The Effect of Montessori Approach-Based Stem Activities on the Academic Self-Respect of Preschool Students[*]

Esila Samur[**]   **Sema Altun Yalçın**[***]

Abstract

This research aims to explore the effect of Montessori approach-based STEM activities on preschool pupils' academic self-esteem. The mixed method, which is one of the methods in qualitative and quantitative data are used together in the research. The participants consisted of 63 preschool pupils studying in kindergarten. In the research, the analysis of quantitative data was obtained by statistical methods, and the analysis of qualitative data was obtained by content analysis. As a result of the findings obtained at the end of the research, it was determined that there was a significant difference between the pre-and post-test scores of the academic self-esteem scale. According to the data obtained from the development observation form, the Montessori approach was based on the STEM activities of the preschool pupils; data analysis revealed that there were positive developments in social and emotional development, cognitive development, motor development, language development and self-care skills. According to analysis of the semi-structured teacher interview, the preschool pupils in the study have improved problem solving skills; they can use the desired material with the desired feature and quality, and they act in a more balanced and coordinated manner. Their communication with their peers has also improved, they can remember previous information by focusing their attention, and their psychomotor skills have increased.

Keywords: Academic self-respect, Montessori approach, preschool student, Stem training.

---

[*] The paper was produced from the master's thesis completed at Erzincan Binali Yıldırım University Institute of Science prepared by the first author under the supervision of the second author.
[**] *Corresponding Author:* PhD Student, Erzincan Binali Yıldırım University, Faculty of Education, Department of Science Teaching, Erzincan, Turkey. E-mail: esilasummer24@gmail.com, https://orcid.org/ 0000-0002-2927-318X.
[***] Prof. Dr., Erzincan Binali Yıldırım University, Faculty of Education, Department of Science Teaching, Erzincan, Turkey. E-mail: sayalcin@erzincan.edu.tr, https://orcid.org/ 0000-0001-6349-2231.

Montessori Yaklaşımı Temelli Stem Etkinliklerinin Okul Öncesi Öğrencilerinin Akademik Benlik Saygıları Üzerine Etkisi[*]

Esila Samur[**]   **Sema Altun Yalçın**[***]

Öz

Bu araştırma, Montessori yaklaşımı temelli STEM etkinliklerinin okul öncesi öğrencilerinin akademik benlik saygıları üzerindeki etkisini araştırmayı amaçlamaktadır. Araştırmada nitel ve nicel verilerin bir arada kullanıldığı yöntemlerden biri olan karma yöntem kullanılmıştır. Araştırma örneklemini ana okulunda eğitim-öğretim gören 63 okul öncesi öğrencisi oluşturmaktadır. Araştırma içerisinde nicel verilerin analizi istatistiki yöntemlerle, nitel verilerin analizi içerik analiziyle elde edilmiştir. Araştırmada elde edilen bulgulara göre, akademik benlik saygısı ölçeği ön-son test puanları arasında anlamlı bir farklılık gösterdiği belirlenmiştir. Gelişim gözlem formundan elde edilen verilere göre uygulanan Montessori yaklaşımı temeli STEM etkinliklerinin okul öncesi öğrencilerinin; sosyal ve duygusal gelişimi, bilişsel gelişimi, motor gelişimi, dil gelişimi ve özbakım becerileri üzerinde pozitif yönde gelişimler gösterildiği tespit edilmiştir. Yarı yapılandırılmış öğretmen görüşme formundan okul öncesi öğrencilerinin; problem çözme becerilerinin geliştiğini, istenilen malzemeyi istenilen özellikte ve nitelikte kullanabildiklerini, daha dengeli ve koordineli hareketlerde bulunduklarını, akranları ile olan iletişimlerinin geliştiğini, dikkatlerini toplayarak daha önceki bilgileri hatırlayabildiklerini ve psikomotor becerilerinin arttığını tespit edilmiştir.

Anahtar Sözcükler: Akademik benlik saygısı, Montessori yaklaşımı, okul öncesi öğrencisi, Stem eğitimi.

[**] *Sorumlu Yazar:* Doktora öğrencisi, Erzincan Binali Yıldırım Üniversitesi Eğitim Fakültesi, Fen Bilimleri Öğretmenliği, Matematik ve Fen Bilimleri Anabilim Dalı, Erzincan, Türkiye. E-posta: esilasummer24@gmail.com, https://orcid.org/0000-0002-2927-318X.

[***] Prof. Dr., Erzincan Binali Yıldırım Üniversitesi Eğitim Fakültesi, Fen Bilimleri Öğretmenliği, Matematik ve Fen Bilimleri Anabilim Dalı, Erzincan, Türkiye. E-posta: sayalcin@erzincan.edu.tr, https://orcid.org/ 0000-0001-6349-2231.

