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Research Article

Pre-School Teacher Candidates' Views on STEM Applications Based on Montessori Approach[1,2]

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Abstract

The aim of this study is to determine the pre-school teachers' opinions about Montessori approach based STEM activities. In the study, during the fall semester of the 2017-2018 academic year, the education faculty of a state university pre-school teacher studied at the 3rd grade and 50 teachers were trained and 15 people were interviewed. In the research, case studies pattern based on the effects of the program, one of the qualitative research methods, was used. "Montessori approach based STEM applications Interview Form" was used as a qualitative data tool developed by the researcher in the study. Qualitative data were analyzed using content analysis method. As a result of data analysis, it was determined that pre-service teachers about Montessori approach based STEM applications have a positive opinion and they intend to use these applications in their lessons in the future. In addition, it is seen that these practices improve the cognitive and psycho-motor features of prospective teachers. It has been changed in the perspective of preservice teachers towards science and technology in their daily lives.

Keywords: *Montessori approach, Prospective teachers, STEM*

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Okul Öncesi Öğretmen Adaylarının Montessori Yaklaşımı Temelli STEM Uygulamalarına Yönelik Görüşleri

Öz

Bu çalışmanın amacı, okul öncesi öğretmen adaylarının Montessori yaklaşım temelli STEM etkinliklerine ilişkin görüşlerini tespit etmektir. Çalışmada 2017-2018 eğitim öğretim yılının güz döneminde bir devlet üniversitesinin eğitim fakültesi okul öncesi öğretmenliği 3. sınıfta öğrenim görmekte 50 öğretmen adayına eğitimler verilerek aralarından 15 kişi ile mülakat gerçekleştirilmiştir. Araştırmada nitel araştırma yöntemlerinden durum çalışması desenlerinden programın etkilerine dayalı durum çalışmaları deseni kullanılmıştır. Çalışmada araştırmacı tarafından geliştirilen nitel veri aracı olarak "Montessori yaklaşım temelli STEM uygulamaları Görüşme Formu" kullanılmıştır. Nitel veriler içerik analizi yöntemi kullanılarak analiz edilmiştir. Veri analizleri sonucunda, Montessori yaklaşım temelli STEM uygulamalarına yönelik öğretmen adaylarının olumlu görüşe sahip oldukları, bu uygulamaları ilerde derslerinde kullanmayı düşündükleri tespit edilmiştir. Ayrıca, bu uygulamaların öğretmen adaylarının bilişsel ve psiko-motor birçok özelliğini geliştirdiği de görülmektedir. Öğretmen adaylarının günlük yaşamlarındaki fene ve teknolojiye karşı bakış açılarında değişiklerde meydana gelmiştir.

Anahtar Sözcükler: *Montessori yaklaşımı, Öğretmen adayları, STEM*

Introduction

Children come to the world with a natural sense of curiosity and discovery (Durbin, Pickett & Powell, 2011). Specialist guides are needed to guide the children to use these natural curiosities with scientific process skills, to do more scientific activities, and to become a qualified individual with 21st century skills, that is, they can produce solutions to the problems they face in life, think critically and develop creativity. When the right guidance is provided, children can obtain positive experiences especially in the field of science. For this reason, basic preschool education and the role of preschool teachers trained in this field are very important (Aguilar, 2016; Moomaw, 2012). These trainings are handled in today's education program in the world for many years, but quite effective results in pre-school education, which is located Montessori approach is not common in Turkey (Eratay, 2009). The Montessori approach is an educational approach developed by Maria Montessori, the first Italian female doctor to oppose the educational life that includes strict rules (Doğru, 2009). The Montessori approach is an education approach developed by Maria Montessori to best support the development and education of young children (Hobbs, 2008). Aims in the Montessori approach; to develop the child's self-confidence, initiative, knowing what he wants and implementing it, acting independently, problem solving, critical analysis, using creative skills, concentration, regularity, helping and respecting others. In order to achieve these goals, firstly, to ensure that the child lives by himself without forcing the joy of learning; The second is to help perfect the learning mechanism (Özdağ, 2014). Montessori schools are designed in a format that allows children to use the necessary teaching materials and do activities related to daily life without help from adults. In these schools, it is not the areas that adults dominate, but the areas where children are independent and to improve their own control (Arslan, 2016). STEM education is another highly effective education approach in training other important and future quality and productive individuals. STEM education, which has common goals with the Montessori approach, is an education that can be easily integrated with the preschool education program, and that allows children to understand the technology and engineering sciences developed in their environment and to establish a connection between these four disciplines (Koyunlu Ünlü & Dere, 2018). STEM is made up of abbreviations of English words, Science, Technology, Engineering and Mathematics (Gonzalez & Kuenzi, 2012).

