Journal name	International e-Journal of Educational Studies
Abbreviation	IEJES
e-ISSN	2602-4241
Founded	2017
Article link	http://doi.org/10.31458/iejes.1505901
Article type	Research Article
Received date	27.06.2024
Accepted date	15.09.2024
Publication date	27.10.2024
Volume	8
Issue	18
pp-pp	255-266
Section Editor	Assoc.Prof. Dr. Deniz KAYA
Chief-in-Editor	Prof. Dr. Tamer KUTLUCA
Abstracting & Indexing	Education Source Ultimate Database Coverage List EBSCO Education Full Text Database Coverage List H.W. Wilson Index Copernicus DRJI Harvard Library ASCI SOBIAD
Article Name	The development of Non-Formal Learning Organization Skills in Preservice Math Teachers

Author Contribution Statement

[1] Melike TURAL SÖNMEZ
Assoc. Prof. Dr.
Kırıkkale Üniversity, Faculty of Education, Kırıkkale, Turkey

Conceptualization, methodology, data collection, data analysis, and reporting

Abstract

Although the effects of out-of-school learning on students' learning have attracted significant attention among education researchers in science and social sciences, little is known about the development of pre-service elementary mathematics teachers' skills in utilizing out-of-school learning in mathematics lessons. The aim of this research is to investigate the impact of activities conducted within the scope of the out-of-school learning environments in mathematics education on pre-service elementary mathematics teachers' skills in organizing non-formal learning. The study utilized a sequential explanatory design, which is a mixed-method approach. The quantitative part of the research employed a "single-group pretest-posttest design without a control group" from experimental designs. This study involved 35 third-year teacher candidates enrolled in the Primary Education in Math Program (PREDMAP) at a state university located near Ankara, the capital city of Turkey. The data collection instrument used in the study was the Out-of-School Learning Regulation Scale (OOSLRS), developed by Bolat and Köroğlu (2020), which consists of four dimensions: knowledge, planning, implementation, and evaluation of out-of-school learning. Additionally, teacher candidates were asked to write reflective essays about their thoughts on the program at the end of the study. In the study, 10 theoretical training sessions and 4 technical field trips were implemented. The research utilized a single-group pretest-posttest design, and the data were analyzed using paired sample t-tests. The analyses revealed that prior to the program, pre-service math teachers had the highest scores in the knowledge dimension and the lowest scores in the implementation dimension of organizing out-of-school learning. Significant differences were found in the pretest scores of preservice math teachers only in the knowledge dimension based on their previous experiences in organized out-of-school learning environments during their educational lives. When examining the final scores derived from the OOSLRS, preservice math teachers achieved their highest scores in the knowledge, planning, evaluation, and implementation dimensions, respectively. Significant improvements favoring the post-test application were observed across all dimensions between pretest and posttest scores. Data from reflective essays written by the preservice math teachers indicated their emphasis on active participation and included suggestions particularly in the implementation dimension.

To cite this article:

Tural-Sönmez, M. (2024). The development of non-formal learning organization skills in preservice math teachers. *International e-Journal of Educational Studies*, *8*(18), 255-266. https://doi.org/10.31458/iejes.1505901

Research Article

The Development of Non-Formal Learning Organization Skills in Preservice Math Teachers *

Melike TURAL SÖNMEZ [1]