Introduction

STEM brings a holistic viewpoint on science, technology, engineering, and mathematics. Providing qualified science and mathematics education with STEM training to individuals in developed countries and ensuring guidance in the flexible curricula development process are the desired goals (Çolakoğlu and Gökben, 2017; Özcan and Koca, 2019). Based on STEM training, it is argued that it should be started in the preschool period for pupils to adopt the concepts of creativity, curiosity, critical thinking and cooperation (Uğraş, 2017). The STEM training given in the preschool period is expected to enable the child to make innovations that will add significance to daily life by combining the main concepts of mathematics and science with engineering and technology. In addition, the language development, school readiness and social development of the child can be supported with STEM training (Günşen et al., 2019). It is of great significance to begin STEM training during the preschool period for individuals so that they can acquire these skills more easily (Kelley and Knowles, 2016). This emerging situation brings out a new idea that applying STEM activities based on the Montessori method provides greater benefit in the education of a child in the preschool period (Çakır, 2018).

The most significant feature of education based on the Montessori method is that it is child-centred. In the educational environment, children should be allowed to move freely and comfortably. Maria Montessori asserts there can be no independence without freedom. Therefore, she has formed the basis of the education model on the term "freedom" (Durakoğlu, 2010). The children, who participate actively, gain the freedom to choose, and thus, they choose the materials they will use and decide what to do and how to do it (Kaza, 2021). The Montessori education approach, which takes the freedom and discovers concepts in the centre, apart from these concepts, contributes even to the creativity, communication and problem-solving skills of children. Another aim of this approach is not only to transfer information to the child but also to the child's willingness to learn. Montessori education is an approach that emphasizes helping the child without pressure or coercion, expressing what s/he wants easily, and self-confidence, esteem and independence skills (Güler, 2021; Uçar, 2019).

STEM and Montessori education form a whole, and the first letter of the word shortened as STEM refers to the word "Science." Science is the focal point that exists in the curricula of "Montessori Child House" by Maria Montessori. In a classical preschool classroom, game-based sensory experiences that focus on the disciplines of mathematics and reading are provided to the children. The pupils are allowed to create patterns, work on handwriting, and participate in group story time by introducing them to the letters and numbers. In the Montessori classes, zoology, botanic and physical curriculum, namely science, are introduced to pupils.; Children learn the shapes of leaves and the animal world and begin to identify the classes of fish, mammals, reptiles and amphibians. They divide the living and non-living organisms into categories among themselves by acquiring knowledge related to water, air and soil. Pupils learn detailed information about the concepts by growing up with the Montessori curriculum (Fher, 2020). For this reason, it can be stated that STEM and Montessori education serves common purposes. At this point, providing integrated education with the Montessori approach, which is based on the activities carried out in the field of STEM in the preschool period, will provide easy and permanent learning. In the studies related to the Montessori approach, it has been suggested that the Montessori approach is more effective than traditional educational programs in improving children's creativity, relationships with teachers and peers, motivation and reasoning skills (Keçioğlu, 2015).

Montessori emphasizes that one of the most significant values of humans is "personality." According to her, the development of the personality as a whole throughout the education process is more important than learning (Veli, 2020). One of the elements that constitute personality is the concept of self. Self refers to the individual's expressing thoughts related to who the individual is, what it means, what s/he can do, and how s/he will adapt to the environment s/he lives in (Uzunoğlu, 2019). The earlier these qualifications are gained by the individuals, the easier they will make their choices at this point. There are various sub-dimensions of the concept of self. One of these dimensions is the academic concept of self (Ocak and Sarlık, 2016). Academic self-concept is explained as an individual's ability to improve on how talented he or she is compared to other individuals, in the case of a certain academic effort (Arseven, 1986). The beginning of academic process begins with preschool education. The skills of mathematics and literacy in the preschool period are called "early academic skills." Acquiring early academic skills for children in the preschool period is a preliminary preparation for acquiring academic

