped in 5 categories as individual development, learning process, learning, activity and iDea.

PST$_8$: "… We used the windmill model that I made very effectively in the classroom. I think that I can use robots easily when I think from this point of view. For example, I can explain simple machines by making robots. I think it can be very useful for students to design new and original projects."

PST_{10}: “I think that such studies will make students love the lesson more. In addition to this, I think that these studies increase the ability of students to use the information they have learned in daily life. Likewise, we can bring many things that we may encounter in daily life to the classroom environment under our control. It can be applied to students while teaching many topics in educational environments. It allows us to use time effectively and provides saving on time. Students are provided to learn by living and doing…”

PST_{12}: “A robotic implementation is a fun and brainstorming activity. It provides benefits as it is one of the freest environments for students. Robots are available everywhere today. So, it can also be used in education…”

PST_{27}: “I think that robotic implementations should definitely be used. It is both fun and interesting and concrete learning process for students. I think it's easy to use. We can teach many science subjects and experiments with robots in a more interesting way.”

PST_{35}: “I think that robotic technologies will be beneficial for students. Students can keep the movements in their minds. Robots provide concreteness. It can be useful for turning many abstract subjects into concrete. Therefore, they can be used. When they are used, students will adopt the course better. A more fun classroom environment will be created, their motivation will increase, and they will learn effectively.”

Question 2. How would you describe your level of efficacy at a robot programming? Please justify your answer by evaluating the robotic intervention you attended.

When the answers of pre-service teachers regarding this question were examined, it was seen that 3 codes termed as good, medium and beginner were obtained. At this point, most pre-service teachers (n = 28) determined that they could benefit from robotic technologies to use in educational environments. Besides, it was seen that all participants expressed their willingness to develop themselves. In addition, 34 pre-service teachers explained that study processes of robotic technologies were not as difficult as they expected.

Table 13. Individual evaluation opinions for programming

Code	n
Good	17
Medium	22
Beginner	7

PST_2: “Although I am not very professional in algorithm, I can program a medium level robot. I think this is enough for me when I become a teacher. So, of course, I will continue to improve myself in this field. But now I believe that I can teach with robotic technologies. So, I think my situation is fine on this matter...”

PST_{20}: "I feel competent, but I have to practice more. I have to produce more projects. I need this to make original and interesting designs."

PST_{36}: "I think I'm at beginner level. I have never known before. In this course, I learned a lot about the robotics. I practiced. I understood robotics logic. I think I have to do more projects to move forward. I will improve myself in this field. When the robotic name is mentioned, people are afraid, but robotics is a good product of interdisciplinary cooperation."

PST_{38}: "I received robotics education, but I don't think I can manage a training yet. I have to work a little more for this. That's why I'm at a medium level in this field…"

PST_{41}: "It never existed before. I was a little scared when our teacher first said robotics in the course. In a word, these kinds of things have always been very complicated to me. But I never had as much difficulty as I guessed. It is necessary to deal with such things a little bit. It's easy after. I think I am at a good level thanks to this course. I learned a lot. I will continue to do it."

Question 3. Explain how often you follow the studies in the field of robotics, please.

When the answers given to this question were examined, it was seen that 4 pre-service teachers stated that they did not follow the studies related to robotic technologies. However, 42 pre-service teachers announced that they started following the studies on this field regularly. 25 of these participants determined that they started to investigate the studies in the field of robotics because their experiences which they gained during the intervention process aroused their curiosity. Similarly, 16 participants identified that they have to follow this news in order to improve themselves, while 7 participants reported that they started the follow-up process due to their wishes to use robotic applications.

Table 14. Robotic studies follow-up levels of participants

Code	n
Social media	40
Web site	31
Written media	18

PST_9: "There are pages I follow every day. I've also been a member of some forums. I watch videos on YouTube as well, and there are channels I start watching. I look at it from various sources. Every day I examine the sources I follow…"

PST_{11}: "Obviously, I started following this course. I wouldn't even think of it before. I followed many pages in all my social media accounts. I also follow the magazines and started to buy regularly."

PST_{21}: “I wasn't doing it before. But after this course, I started following all the time. Because it was very interesting, and I started to wonder. I started to follow some pages from social media. Also, I started to read news about it on the Internet…”

4. Discussion

The aim of this study is to design an activity process in which pre-service science teachers will experience robotic technologies and to determine the pre-service teachers' opinions about this process. For this purpose, a 4-week activity process has been designed for pre-service science teachers. Throughout the process, pre-service teachers worked in groups and each group was guided. A structured interview form was used to determine pre-service teachers' opinions on the process.

When the findings related to the pre-interview process were examined, it was seen that most of the pre-service teachers had not participated in any robotic studies before. Also, it was drawn attention that pre-service teachers who had previously experienced several study processes about robotics or coding could not remember the programs used or the working principles of mechanisms. From this point of view, it is recommended to prepare a learning environment where students can have a long-term and one-to-one experience in robotic implementation studies and to provide guidance to the participants throughout the process. As a matter of fact, experience is expressed as an important factor in providing technology integration to educational processes (Abbott & Faris, 2000; Bingimlas, 2009; Ertmer & Ottenbreit-Leftwich, 2010; Hennessy, Ruthven & Brindley, 2005; Wouters, Van Nimwegen, Van Oostendorp & Van Der Spek, 2013). The impact of the experience factor on the implementation of various instructional technologies is similarly emphasized for robotic technologies (Cummings, 2017).

When the opinions of pre-service teachers about the integration of robotic technologies into educational processes were examined, it was observed that after the completion of the out-of-school activity process, the participants emphasized the positive effects of robotic technologies especially on individual development and learning. It was remarkable that most of the participants emphasized the points that student development related to several skills such as problem-solving skills will be supported, students will show positive tendency towards the course and learning will increase with use of these technologies. Besides, at the beginning of the intervention process, it was seen that 17 of the pre-service teachers stated that they had never followed the studies in the field of robotics. In addition to this, it was observed that most of the participants who stated that they were following the news described their follow-ups as occasional or casual. When the views on this issue were re-evaluated upon completion of the intervention process, it was concluded that 4 participants stated that they still do not follow robotic technologies. However, most of the participants explained that they started regular follow-up for reasons such as increased curiosity about this issue, their desire to improve themselves or use of these applications. At this point, it is thought that awareness towards robotic was created among pre-service teachers through designed out-of-school activity process. In addition, the participants identified that they want to teach their students such technologies in their future professional lives. In this context, it can be concluded that participants are provided with a positive tendency towards robotic technologies by reaching the purpose of the out-of-school activity process for this study. Indeed, the objectives of informal science education carried out in out-of-school settings are expressed as promoting the change in the learning environment, developing the level of interest in science and increasing the success rate of students in science education (Dori & Tal, 2000). Based on this point of view, it was concluded that participants of the study can access such practices through out-of-school learning environments and that they have positive opinions at this point.

With the intervention process designed as an out-of-school learning environment for robotic technologies, the pre-service teachers' perceptions of self-confidence towards robotics increased. In fact, while most of the participants defined themselves as “inadequate” about robotic technologies before the intervention process, they stated that they made progress generally and that they reached a level that they could design. At this point, it can be determined that with the active use of instructional technologies, pre-service teachers diverge from negative views stemming from the traditional perspective on technology integration (Hennessy, Ruthven & Brindley, 2005; Polly, Mims, Shepherd & Inan, 2010). In this context, it is suggested that a wide variety of robotic software and platforms that offer ease of use should be presented to pre-service teachers and pre-service teachers should be given the opportunity to experience firsthand (Mataric, 2004).

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