Abstract

Although the effects of out-of-school learning on students' learning have attracted significant attention among education researchers in science and social sciences, little is known about the development of pre-service elementary mathematics teachers' skills in utilizing out-of-school learning in mathematics lessons. The aim of this research is to investigate the impact of activities conducted within the scope of the out-of-school learning environments in mathematics education on pre-service elementary mathematics teachers' skills in organizing non-formal learning. The study utilized a sequential explanatory design, which is a mixed-method approach. The quantitative part of the research employed a "single-group pretest-posttest design without a control group" from experimental designs. This study involved 35 third-year teacher candidates enrolled in the Primary Education in Math Program (PREDMAP) at a state university located near Ankara, the capital city of Turkey. The data collection instrument used in the study was the Out-of-School Learning Regulation Scale (OOSLRS). Additionally, teacher candidates were asked to write reflective essays about their thoughts on the program at the end of the study. The analyses revealed that prior to the program, pre-service math teachers had the highest scores in the knowledge dimension and the lowest scores in the implementation dimension of organizing out-of-school learning. Significant differences were found in the pretest scores of preservice math teachers only in the knowledge dimension based on their previous experiences in organized out-of-school learning environments during their educational lives. Significant improvements favoring the post-test application were observed across all dimensions between pretest and posttest scores. Data from reflective essays written by the preservice math teachers indicated their emphasis on active participation and included suggestions particularly in the implementation dimension.

Keywords: Non- formal learning, out of school learning, teacher tarining, math education

1. INTRODUCTION

One of the most important characteristics of quality education is the appropriate balance between theory and practice (Erentay & Erdoğan, 2009). The idea that any type of out-of-class learning environment that could benefit students can be utilized for applied education has been brought up (Metin-Göksu, 2020; Saraç, 2017). Educational processes involving field trips, observations, visits to social, cultural, industrial and scientific venues, nature education, virtual reality applications, sports activities, environmental club events, assignments and projects directly related to specific locations, cultural, social, and scientific programs, and spatial practices for lifelong learning encompass out-of-classroom learning environments (Fidan, 2012). These nonformal context can enhance school learning (Falk & Dierking, 2000; Rennie & Johnston, 2004). Resnick (1987) identifies four dimensions of outside of school activities: “engage younge people in social groups and function collaboratively”, “rely on tools to shape and facilitate cognitive activity and engagement”, “are embedded within contexts and incorporate the use of artifacts and practices that surface within a particular activity” and “develop scientific competencies”. Maarschalk (1988) stated that nonformal and informal education are separated from each other as follows: While nonformal education proceeds

Received Date: 27/06/2023 **Accepted Date:** 15/09/2024 **Publication Date:** 27/10/2024

*__To cite this article:__ Tural-Sönmez, M. (2024). The development of non-formal learning organization skills in preservice math teachers. *International e-Journal of Educational Studies, 8*(18), 255-266. https://doi.org/10.31458/iejes.1505901

[1] *Assoc. Prof. Dr., Kırıkkale University, Faculty of Education, melikesonmez@kku.edu.tr , Turkey*

Corresponding Author e-mail adress: melikesonmez@kku.edu.tr

in a planned but adaptable way in institutions such as in service training, field trips, museum visits and educational television and radio while informal education occurs in situations in life that come about spontaneously, for example within the family circle and neighborhood. Falk and Dierking (2000) state that the outcomes of visiting and interacting in nonformal learning environments were the result of many factors: visitors personal and collective experiences, their interest and motivation, the social and inter subjective situations that arise through participation, the physical space itself and random factors that can not easly be explained.

1.1. Place of Out-of-School Learning Environments in the Turkish Education System

In the history of Turkish education, effective utilization of out-of-school learning environments has led to the formation of approaches and organizations, and periodic updates of programs. For instance, during the Seljuk Empire, the establishment of the master-apprentice relationship and on-the-job training supported by the Ahi organization exemplify this approach (Metin Göksu, 2020). Similarly, during the Ottoman Empire, the Mühendishane-i Berr-i Hümayun implemented practical lessons in specific fields on certain days, gathering students for hands-on learning (Akyüz, 2013). In the Turkish Republic era between 1940-1947, the educational structure of the Village Institutes exemplified a structuralist approach that effectively utilized out-of-school learning environments. Learning in Village Institutes extended beyond traditional classroom and laboratory settings to encompass a natural, social, and cultural research and exploration area ranging from the immediate surroundings of the school to nearby villages, towns, and regions (Aytaç, 1980). In these Village Teacher Schools, alongside general academic subjects, vocational and agricultural skills were taught outside the classroom through practical applications. As a result, graduates of these Village Institutes became individuals equipped not only with teaching knowledge and general culture but also with practical skills in agriculture and craftsmanship, enabling them to manage and supervise agricultural activities effectively (Metin-Göksu, 2020; Oğuzkan, 1990).