skills in their future school life. In addition, acquiring early academic skills sets the basis for raising successful, self-controlled, entrepreneurial, researchers, individuals who can use their talents and express their feelings and thoughts easily (Ocak and Sarlık, 2016). The interaction between children and the environment, examining the environment carefully and adapting effectively to changes are ensured by academic self-esteem. Academic self-concept is defined as how the child regards his/her learning ability among other classmates (Warash and Markstrom, 2001). Shavelson and Bolus, (1982) investigated self-esteem as a holistic approach and divided it into two under the heading of "Global Self-esteem". These headings are "Academic Self-esteem" and "Non-academic Self-esteem". Academic Self-esteem is evaluated under five sub-dimensions. These are Turkish, Mathematics, Science, Social Sciences and Others. Can (2015) has determined in his research that pupils with high achievement levels also had high academic self-esteem and learning levels. It was emphasized in this study that the effect of academic self-esteem on achievement was higher than the effect of achievement on academic self-esteem. Cevher and Buluş (2006) have referred that acquiring academic self-esteem in the preschool period is significantbecause, gaining academic self-esteem to the individual in the preschool period, and bringing the level of academic success to higher levels is critical in raising individuals with a high desire to learn and strong communication skills in the social environment (Karaca et al., 2016). Integrating Montessori and STEM training, which serves the same purposes as supporting the development of academic self-esteem, and giving it at an early age is important in terms of raising the individuals who research, question, analyze, produce, create solutions to problems, and who are creative, have high academic success, have strong communication with their environment, and who are self-confident, successful in basic sciences and have knowledge (Altun Yalçın and Çakır, 2020). At that point, applying the STEM activities based on Montessori approach in the preschool period is of great significance in terms of developing academic self-esteem for the children.

This study aims to investigate the effect of STEM activities planned based on the Montessori approach on preschool pupils' academic self-esteem.

Method

Research Design

In this research, we used a mixed method which consists using the qualitative and quantitative data together to investigate the effect of the STEM activities based on Montessori approach of preschool pupils on their academic self-esteem. The mixed method is called the method in which both quantitative and qualitative data are used to comprehend the study problems better by the researcher (Creswell, 2007). In this study, mixed method and sequential explanatory mixed research design were used since the quantitative research was dominant (Creswell, 2008).

Research Sample

The population of this study was determined as 4-5-year-old children attending preschool in schools where Montessori approach-based STEM activities were not implemented.

The research sample consisted of 63 preschool pupils from two different state schools within the scope of the Ministry of National Education in the fall term of the 2019-2020 academic year. In identifying the sample, it was determined that the Montessori approach-based STEM activities had not been applied in these schools before. In this research, the purposive sampling method among the non-random sampling methods was used and current classroom forms were not changed (Büyüköztrük et al., 2008).

Necessary permissions for the quantitative data collection tool that was applied in the research were obtained from the entitled authors. In addition, necessary references were made to the authors within the scientific framework. The participants were informed before the activities to be implemented. Necessary permissions were obtained from the participants by means of the informed consent form. Ethics committee permission was obtained from Erzincan Binali Yıldırım University Human Research Ethics Committee, dated 28/09/2020, number 03.

Research Instruments and Procedures

Data Collection Tool: The Academic Self-esteem scale, which was developed by Cevher and Buluş (2006) and appropriate to the evaluation process of the Montessori approach-based STEM activities was performed in collecting the quantitative data in the research. In the research, since the number of independent variables was odd the single-group pre-test post-test model was used, which is one of the single-factor design and single-group experimental designs (Karasar, 2013). In the application process of the research, a pre-test was performed on a single group without any training. Then, Montessori approach-based STEM activities were implemented and a post-test was administered to the same group using the same measurement tools. Analyzes regarding the dependent variable were made by looking at the differences between the pre-and post-test.

In collecting the qualitative data, the "Ministry of National Education Preschool Education Curriculum (2013) Development Observation Form" and "Semi-structured Teacher Interview Form" were used.

Data Analysis

The quantitative data were analyzed through SPSS. A normality assumption test was administered by "Kolmogorov-Smirnow test." By considering the skewness coefficient of all the measurements and the histogram graphs, the Kolmogorov-Smirnow suitability was checked. The data obtained from the Kolmogorov-Smirnow test are accepted as they demonstrated normal distribution when the data group was $p>0.05$ (Can, 2016). The Kolmogorov-Smirnow values of the academic self-esteem scale were 0.200 for the pre-test, and 0.062 for the post-test ($p>0.05$, Can, 2016). The skewness coefficient of the academic self-esteem scale was -0.258 for the pre-test and -0.632 for the post-test, and the kurtosis coefficient was: 0.161 for the pre-test and -0.096 for the post-test. As a result of the emerging values and graph measurements, since the kurtosis and skewness values were calculated between +1.96 and -1.96, it indicated a normal distribution (Can, 2016). A paired samples t-test was applied to find out if there was a meaningful difference between the pre-test and post-test scores of the academic self-esteem scale applied to the sample group.

Content analysis method was employed in analysing the qualitative data. First, the codes and categories were produced based on the data. Next, for the validity and reliability of the analysis, we got the opinions of two different experts and later combined them. In the analysis of the qualitative data, the Miles and Huberman's (1994) reliability formula was used and the reliability was found as 89.7%. If the reliability value between the coders is above 80%, it indicates that it is reliable (Miles and Huberman, 1994).