Preschool children are mostly interested in science education, including animals, plants and the environment. Today, although there is technology all over life, children are not provided with sufficient education in these areas (Bers et al., 2013; Elkin at el., 2014). At this point, STEM education gains importance by establishing a connection between the disciplines of science, technology, engineering and mathematics to help children grow up in this field (Yıldırım, 2020). In these four disciplines, it supports the research processes of the child such as discovering, asking questions and making predictions (Yıldırım & Topalcengiz, 2019). Thanks to STEM activities developed in accordance with the development levels of children before school, it will enable them to discover and learn materials by using more than one sense organs (Koyunlu Ünlü & Dere, 2018). Chesloff (2013) sees the concepts in the heart of STEM as curiosity, analysis, creativity, collaboration, problem solving and critical thinking, and therefore argues that this education should start in the preschool period in order to gain the fundamentality and permanence of these skills in the individual. Although STEM education is not offered to students in an integrated form, it is included in pre-school education (MEB, 2016). In many studies, it is stated in the literature that the importance of educating individuals who will provide innovative solutions to the complex problems encountered in the future and contribute to economic developments by providing STEM experience to children in the preschool period (Aronin &Floyd, 2013; Chesloff, 2013; DeJarnette, 2012). Unfortunately, it is very difficult to find teachers with this education in our country. In the literature review about STEM in our country, it is seen that studies in this field have just started to increase. However, sufficient teachers could not be trained at the desired level yet (Çepni, 2017). The same is true for the Montessori approach. In line with Montessori principles, preparing new materials and activities suitable for the needs of the developing age and using them in the program in an appropriate way is an important point that should be adopted in child education (Oğuz & Köksal Akyol, 2006). For this reason, in order to apply Montessori approach in preschool education programs, educators who have adopted this approach must be present in the school. Therefore, in order for these trainings to be given before the school, we need to train our specialist teachers in these fields. These two educational approaches have the same goals (complementing each other with 21st century skills, researching, questioning, analyzing, producing, generating solutions to problems, educating creative individuals). Considering the literature, the number of studies carried out integrated with the Montessori approach and STEM education is very low. And two studies on this subject are as follows; Açıkgöz (2018); With Montessori, which is one of the pre-school approaches in science education, she conducted a

study that includes the opinions of 14 preschool teachers in order to determine the extent to which STEM education approaches can be applied in the pre-school education program and what are their similar and different aspects. Elkin et al. (2014) in their work; They explored how to apply the robotic curriculum in early childhood Montessori classes. This shows that the studies in which these fields are carried out are very few. Aslan Tutak et al. (2017) stated in the results of their studies that teacher candidates should be made conscious about STEM education without graduating from the university, and emphasized that due to STEM's interdisciplinary approach, teachers do not have knowledge in fields other than their own fields and that necessary information should be provided in these fields. Thanks to the planned STEM applications with the help of games implemented in preschool period, important concepts and skills that can be given to the child can be given. They have a curious and inquisitive spirit, especially against the events and objects that take place around the preschool children. By allowing them to ask questions and create hypotheses within the planned game, skills and knowledge about STEM fields can be developed (Uyanık Balat & Günşen, 2017). A personality structure, the foundation of which is laid with preschool education, psycho-social development and body development continues to develop in the same direction in the following years. Therefore, the experiences we bring to children in this period greatly affect their view of life in the future. This is very important for a country to have quality and productive individuals (Mutlu et al., 2012). In the study of Çepni (2017), the features of STEM education to be considered while integrating to the preschool period; It should include concrete experiences, focus on a single question, research, build on the events around the child, and be a topic of interest and attention. Montessori approach, which includes pre-school education approach that includes common goals with STEM education, helps the child to freely play and gain daily life skills, create a sense of responsibility, and develop mental and physical development in the environment prepared in line with the gains (Arslan, 2016). For STEM and Montessori approaches, which are effective in raising the quality individuals required for the development of the country, teachers who are well-educated, equipped and have pedagogical knowledge in their fields should be trained (Wang, 2012). In line with these importance and requirements, it is aimed to train teachers who know Montessori and STEM trainings and who are experts in these fields in the future.