In Turkey, the current primary education mathematics curriculum (Ministry of National Education (MoNE), 2018) does not explicitly mention the use of out-of-school learning environments. The program states that "flexibility is granted to teachers within the framework of the program's recommendations and objectives in determining the teaching approach and organizing learning environments" (p.14).However, in the upcoming 2024 mathematics curriculum (MoNE, 2024), which will come into effect in the following years, under the framework of "school-based planning," specific time allocations have been designated for various activities such as out-of-school learning activities, research and observation, social activities, project work, local studies, and reading activities at each grade level (MoNE, 2024). It is specified that the allocated time will be planned within the academic year and reflected in annual plans (MoNE, 2024).

Similar to developed countries, in recent years, educational units have been established in museums in Turkey. In 2002, the Rahmi M. Koç Museum pioneered the creation of an "Education Package" specifically for primary education under the title of "Education in Museums." Some museums offer educational services and workshops tailored for students and teachers. Additionally, the number of science centers in Turkey has been increasing, with these centers and museums incorporating activities specifically focused on mathematics education. Moreover, in major cities, large city libraries organize workshops in a planned manner to support children and young people in their learning and participation.

1.2. Non-formal Learning Environments in Mathematics Education

Research on how out-of-school learning environments affect student learning has been increasing in recent years, predominantly conducted in the fields of science and social studies education (Saraç, 2017). Popovic (2011) emphasized that not only for science but also for mathematics. Mathematics is more than memorizing formulas; it needs to help students understand the environment around them and solve their problems. Wager (2012) also state that school mathematics

offer powerful practices that, when connected to out-of-school practices, provide meaning. Drawing connections between out-of-school practice and school mathematics practices and notation is essential.

It has also been documented that teachers candidates lack the subject knowledge and sometimes the resources to direct students to attain meaningful mathematical activity. Teacher candidates need to fully utilize informal or outdoor mathematics learning resources available in their communities. Non-formal learning environments such as Museum assist teachers and teacher candidates in recognizing mathematics in the real world and developing instructional math to help their students make connections between school mathematics and its real world applications. Bahadır and Hırdıç (2018) analyzed middle school students' views and learning experiences regarding the experimental sets in a mathematics museum. The findings of the study revealed that students could explore everyday aspects of mathematics during the visit and thereby acquire new knowledge. It also showed that students believed guided tours with a guide were more beneficial. The study indicated that the implementation provided students with the ability to notice mathematics in everyday life, relate mathematics to other disciplines, and real-life situations.

For teachers to benefit from out-of-school learning environments, which have been shown to benefit students' learning in behavioral, cognitive, and emotional dimensions (Buyurgan, 2017), it is crucial that teachers are knowledgeable about how to effectively utilize such environments. Kır et al. (2021), in their study with mathematics teachers, mentioned that teachers in Turkey reported not having sufficient knowledge about using out-of-school learning environments and not being able to conduct teaching in such environments due to inadequate resources. Teachers also tend to avoid implementing activities in these environments due to reasons such as reluctance to take responsibility, lack of motivation, and negative past experiences (Çiçek & Saraç, 2017; Kır et al., 2021). Öner-Armagan et al. (2023) suggest arranging museum education courses in universities as an optional/compulsory course, to organize activities for the use of virtual museums, and to encourage pre-service teachers to use virtual museums more as a digital course material.

Regarding specific learning outcomes suitable for implementation in out-of-school learning environments, mathematics teachers suggested that the most appropriate outcomes were related to the domains of 'geometry and measurement' and 'numbers and operations', while they did not express views on the feasibility of conducting out-of-school learning activities in the domains of 'data processing' and 'probability' (Kır et al., 2021).