Findings

In this study, the effect of STEM activities based on the Montessori approach on preschool pupils' academic self-esteem was investigated. For this purpose, different measurement tools were used as quantitatively and qualitatively. The statistical analyses of the quantitative data were carried out through a paired samples t-test. On the other hand, content analysis was applied to the analysis of the qualitative data.

Findings and Comments on the First Sub-Problem

A paired samples t-test was used to find out if there was a meaningful difference between the pre-test and post-test scores in terms of the academic self-esteem of the sample group in which STEM activities based on the Montessori approach were implemented in the research. The academic self-esteem pre-test and post-test scores related to the first sub-problem in the paired samples t-test results are presented in Table 1.

Table 1
Academic Self-Respect Scale Paired Samples T-Test Results

Measurements	N	Mean	Ss	T	Sd	p
Pre-test	62	85.032	15.461	-4.536	61	.000
Post-test	62	89.693	16.525			

p<0,05

A statistically significant difference was observed between the pre-implementation score average ($\bar{x}$ Pre-test = 85.032) and the post-application score average ($\bar{x}$ Post-test =89.693) in the results of the test, which is indicated in Table 1 (t62: -4.536, p< 0.05; Can, 2016). Thanks to this statistically significant difference, it can be expressed that the STEM activities based on the Montessori approach improve the academic self-esteem of preschool pupils.

Findings from the MoNE Development-Observation Form

Within the scope of the research, the "Ministry of National Education Preschool Education Curriculum (2013) Development Observation Form" was used to observe what kind of effects the development of the sample group in which Montessori approach-based STEM activities were applied. The results of the content analysis in terms of motor development were presented in Table 2.

Table 2
Motor Development

Category	Code Name	Frequency (f)	Rate (%)
Coordination	Coordinated	1	0.8
	Bodily coordination	1	0.8
	Balanced	2	1.7
	Hand-eye coordination	3	2.6
	Gives shape to the material	5	4.3
	Removes objects	11	9.5
	Attaches objects	11	9.5
	Object control	20	17.3
Skill	Big muscle	2	1.7
Movement	Pulls	1	0.8
	Pushes	1	0.8
	Rhythmic	1	0.8
	Stands on a single foot	1	0.8
	Runs	2	1.7
	Skips	2	1.7
	Jumps	3	2.6
	Cuts	4	3.4
	Active	11	9.5
Total		115	98.9%

The categories, codes, frequencies and rates of motor development obtained from the Development and Observation Form are presented. In the Coordination category, pupils' observations are presented in relation to coordination and balance skills. The preschool teacher claimed that their pupils could easily perform movements that required balance, walk in a straight line easily, and successfully achieve physical coordination after the activities. In the skill category, teacher's statements were related to the effects on pre-schoolers muscle development. The teacher claimed that the preschool pupils' psychomotor skills developed after the activities, they could easily use scissors and give shape to soft materials. In the category of movement, there were expressions related to how the pre-schoolers' movement development changed and developed. It included teacher's statements showing how the influence of the activities on the movement development of preschool children changed and developed.

Table 3
Cognitive Development

Category	Code Name	Frequency(f)	Rate (%)
Product creation methods and techniques	Cause- effect	6	4.6
	Learn	9	7.03
	Part – whole	20	15.6
	Produces problem	20	15.6
	Solves problem	21	16.4
Cognitive activities	Focuses	1	0.7
	Says colours	1	0.7
	Knows numbers	2	1.5
	Recalling	2	1.5
	Perception	2	1.5
	Grouping	5	3.9
	Ordering	6	4.6
	Matching	9	7.03
	Observation	13	10.1
Other	Material	1	0.7
	Presence	2	1.5
	Creates a plot	3	2.3
Total		128	99.06%

The teacher reported that pupils created appropriate solutions by creating a problem situation while creating a product, established a cause-effect relationship and learned by understanding the part-whole relationship in the codes in the category of product creation methods and techniques as seen in Table 3. In the category of cognitive activities, the teacher expressed that their pupils were able to do the activities that required cognitive skills at the end of the activities. In the invention category, the preschool teacher pointed out that the activities carried out helped the pupils to create different products and to gain a different perspective. In the category 'other,' the teacher stated that the pupils counted the events in the order in which they occurred and learned the characteristics of the events or entities at the end of the activities.