Method

Research Model

In the study, a status pattern based on the effects of the program, a case study pattern, which is a qualitative research method, was used. Case study is a descriptive qualitative research approach that allows an in-depth study of a subject or situation within a certain time frame (Creswell, 2002). Case study is one of the systematic pattern types that includes steps such as gathering information, organizing, interpreting and reaching research findings, just like a detailed planning in architecture (Aytaçlı, 2012). Case studies based on the effects of the program determine the effect of the program and provide information about the causes of success or failure (Aytaçlı, 2012).

Working Group

The research was carried out with 50 pre-service teachers studying at the 3rd grade within the scope of "Pre-School Science Education" course at the university of a medium-sized province of Eastern Anatolia. In the study, pre-service teachers were applied STEM activities based on Montessori approach for 14 weeks. After the applications, data were collected with 15 volunteer candidates among the participants with interview forms prepared in accordance with the purpose of the research.

Data Collection Tools

As part of this study, “Montessori approach based STEM applications Interview Form” was used as data collection tool. The semi-structured interview form developed by the researcher consists of 4 questions. These questions were reviewed in line with expert opinions. After this process, the semi-structured interview form was finalized.

Analysis of Data

Qualitative data obtained as a result of the study were interpreted by content analysis. In these analysis methods, restricted codes are revealed from the interviews made by the researcher and related categories are created. Then, the statements of these categories indicating the underlying reality are tried to be revealed (Yıldırım & Şimşek, 2008). The interview data were recorded and the data were converted into writing and analyzed in accordance with the stages of the content analysis. The qualitative data obtained were analyzed in four stages: coding the data in accordance with the content analysis, finding categories, organizing and defining codes and themes, and interpreting the findings.

Research Process

In the study, during the implementation of STEM activities based on Montessori approach, firstly, field search was made and it was investigated which philosophy and application approaches of educational environments were targeted and learning steps and environments were used. The data obtained as a result of the screening were tried to be combined with the results of the literature review, which students generally enjoyed from what kind of teaching environments, which ones had positive effects on the students, and the expectations from the educational environments. In the activities, pre-service teacher candidates were given by integrating with the applications in order to gain only the necessary information and internalize it without extending the theoretical course phase. Particular attention was paid to some points in the selection of activities and applications. These; The activities that are implemented have absolutely STEM education features, they can be used to excite teacher candidates by using their knowledge of the field and create new and new designs, products, they contain the qualities they can solve with their own experience and knowledge about the problems they face, and in their personal development in the future professional life. Particular attention has been paid to the level of use. Activities are cylindrical small sponges made of simple, waste materials, robotic-coding legos and types (starch designed for preschool and colored with food dyes), which can be found in every area of daily life, including different application areas. they are easily glued together and the desired design is formed). STEM activities based on the Montessori approach were applied to the candidates by expert researchers during an education period. These practices, which lasted 14 weeks in total, were conducted under the guidance of the researchers themselves. During this training, it was tried to help prospective teachers to develop their problem solving, creativity and critical thinking skills, to gain different

perspectives, to obtain information from primary sources, to link their knowledge with daily life situations and to design their own products with the information they learned. In this application process, firstly, preservice teachers were given basic theoretical information about STEM education and Montessori approach. Then, each week, groups not exceeding four were asked to form the activities determined by the experts. After the groups were formed, the necessary materials were introduced by explaining the theoretical information (information such as science and mathematics required for the activity, showing the activity to be done by drawing) in a short and sufficient level regarding how to do about the determined activity of the week.

Each group was asked to buy the available materials prepared for the event and complete their activities within the specified time. In the activities, activities involving simple materials were made first, and then robotic coding and type studies were applied. After all the activities were finished, each group was asked to present the necessary materials and activities on a subject they wanted in accordance with the Montessori approach-based STEM activities in line with the gains they determined.

Ethics Committee Information

Erzincan University Human Rights Ethics Committee is a study dated 30.11.2017 and numbered 09/09. In the study, volunteer individuals selected to collect data in the sample group were informed about the subject by signing an approval form. No action has been taken regarding Scientific Research and Publication Ethics and all rules in the Higher Education Institutions Scientific Research and Publication Ethics Directive have been followed.