In a study by Gül and Saz (2023) focusing on teachers' competencies related to out-of-school learning, it was found that while teachers had sufficient knowledge about knowing and planning out-of-school learning environments, they had lower competencies in implementation and evaluation phases. The study also revealed that mathematics teachers did not show significant differentiation in their out-of-school learning competencies compared to teachers from other disciplines. Xenofontos and Hizli-Kalkan (2022) examine student teachers' observations within a Mathematics Fair, which was part of a mathematics methods module of a primary education undergraduate programme. Employing a thematic analysis approach, they identified four themes discussed by students: the task; learning; teaching; non-formal environment.

In literature review, it has been noted that teachers do not possess sufficient knowledge about out-of-school learning environments, and they request in-service training on this topic (Sarıoğlan & Küçüközer, 2017). They also suggest that practical and application-oriented courses focusing on this subject during undergraduate studies could be beneficial in equipping teachers with more expertise in out-of-school education (Kır et al., 2021). Saraç (2017) conducted a content analysis of national studies on out-of-school learning environments between 2007-2016, indicating that these studies predominantly involved middle school students and teachers. They were designed to examine educational issues arising in out-of-school learning environments and their impact on students' interest, attitudes, and learning outcomes. There is a lack of studies in the literature evaluating the

development of preservice mathematics teachers' skills in utilizing out-of-school learning environments. Empirical literature also suggests limited exploration of how well professional development programs align with the needs of preservice math teachers (Popovic, 2011).

The aim of this research is to investigate the impact of activities conducted within the scope of the "out-of-school learning environments in mathematics education" course, on the organizational skills of pre-service math teachers regarding out-of-school learning. The following questions were investigated to achieve this aim:

- What are the initial knowledge levels of pre-service math teachers regarding organizing out-of-school learning? Do the pre-test scores of pre-service math teachers in organizing out-of-school learning differ according to gender and their experience on planned out-of-school learning environments during their student life?
- Are there significant differences between the pre-test and post-test scores of pre-service math teachers in organizing out-of-school learning when activities within the scope of the out-of-school learning environments in mathematics education course are implemented?
- What are the conclusions drawn from the reflective essays written by pre-service math teachers at the end of the out-of-school learning environments in mathematics education program?

2. METHOD

2.1. Design of the Research

In this study, a sequential explanatory design, which is a mixed-method approach, was used. The quantitative part of the research employed a "One-group pretest-posttest design without control group," which is a type of experimental design. According to Büyüköztürk et al. (2008) this design, the effect of the experimental treatment is tested on a single group through a study conducted with the same subjects and measurement tools before application as pretest, and after application as posttest. The qualitative part of the research involved analyzing data from reflective essays of pre-service math teachers using content analysis. This approach allowed the researchers to first gather quantitative data to assess the effectiveness of the educational intervention using statistical analysis, and then to delve deeper into participants' perspectives and experiences through qualitative analysis of their reflective essays.

2.2. Participants of Study

The study comprises third-year pre-service math teachers who enrolled in the elective course "Out-of-School Learning Environments in Mathematics Education" at a state university located near Ankara, the capital city of Turkey. These students participated regularly in the study for at least 12 weeks, including attending all field trips organized as part of the course. According to the student information form, 24 of the participating pre-service math teachers were female, and 11 were male. Among them, 27 pre-service math teachers indicated that they had not previously benefited from planned out-of-school learning environments in their educational experience, while 8 students reported that they had. Additionally, 2 pre-service math teachers had previously taken elective courses related to the use of out-of-school learning environments, although these courses did not specifically focus on mathematics.

Before the implementation of the study, 10 pre-service math teachers considered the utilization of out-of-school learning environments unnecessary for mathematics education, while 25 pre-service math teachers believed that such environments could be beneficial for learning mathematics. Table 1 outlines the characteristics of the 35 pre-service math teachers who participated in the study.