Table 4
Language Development

Category	Code Name	Frequency (f)	Rate (%)
Verbal skill	Breath control	1	0.8
	Sound direction	1	0.8
	Different word	1	0.8
	Says, family members	1	0.8
	Says address	2	1.6
	Self-expression	6	4.8
	Pronunciation	7	5.6
	Word	15	12.1
	Communication	20	16.2
Empathy skills	Perception	1	0.8
	Wait for peers	1	0.8
	Eye contact	2	1.6
	Asking question	6	4.8
	Comprehending	10	8.1
	Watching	20	16.02
	Listening	21	17
Basic Communication Concepts	Spelling rules	4	3.2
Total		123	99.2%

In Table 4, in the codes belonging to the verbal category, the teacher indicated that after the activities, the pupils' communication skills improved, their language skills improved, and their verbal communication increased. After the activities in the empathy category, the teacher claimed that their pupils developed empathy, learned to listen to each other, and did not hesitate to express themselves and ask questions. In the category of basic communication concepts, the preschool teacher reported that their pupils used Turkish effectively after the activities and that they followed the rules of Turkish and spelling.

Table 5
Social and Emotional Development

Category	Code Name	Frequency(f)	Rate (%)
Environmental factors	Friend	2	1.8
	Tools and equipment	5	4.5
	Different environment	20	18.1
Behaviour	Effort	1	0.9
	Willing use	2	1.8
	Willing participation	5	4.5
	Adapting	7	6.3
	Obeying the rules	20	18.1
	Responsibility	24	21.8
Social efficacy	Task	2	1.8
Other	Physical	1	0.9
Total		110	99.92%

In Table 5, the codes in the environmental factors consisted of the statements about the pupils adapting to different environments, making friends, using the necessary equipment willingly and adapting to new events. The highest frequency among the codes was found in the code of the different environments. The preschool teacher stated that after the activities, the pupils developed friendships, initiated communication, showed adult behaviour and spontaneously started a task. In the category of Behaviour, the teacher pointed out that their pupils developed a sense of responsibility, fulfilled their responsibilities, participated voluntarily in activities, followed the rules set in different environments, and made an effort to complete the assigned tasks given at the end of the activities. In the category of social efficacy, the teacher stated that the activities had a positive impact on their pupils' social competencies positively, so that they spontaneously initiated activities, participated in activities, and became leaders in their groups. Although the pupils sometimes experienced problems in taking on the leadership role during the activity, they adapted to the group by solving their problems. In the category 'other,' the teacher reported that their pupils expressed their positive or negative feelings and described their physical characteristics.

Table 6
Self-Care Skills

Category	Code Name	Frequency (f)	Rate
Individual Competence	Self-care skills	1	2.5
	Takes off clothes	3	7.5
	Chooses his/her clothes	4	10
	Washing hand-face	4	10
	Eating	7	17.5
	Wearing clothes	7	17.5
Hygiene	Organises environment	1	2.5
	Behaviour	1	2.5
	Cleaning rules	2	5
	Appropriate	3	7.5
	Uses cleaning materials	7	17.5
Total		40	100%

In Table 6, the codes in the category of individual competence included teacher's statements about pupils being able to choose clothes suitable for changing weather, to put on and take off their clothes spontaneously, to achieve self-care skills, to wash by hand, to buy as much food as they need, and to choose the food they want. In the category of hygiene, the preschool teacher claimed that their pupils were able to choose and use cleaning materials, pay attention to cleaning rules and keep their environment clean. They also stated that their pupils' cleaning skills developed positively.

Findings from the semi-structured teacher interview form

A semi-structured teacher interview was held with a preschool teacher who attended voluntarily and taught the preschool pupils in a school in which STEM activities based on the Montessori approach were used. The interview aimed to determine the teacher's thoughts to identify the effect of STEM activities based on the Montessori approach on the academic self-esteem of preschool pupils. During the interview, the teacher was asked 6 open-ended, semi-structured questions. The teacher's written responses were obtained. The teacher's written answers were obtained.

To summarise the data obtained from the teacher interview form, it can be suggested that the STEM activities based on the Montessori approach developed the pupils' skills in making decisions, coming up with new ideas for the problems they encountered, expressing themselves easily, increasing communication with their peers, completing the tasks given easily, cooperating with their peers and developing leadership skills. In addition, the preschool teacher stated that it had a positive impact on the pupils.