Findings

In this section, the findings regarding the qualitative data obtained as a result of the interview form are included.

Table 1.

"Do you think that STEM Education can be easily applied to preschool children? Why is that?" Pre-service teachers' views on the question

Category	Code Name	Frequency (F)	Percentage (%)
Material Properties	Must be great	1	1,96
	Should be bold	1	1,96
	Must have safe adhesives	1	1,96
	Should be appropriate for the level	1	1,96
Material Properties	Should match the target	1	1,96
	Don't be fun	2	3,92
	Child development	1	1,96
	Relevance to the subject	1	1,96
	Interesting	1	1,96
	Striking	1	1,96
	Intriguing	1	1,96
From the educational perspective	Fully reflective	1	1,96
	State of the country	1	1,96
	Getting out of the mold	1	1,96
	Being open to innovation	1	1,96
	Orientation in line with gains	1	1,96
	Giving from the foundation	4	7,84
	Preschool suitability	4	7,84
	Ease of application	2	3,92
	Forward steps	4	7,84
	Guidance help	2	3,92
	Don't do it alone	2	3,92
	Motivation	1	1,96
	Increasing participation and breakthrough	4	7,84
From the Perspective of the Child	Types suitable	3	5,88
	Lego is not available	2	3,92
	Small muscle skills	1	1,96
	Electrics are hard	1	1,96
	Simple material suitable	3	5,88
	Generally suitable	1	1,96
Total		51	99,96(%)

Table 1 presents the answers of the candidates to the question as a result of the interview and 4 different categories have emerged. In the material properties category; they should be large (f = 1), thick (f = 1), safe adhesives (f = 1), level appropriate (f = 1). Here, pre-service teachers stated that the materials used in the activities for the answer to the question are a bit thicker and larger so that the children can easily grasp, and that silicone can be dangerous as a glue, and if the safer adhesives are used instead of the level of the activity, it can be easily applied to preschool. In the material properties category; should be suitable for the goal (f = 1), being fun (f = 2), developing the child (f = 1), fitness to the subject (f = 1), interesting (f = 1), remarkable (f = 1), curiosity there are awakening (f = 1) codes. The highest frequency in the codes belongs to the code of fun (f = 2). The pre-service teachers' opinions about the

characteristics of the materials created in the activities, which will have a positive effect on the child, are included in these codes. They stated that choosing the material in accordance with the subject and goals will help the child draw the attention and attention to the subject, create a curiosity towards the child, perform the activity without getting bored, and develop the child. In terms of education, in its category; fully reflective (f = 1), state of the country (f = 1), extrusion (f = 1), openness to innovation (f = 1), orientation in line with gains (f = 1), giving from the foundation (f = 4), preschool suitability (f = 4), ease of implementation (f = 2), forward steps (f = 4), guidance assistance (f = 2), doing it alone (f = 2), motivation (f = 1), There are codes of increasing participation and excretion (f = 4). Here, pre-service teachers stated the appropriateness of the activities in terms of education with their reasons, together with their knowledge. The codes with the most frequencies in the category are codes of foundation (f = 4), preschool suitability (f = 4), forward steps (f = 4) and increasing participation and excretion (f = 4). Preservice teachers stated that STEM activities created based on Montessori approach are very necessary for the development of individuals in terms of scientific skills and it is a good education with ease of application.

They stated that this education should be given to the child from the foundation, that is, preschool period. In the guidance code, the candidates stated that these activities can be challenged by the child alone and will be easier with the help of a guide. In the code of forward-looking steps, candidates stated that when this education is given from a young age, large forward-looking steps will be taken in terms of science. They also stated that these activities will motivate the preschool children to the lesson and thus lessons will be held with a more active participation. Some of our teacher candidates stated that this education is very nice and useful, but our country is not fully prepared to implement such a system and teachers do not have the idea that education will have difficulties in getting out of a specified pattern and this may not cause the education goals to be reflected to the child exactly. In the code of being open to innovation, the importance of being open to innovation was emphasized by stating that the activities of the candidates are different and that this will improve the children.