<div align="center">

Result and Discussion

</div>

According to the research conducted to measure the effect of the Montessori approach to STEM activities on preschool children's academic self-esteem, significant differences were found. According to the findings of this research, it can be stated that the applications consisting of STEM activities based on the Montessori approach developed preschool children's academic self-esteem. The studies that have been conducted to find that STEM activities based on the Montessori approach develop students' academic self-esteem support the findings of our study. Studies in this field, such as Yıldırım (2021), found that the scientific process skills of pupils who attended the Montessori preschool program between 60-72 months were positively affected at the end of the M-STEM program. It was claimed that the M-STEM program was more effective for the pupils who were new to preschool; that it would be beneficial to integrate STEM activities with the Montessori education program in the development of children's scientific process skills, especially for children who are just starting the Montessori program. Çakır (2018) found that the applications involving STEM activities based on the Montessori approach developed the pre-service teachers' problem-solving, critical thinking tendencies and creativity skills of pre-service teachers. Açıkgöz (2018) suggested that the applications, which consisted of STEM activities based on the Montessori approach, developed preschool teachers' problem-solving skills. Fher (2020) investigated the impact of STEM activities on the Montessori-based courses given to pupils in the preschool period. It was claimed that the effectiveness and participation of the pupils in the course decreased in the course where the Montessori materials were used; however, in the course integrated with the STEM activities, the pupils were more effective and willing to participate in the course. Jones (2017) expressed positive opinions about the STEM activities, that they included high technology activities in their courses, that the students also valued the development of technical skills, and that the teachers interviewed all struggled to incorporate teaching technology in a way that was compatible with the Montessori paradigm. At the end of the research, it can be interpreted that STEM activities based on the Montessori approach develop the pre-schoolers' academic self-esteem.

In terms of the qualitative data analysis of the research, it was observed that the preschool children could use the materials according to their purposes, their psychomotor skills developed and their physical coordination improved at the end of the activities. As a result of the observations, it was found that the STEM activities based on the Montessori approach had a positive effect on motor development. Beken (2009), whose findings are similar to those of this study, compared the dexterity development of a preschool child attending a MoNE state school and a child attending a private school using the Montessori method. In this study, it was found that the development of dexterity was higher in the pupils who received Montessori education. Ulutaş, Demir and Yayan (2017) applied 40 activities including

the use of psychomotor skills, to a group of pupils aged 5-6 years. At the end of the study, it was found that motor skills had increased. The development of visual and motor coordination in early childhood begins with the use of the hands and body in pointing at different objects in the visual field. The development of visual and motor coordination is one of the basic steps. Visual perception education is an education for the perception of visual stimuli and the formation of appropriate motor and cognitive responses (Durulan and Angın, 2023; Ercan and Aral, 2011). Visual perception and psychomotor training can be included under the heading 'other' when examining the sub-dimensions of academic self-esteem dealt with by Shavelson and Bolus, (1982) are examined. It can be argued that these developments in visual perception and psychomotor skills develop preschool children's academic self-esteem.

The qualitative data analysis revealed that after the activities, it was found that the preschool children were able to find appropriate solutions to the problems, establish a part-whole relationship, make classifications, establish cause-effect relationships, generate original ideas, remember the information they had learned and arrange the events in their order of occurrence. Considering the data obtained, it was found that STEM activities based on the Montessori approach had a positive effect on cognitive development. Yalçın (2020), who obtained results that supported the findings of this study, claimed that the preschool STEM activities prepared according to the focused thinking model showed that the children's creativity and problem-solving skills improved positively. Dereli (2017) suggested that the psychosocial development and problem-solving skills of children trained with the Montessori educational curriculum were higher than those trained with the MoNE curriculum. Dedeoğlu (2018) found that Montessori education increased students' cognitive development and social efficacy more than preschool students, who were educated with the MoNE curriculum. It can be interpreted that achieving the same results separately from STEM and Montessori education, applied to preschool pupils, indicates that STEM activities based on the Montessori approach increase cognitive development. Another area related to children's cognitive skills and included in the area of academic skills is mathematical skills. Their performance in basic skills such as numbers, classification, modeling and measurement, which are considered in mathematics, requires the activation of high-level cognitive skills. Children's mathematical problem-solving is also related to the use of cognitive processes (Uyanık and Alisinanoğlu, 2016; Yıldız Altan and Temel, 2022). It can be argued that by enabling the development of these skills, children's academic self-esteem improved.

In addition, as a result of the qualitative data analysis, it was observed that the preschool children increased their communication with their peers, used language for communication purposes, learned new concepts and used them in their daily life, knew the word equivalent of objects, could express their thoughts, their vocabulary increased, they could pronounce words correctly and could use Turkish with rules and correctly at the end of the activities. According to the data obtained, it was found that STEM activities based on the Montessori approach had a positive effect on language development. Supporting the findings of this study, Kayılı, Koçyiğit and Erbay (2009), who conducted a parallel study to this one, found that those who were educated with the Montessori method between the ages of 5 and 6 had higher language skills than those who received preschool education according to the MoNE curriculum. The increase in language development also affects the development of literacy. All activities related to language development in the preschool period also affect the development of future reading and writing skills (Buğan, Çorapçı, and Ada, 2022; Uyanık and Alisinanoğlu, 2016). It can be interpreted that having a "Turkish" education in the subdimensions of academic self-esteem and increasing children's language development also develops students' academic self-esteem. According to the qualitative data of the study, after the research it was found that the preschool children had a sense of responsibility, adapted to the different environmental rules they encountered, could use the object themselves, could easily express positive and negative thoughts, started a new task voluntarily and made an effort to finish the task they started, could express their feelings and cooperate.

According to the data obtained, Kuşçu, Bozdağ, and Yıldırım Doğru (2014), who obtained results that support the findings of the present study suggesting that STEM activities based on the Montessori approach enhance social and emotional development, and found that the preschool students educated with the Montessori education had higher social and emotional skills compared to the students educated with the MoNE curriculum. It was observed that the children who received the Montessori education

exhibited behaviours such as finishing the work they started, waiting their turn and taking responsibility more often than the children who received the MoNE curriculum. Koçyiğit and Kayılı (2008) found that the preschool children who were educated with the Montessori method experienced a higher development of social cooperation, interaction and independence than those who were educated with the classical MoNE curriculum. The provision of basic academic skills to children in the preschool period increases the level of readiness of children for primary education. In addition, it also provides higher academic skills in future periods (Uyanık and Kandır, 2010). At this point, social and emotional development will increase the child's academic achievement. And it can be argued that the increase in their academic achievement will also increase their academic self-esteem.

Our qualitative data also revealed that the pre-schoolers were able to dress appropriately for the weather conditions, meet their needs independently, show appropriate behaviour in case of danger, and organize their environment by leaving it clean at the end of the activities. According to the data obtained, STEM activities based on the Montessori approach were found to have positive effects on self-care skills. Supporting the findings of the study, Saki (2020), who obtained parallel results, found that psychological resilience, seeking help, assertiveness-confidence, self-regulation, peer relations, attachment, social competence, emotion control, and problem-solving skills also increased in the children who were educated with the Montessori philosophy. The Montessori philosophy was also found to enable the development of self-care skills. Self-care skills in early childhood are defined as the student's ability to meet basic needs such as cleaning, eating, sleeping, etc. The better the child learns these basic skills, the more successful they will be in other areas of development such as physical, mental, spiritual and social. However, children must first meet their basic needs, i.e., acquire some self-care skills, in order for the child to be successful in the areas of physical, mental, spiritual, and social development (Konya, 2007). This means that a child who cannot acquire self-care skills will not be successful academically. At this point, it can be argued that a child with developed self-care skills will not only achieve academic success but will also improve the child's academic self-esteem.

References

Açıkgöz, S. (2018). *Comparison of STEM and Montessori methods, one of the pre-school approaches in science education, in line with the opinions of teachers.* (Unpublished Master Thesis), Kastamonu University, Institute of Science and Technology, Kastamonu.

Altun Yalçın, S. & Çakır, Z. (2020). STEM training with Montessori approach, applied STEM training with teaching-learning approach in lesson plans. M. Çevik (Ed.), N*obel Publishing,* (pp. 125-139). Ankara.

Buğan, B., Çorapçı, F. & Ada, F. E. (2022). Socio-Emotional Development in Preschool Period: Examining the Predictive Role of Temperament, Language Development and Emotion Understanding Skills. *Education and Science], 47(209),* 1-23.

Beken, S. (2009). *The effect of montessori method activities on the development of hand skills of 5–6-year-old children.* (Unpublished Master Thesis), Adnan Menderes University Institute of Social Sciences, Adana.

Cevher, F. N. & Buluş, M. (2006). Academic self-esteem in 5–6-year-old children attending pre-school education institutions. *Dokuz Eylul University Buca Education Faculty Journal],* 20, 28-39.

Creswell, J. W. (2006). Understanding Mixed Methods Research, (Chapter 1), Available at: http://www.sagepub.com/upm-data/10981_Chapter_1.pdf

Creswell, J. W. & Tashakkori, A. (2007). Differing Perspectives on Mixed Methods Research, *Journal of Mixed Methods Research, 1*(4), 303-308.

Creswell, J. W. & Sözbilir, M. (2017). *Introduction to mixed methods research.* Pegem Akademi.

Çakır, Z. (2018). *Examination of the effect of Montessori approach-based STEM activities on pre-school teacher candidates.* (Unpublished Master Thesis), Erzincan Binali Yıldırım University, Institute of Science and Technology, Erzincan.

Çolakoğlu, M. H. & Gökben, A. G. (2017). STEM studies in education faculties in Turkey. *Journal of Research in Informal Environments,* 2(2), 46-69.

Dedeoğlu, S. (2018). *Comparative analysis of cognitive development and social competencies of children educated according to MEB preschool education program and Montessori program.* (Unpublished Master Thesis), Necmettin Erbakan University, Institute of Educational Sciences, Konya.

Dereli, E. (2017). Investigation of the effects of montessori education program on children's psychosocial development and social problem-solving skills. *Journal of Ahi Evran University Kırşehir Education Faculty,* 18(2), 135-153.