In the category of suitability for the child; types are suitable (f = 3), lego is not suitable (f = 2), small muscle skills (f = 1), electrics are difficult (f = 1), simple material is suitable (f = 3), general is suitable (f = 1) There are codes. In the category, the most frequent types have appropriate (f = 3) and simple materials have appropriate (f = 3) codes. Here, pre-service

teachers' opinions about which of their activities are more suitable for the child's level are included. Some pre-school teacher candidates stated that type studies are very suitable for the child, some of them do not find robotic coding legos very suitable because they require little muscle skills, they will have some difficulties in electrical activities, some of them will be very suitable for their simple materials and some of them can be applied to children in general.
"Do you think that STEM Education can be easily applied to preschool children?" Some of the teacher candidates regarding the question expressed their thoughts as follows.

S1: "... Absolutely, yes. Preschool children can do many things we cannot do. We approached with a little fear and hesitation, but this is a fundamental issue. Basically, if good education is given, as they do and succeed, they take huge steps when they reach our age... "

S2: "... Sure. Since curiosity is more in children, there is more participation and breakthrough... "

S3: "... Yes. It can be easily applied in a way that can attract their attention and attention..."

S4: "... It may be difficult to apply alone. But if anyone guides, they do. Especially the types are very suitable... "

S5: "... At first they have difficulties, but they apply and learn as they explain over time..."

S6: "... It is very important to motivate the child. It is very important to which area we will direct, if attention is paid to these issues ... "

S7: "... Applicable only electrical ones may seem a little difficult..."

S8: "... Many of them can be applied, but not those who require little muscle skills. In other words, events with legos. Because their development has not been completed yet. But simple materials and types are fine... "

S9: "... If the necessary deficiencies are completed, yes. For example, in terms of psychomotor skills, materials should be larger, thicker, silicone guns in the bonding part can be dangerous, safer, there should be adhesives for the child... "

S10: "... Our country is not fully ready for this education. This education may not be fully reflected to the child. In other words, our education has been molded and it is difficult to get out from now on... "

S11: "... It would be great if we bring it down to the level of children..."

S12: "... Not all but it would be nice if it is applied according to the subject and the target. Differences develop the child... "

Table 2.

"What did you generally feel in these events? Why is that?" Pre-service teachers' views on the question

Category	Code Name	Frequency (F)	Percentage (%)
Emotion	Amazing	2	8,69
	Positive emotions	1	4,34
	Beautiful	1	4,34
	Funny	9	39,13
	Exciting	1	4,34
	Happy	3	13,04
Benefit	Designing interesting products	1	4,34
	Resting	1	4,34
	Abundant activity	1	4,34
	Unleash creativity	1	4,34
	Being simple-applicable	1	4,34
	Tasting a sense of success	1	4,34
	Ability to assimilate	1	4,34
Total		23	100(%)

In Table 2, as a result of the interview, the answers of the candidates for the question were included and 2 different categories emerged. In the emotion category; There are surprising (f = 2), positive emotions (f = 1), beautiful (f = 1), fun (f = 9), exciting (f = 1), happy (f = 3) codes. The highest frequency in the category belongs to the fun (f = 9) code. Here are statements expressing the feelings and feelings of prospective teachers during the activities. In other words, statements were made stating that the candidates found the activities very enjoyable, enjoyable, interesting and surprising, very beautiful and creating a product was an exciting and happy feeling. In the utility category; designing interesting products (f = 1), resting (f = 1), abundant activity (f = 1), revealing creativity (f = 1), being simple-applicable (f = 1), tasting the sense of success (f = 1), absorption (f = 1) codes. Here, statements are made stating the reasons why pre-service teachers feel the emotions in the above emotion category. In other words, the candidates stated that the fun of the activities provided them to rest when they came to this lesson from the other tiring lessons, they passed a course with plenty of activities, they developed their ability to design different products, they exposed their creativity, they practiced without difficulty because they did it in a group.

"What did you generally feel in these events? Why is that?" The views of some pre-service teachers regarding the question are given below.

S1: "... First of all, we were abundantly surprised. Then we assimilated. Then we had positive emotions..."

S2: "... It was nice. In general, I did not encounter any negativities. I was a member who combined the materials and had a lot of fun… "

S3: "... It was simple and fun…"

S4: "... I had a lot of fun. I tasted the sense of success… "

S5: "... It was exciting. We did not know the result. We were in a struggle and eventually products that surprised us appeared. "

S6: "... This lesson about science for us was like rest and activity…"

S7: "... It was very fun, we were happy. It was useful in exposing our creativity to the problem that we all came across. "

Table 3.