Durakoğlu, A. (2010). Reading and writing education in Montessori method. *Journal of Family and Society Education-Culture and Research,* 20(20), 1303-0256.

Durulan, D. & Angın, D. (2023). Examining the Effect of Mind and Intelligence Games on Preschool Children's Attention and Visual Perception Levels. Journal of Dokuz Eylül University Social Sciences Institute, 25 (1), 333-357

Ercan, Z. G. & Aral, N. (2011). Investigation of the effect of visual perception training on visual-motor coordination development of kindergarten children. *Turkish Journal of Educational Sciences,* 9 (3), 443-465.

Fehr, K. (2020). *STEM Integration in the Montessori Early Childhood Classroom,* (Unpublished Master Thesis), University of Wisconsin, Madison-ABD.

Güler, S. (2021). *Sharing of Children in a Preschool Educational Institution Implementing a Montessori Progra].* (Unpublished Master Thesis), Fatih Sultan Mehmet Foundation University, Graduate School of Education, Istanbul.

Günşen, G., Uyanık, G. & Akman, B. (2019). Determination of pre-school teachers' stem semantic perceptions and their thoughts on stem approach. *Kastamonu Journal of Education, 27*(5), 2173-2186.

Jones, S. J. (2017). Technology in the Montessori Classroom: Teachers' Beliefs and Technology Use, *Journal of Montessori Research*, 3(1), 16-29.

Karaca, N. H., Akyol, T., Karaca, L. & Can Yaşar, M. (2016). Examination of pre-school teacher candidates' problem-solving skills and self-esteem according to some variables. *Afyon Kocatepe University Journal of Social Sciences,* 18(1), 199-220.

Kaza, Ö. (2021). *Examination of the creative thinking skills of preschool students who applied pre-school education program with Montessori education.* (Unpublished Master Thesis), Ondokuz Mayıs University Graduate Education Institute, Samsun.

Keçecioğlu, Ö. (2015). *Examination of the social skills of 5-year-old children who are educated according to the MEB preschool education program and Montessori approach.* (Unpublished Master Thesis), Marmara University, Institute of Educational Sciences, Istanbul.

Kelley, T. R. & Knowles, J. G. (2016). A Conceptual Framework for Integrated STEM training, *International Journal of STEM training*, 3(1), 1-11.

MEB (2013). Okul Öncesi Eğitim Programı. Ankara: Millî Eğitim Bakanlığı Yayınları.

Ocak, G. & Sarlık, B. (2016). A cademic self-esteem in 5–6-year-old children attending pre-school education institutions. *Journal of Education and Teaching Research*, 5(22), 182-194.

Özcan, H. & Koca, E. (2019). The effect of STEM approach and pressure subject teaching on secondary school 7th grade students' academic achievement and attitudes towards STEM. *Journal of Education and Science],* 44(198), 201-227.

Shavelson RJ & Bolus R. (1982). Self-concept: the interplay of theory and methods, *Journal of Educational Psychology*, (74), 13–17.

Uğraş, M. (2017). Preschool Teachers' Views on STEM Practices. *Journal of New Approaches in Education, 1(1),* 39-54.

Ulutaş, A., Demir, E. & Yayan, E. H. (2017). Investigation of the effect of motor development training program on gross and fine motor skills of 5–6-year-old children. *Abant İzzet Baysal University Journal of Education Faculty, 17*(3), 1523-1538.

Uyanık, Ö. & Alisinanoğlu, F. (2016). The Effect of the Academic and Language Skills Education Program upon 61–66-Month-Old Children's Cognitive Skills Early Academic and Language Skills. *Mediterranean Journal of Humanities, 6*(2), 459-481.

Uyanık, Ö. & Kandır, A. (2010). Early Academic Skills in Preschool Period]. *Journal of Theoretical Educational Sciences, 3*(2), 118-134.

Veli, E. S. (2020). *Investigation of the Effect of Montessori Education Method on Daily Life Skills and Parental Attitudes of Preschool (36-66 Months) Children.* (Unpublished Master Thesis), Istanbul Sabahattin Zaim University, Graduate Education Institute, Istanbul.

Warash, B.G. and Markstrom, C.A. (2001). Parental perceptions of parenting styles in relation to academic self-esteem of preschoolers, *Education,* 121, 485-494.

Yıldım, Z. (2021). *Investigation of the effect of the M-STEM program developed for 60-72 months old children attending Montessori education on children's scientific process skills.* (Unpublished Master Thesis), Yıldız Technical University Institute of Social Sciences, Istanbul.

Yıldız Altan, R. & Temel, Z. F. (2022). Examination of Learning Processes Supporting Metacognitive Skills in Preschool Education. *Journal of Social, Humanities and Administrative Sciences, 5(5),* 582–602.