"Did these activities help you use time effectively and efficiently?" Pre-service teachers' views on the question

Category	Code Name	Frequency (F)	Percentage (%)
Contributions in Time	Efficient use	5	13,15
	Effective use	5	13,15
	Making it fun	1	2,94
	Specific period	7	20,58
	Raising time	6	17,64
	Understanding the importance of time	5	13,15
	Growing the product on time	5	13,15
Total		34	100(%)

In Table 3, as a result of the interview, the answers of the candidates for the question were included and a category of contributions appeared in terms of time. In this category; efficient use (f = 5), effective use (f = 5), making fun (f = 1), certain time (f = 7), raising time (f = 6), understanding the importance of time (f = 5), product There are timely breeding (f = 5) codes. The specific time with the highest frequency in the category belongs to the (f = 7) code. In these codes, teacher candidates stated that completing the activities at the time given to them helps them use the time more efficiently and that they experience the importance of time during the activities. In other words, they stated that they should use the time effectively since they were asked to create the design, the product determined in a given time, and that all these flurries made their time fun.

"Did these activities help you use time effectively and efficiently?" The views of some pre-service teachers regarding the question are given below.

S1: "It happened. We entered into a strange race to avoid time. Time is running out, we are chasing after… "

S2: "It happened. When we were overwhelmed with other lessons, we were having fun at the STEM workshop. We were not only making our time enjoyable but also eventually creating a product… "

S3: "It happened. Because we were asked to produce a certain product in a certain period of time. For this, we tried to train and train without passing the time… "

S4: "... He contributed. We tried to raise it in a certain time. So it was important for us to use time important… "

Table 4.

"Did the information you learned in these activities affect your daily life?" Pre-service teachers' views on the question

Category	Code Name	Frequency (F)	Percentage (%)
In terms of the event	Adding science	1	6,25
	To be able to use mathematics	1	6,25
	Condensation of science	1	6,25
From the perspective of education	Attract attention	1	6,25
	To be able to make sense in daily life	2	12,5
	Integration into the department	1	6,25
	Opportunity to apply at home	3	18,75
	Embody abstract issues	1	6,25
Research	Questioning	1	6,25
	Examination	1	6,25
	Searching in the virtual	1	6,25
	Noticing the shortcomings	1	6,25
Total		16	100(%)

As a result of the interview in Table 4, the answers of the candidates for the question were included and 3 different categories emerged. In terms of effectiveness in its category; There are a total of 3 codes: adding science (f = 1), using mathematics (f = 1), concentration of science (f = 1). Here, preservice teachers stated that they contributed to use the science they learned in the activities in their other lessons in their own fields. They stated that they now use the science step more in their activities related to their fields and besides, they made a presentation or designs by using mathematics together with science. In terms of teaching category; There are codes to attract attention (f = 1), to make sense in daily life (f = 2), to integrate into the department (f = 1), to practice at home (f = 3), to embody abstract topics (f = 1). The highest frequency in the category belongs to the code of application at home (f = 3). In these codes,

pre-service teachers stated that they wanted to use the information they learned in activities due to the benefits and conveniences they would provide in terms of teaching in their professional life. Because the activities are remarkable in terms of education, they can easily motivate children, find the level that can be integrated in their branches and contribute to the meaning of daily life of the child, they can also use it in their professional life because it provides the opportunity to practice the child at home and embody abstract subjects in the science by concretizing it. Expressions stating were given. In the research category; There are codes of questioning (f = 1), examination (f = 1), virtual search (f = 1), noticing the missing (f = 1). Here, pre-service teachers stated that the activities contributed to questioning, analyzing and searching in the virtual in their daily lives. In addition, they stated that they contributed to the awareness of the shortcomings in the event due to the experiences they gained when they were going to hold an event.

"Did the information you learned in these activities affect your daily life?" The views of some pre-service teachers regarding the question are given below.

S1: "... Yes. For example, we had a presentation about mathematics education. I wonder what we can add from here and there is something to be found... "

S2: "... Yes. We are now trying to give more science in our events. We increased our concentration on this... "

S3: "... Yes. As far as we have learned from science, it is not about running programming for the event.

S4: "... Yes. In particular, I realized how much missing information we gave children about science... "

S5: "... Yes. It mostly affected my use in the department. In terms of embodying abstract issues... "

S6: "... Yes. For example, when I learn that mixing increases boiling, I tell my mother to mix the soup at home... "

S7: "... Yes. Actually, we know many things in daily life, but we are not aware. We understood when the teacher clearly showed them... "

Discussion and Conclusion

Within the scope of the study, the pre-service teachers' opinions regarding STEM applications based on Montessori approach were examined. Positive results were obtained as a result of the review. It is emphasized that a well-designed educational environment in all kinds of subjects in the pre-school education program is important for developing effective learning, creative and problem-solving skills of children (MEB, 2013). At this point, STEM education and Montessori approach present the expected educational environments to the child. Considering the principle that Montessori materials are instructive and feasible in the study, similar and positive statements emerged in the answers to the questions about the applicability of STEM education to children in pre-school period and how they felt during the activities. In these results, pre-service teachers evaluated their opinions in terms of material and material properties, education and suitability categories for children. In a way that the materials used in the applications can be easily grasped in accordance with the psychomotor skills of the children; a little thicker and bigger, and if safer adhesives are used (tape etc.) instead of what they think may be dangerous as silicone, the activity subject is also chosen according to the level of the children and if the guides help, the child's psychomotor, which is suitable for the purposes of the Montessori approach, stating that STEM applications can be easily applied to preschoolers. They stated that they would improve their skills as well. Supporting the results of the study, Yıldırım (2019) stated that biomimicry practices contributed to the development of cognitive and psycho-motor skills of prospective teachers in their study examining the opinions of teacher candidates for biomimicry applications in STEM. In his study, Torun (2011) examined the effect of Montessori approach on the concept acquisition, social cohesion and small muscle motor skills of children and reached positive results.

In the study results, again, the candidates stated that the applications will leave positive and permanent effects on the learning of children and stated that they are feasible. They stated that the selection of the material in accordance with the subject and the goals would help the child to draw his attention and attention to the subject, to create a curiosity towards the child, to spend the lesson without getting bored and to develop the child. Supporting the result, Dönmez (2017) examined the opinions of students and team coaches for robotic tournaments within the framework of STEM education. He stated that among the results, the participants stated that they found the activity products fun and functional. He also stated that he increased his

motivation towards the lesson and facilitated the learning of the subject. In parallel with the study, it was concluded that Kılınç, Koç Şenol, Eraslan and Büyük (2013) increased the interest of students towards science lessons of robotic projects. In line with the researches carried out by Özdoğru (2005), they stated that robot kits increased student success and attitudes. Elkin, et al. (2014) investigated how robotic education can be used in Montessori early education classes in their studies titled implementation of robotic curriculum in early childhood Montessori classes. As a result of this research, suggestions about how robotic and engineering concepts can be applied in Montessori early education classes and how they can be integrated effectively are presented. Some of those; The Montessori approach offers a unique way of integrating with robotics training, generating new ideas for children, expressing themselves in a meaningful way, as it rewards personal discoveries and leads each child to a goal, regardless of the way.

When Maria Montessori developed her approach to education, there were no such robotic technologies. They used expressions stating that if they did, they would integrate such technologies into the Montessori approach. The study emphasized the importance of mixing Montessori principles with modern technology and the importance of robotic robots to improve children's creativity. These statements support the findings of the study, stating that STEM education should be started in Montessori classes in preschool period. Again, in the results of the study, the candidates mentioned the importance of working in a team and collaboration. Supporting the study result, Dereli (2017); In his research titled “Investigation of the effect of Montessori approach program on children's psychosocial development and social problem solving skills”, he analyzed the effect of Montessori Education Program on the psychosocial development and social problem solving skills of 4-5 age group children attending pre-school education and obtained positive results. Keçecioğlu (2015) investigated the effect of Montessori approach on the social development skills of the individual compared to normal education and recorded positive results. In his study, Hobbs (2008) examined the effect of the Montessori approach on the social skills and behavior of children aged 3-6. As a result, they found that children trained with the Montessori approach show more behaviors such as justice, equality, and play with their friends and peers in positive emotions. Dönmez (2017) stated that team coaches had the opportunity to collaborate and teamwork as the best feature of the tournament in their study which includes the opinions of students and team coaches for robotic tournaments within the framework of STEM education. Preservice teachers stated that STEM

activities created based on Montessori approach are very necessary for the development of individuals in terms of scientific skills and it is a good education with ease of application. They stated that the importance of this education should be given to the child from the foundation, that is, the preschool period, in raising individuals who are open to innovation with different perspectives. Supporting the results of the study, Yıldırım (2019) stated that the applications allow the prospective teachers to have a different perspective, create an awareness of nature and contribute to imagination and critical thinking skills.

The effects of STEM activities based on Montessori approach in the study were asked about how the candidates use time efficiently and integrate the information they learned with their daily lives. Positive results were achieved in the answers given. Candidates were recorded that completing the activities at the given time helps them use the time more efficiently and helps them better understand the importance of time, make the science more expressive in their daily lives, they want to use the science step more in their professional life and improve their scientific skills. In addition, as a result of STEM applications based on the Montessori approach, there has been a positive change in the prospective teachers' views on technology. Among the studies conducted to support the results, Strong (2013); In his research, in Sullivan (2008) that STEM education developed scientific process skills; In addition, they stated that robotics and science literacy training contributed to the positive development of the student's thinking and scientific process skills. Yıldırım (2019) supports the results of the study examining the pre-service science teachers' views on biomimicry applications in STEM education. As a result of the examination, Yıldırım determined that the candidates have a positive perspective on STEM biomimicry applications and that they intend to include their courses in the future. In addition, as a result of the applications, it was stated that the prospective teachers' opinions about technology have changed positively. Again, Yamak et al. (2014) found that the students' scientific process skills and attitudes towards science provided a positive development at the end of their implementation by associating the design-based learning model with STEM activity. Yıldırım and Altun (2015) determined that they contributed to the academic success of the candidates as a result of their STEM education and engineering practices with prospective science teachers. Yıldırım and Selvi (2017) stated that the practices increased the academic success of students in science as a result of the study they examined the effects of STEM applications and full learning on academic success with secondary school students. In Judson (2014) study, it was stated that there was a positive

difference on success at the end of the study of STEM activities on students' academic achievement. Again Green, (2012), Cosentin, (2008), Kang, Ju and Jang (2013), Hill (2002); have reached similar results in their work, namely that STEM practices have increased academic success.

In the study results, the candidates also emphasized the necessity of giving the activities in pre-school period in terms of teaching and stated that they are remarkable with these practices, and that they can easily motivate the children, and they can provide opportunities for permanent and meaningful learning by embodying abstract subjects in the science. Günşen, Fazlıoğlu and Bayır (2017), which supports the results of the study, will add importance to life in the future by blending the knowledge of basic sciences such as physics, biology, chemistry and math with the fields of technology and engineering, as events such as creating, gaining and using concepts are more active. They stated that it would be possible to create innovations. Therefore, they emphasized the necessity of applying the STEM approach as of preschool years. In the research titled "Mathematics and Science Integration Argument: A Stand for Teacher Education" conducted by Furner and Kumar (2007), they included statements stating that teachers trained with STEM education had an impact on the students' future individuals to achieve more permanent and productive learning. Livstrom et al. (2018) examined the theoretical and empirical aspects of Montessori secondary school science in the USA and its adaptation to the conceptual framework of the integrated STEM in their studies on integrated STEM: Learning from Montessori philosophies and practices. As a result, they stated that Montessori offers an integrated educational approach that significantly positions academic disciplines well supported by STEM and the learning theories involved. In his research titled Comparison of STEM and Montessori methods from pre-school approaches in science education in line with the opinions of teachers, Açıkgöz (2018) investigated the extent to which STEM education approaches can be applied in the preschool education program and what are their similar and different aspects. In the results, the teachers know the Montessori approach, but stated that they learned STEM education for the first time in this research. Within the scope of a general evaluation, it was stated that the teachers showed interest in the research and their ideas about Montessori and STEM would have a positive effect on the development of the child.

Statements of ethics and conflict of interest

"I, as the Corresponding Author, declare and undertake that in the study titled as *"Pre-School Teacher Candidates' Views on STEM Applications Based on Montessori Approach"*, scientific, ethical and citation rules were followed; Turkish Online Journal of Qualitative Inquiry Journal Editorial Board has no responsibility for all ethical violations to be encountered, that all responsibility belongs to the author/s and that this study has not been sent to any other academic publication platform for evaluation. "

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