Table 1. Description of participants

Criterion	Variable	f	%
Gender	Female	24	68
	Male	11	32
Previously involving in planned out-of-school learning environments	Yes	8	22
	No	27	78
Finding meaningful to benefit from out-of-school learning environments in mathematics lessons	Yes	25	71
	No	10	29

When examining Table 1, it is observed that 68% of the participating pre-service math teachers were female, and 78% had not previously been involved in planned out-of-school learning environments during their previous educational experiences. Additionally, 29% expressed the opinion that out-of-school learning environments are not worthwhile for mathematics education.

2.3. Data Collection Tools

In the study, a student identification form was prepared to gather data. This form included questions about participants' genders, whether they had received any training on how to use out-of-school learning environments before, their previous participation in planned school trips during their educational experience, and their opinions regarding the usefulness of out-of-school learning environments in mathematics education.

As the data collection instrument, the Out-of-School Learning Regulation Scale (OOSLRS), developed by Bolat and Köroğlu (2020), was used. The Cronbach's Alpha internal consistency coefficient for OOSLRS is reported as 0.87, indicating high reliability. The scale consists of four dimensions: Knowledge, planning, implementation, and evaluation. The Cronbach's Alpha values for these dimensions are as follows: Knowledge dimension 0.86, planning dimension 0.81, implementation dimension 0.73, and evaluation dimension 0.77. These values suggest that OOSLRS has a structure consisting of these four subscales, which was further confirmed through Confirmatory Factor Analysis (CFA). The scale is structured on a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree."

Furthermore, in the study, pre-service math teachers were also asked to write reflective essays to evaluate the program. They were prompted to reflect on whether implementing out-of-school learning environments in mathematics education is valuable, in which learning areas out-of-school learning environments could be used, their experiences with the program, their opinions about the program, and suggestions for more effective use of out-of-school learning environments in mathematics lessons.

2.4. Data Collection Process

In the 2023-2024 academic year's first semester, the course on Non-Formal Learning Environments in Mathematics Education was conducted over a period of 14 weeks. Prior to commencing the study, all necessary ethical approvals were obtained through appropriate applications. The locations to be visited for the research were identified, contacts were made with responsible individuals, and appointments were scheduled for organized and guided tours. Permission was secured from the Faculty of Education Dean's Office for the planned technical visits. General information about the study was provided to teacher candidates, emphasizing the voluntary nature of participation.

During the first week of the course, a student information form and the Non-Formal Learning Regulation Scale (OOSLRS) pre-test were administered. Subsequently, in the initial weeks, non-formal learning environments and their characteristics were introduced to the students. Teacher candidates were informed about the requirements and permissions necessary for effective technical visits. Museum guides were introduced to the students, and practical applications in this regard were conducted.

Technical visits were organized to three non-formal learning environments: Science Center in the fifth week, Ankara National Library in the ninth week, and Ankara Ziraat Bank Museums in the

eleventh week. The environments selected for the technical visits were chosen to deeply engage with the learning outcomes specified in the mathematics curriculum. Opportunities offered by mathematics workshops in science centers and city libraries were utilized during the visits. During each visit, a guide from the venue staff was appointed to explain these environments to the students and create opportunities for them to ask questions and engage actively. Discussions about these locations and the mathematical learning opportunities they offer were held in the weeks leading up to the visits. The technical visits, guided by a facilitator, provided opportunities for teacher candidates to explore and discuss mathematical learning opportunities from 10:00 to 12:00 for two hours. During the visits, teacher candidates were divided into two groups. Following the collective technical visits, thirty minutes were allocated for teacher candidates to individually explore the environment.

A week after each technical visit, evaluations were conducted in class regarding the visit. Additionally, in the class following the technical visit, teacher candidates worked in groups to prepare activity plans and excursion guides for students based on the Middle School Mathematics Curriculum (MoNE, 2018) learning objectives. These guides and activity plans were shared and evaluated within the class. At the conclusion of the research, students were tasked with selecting a non-formal learning environment outside of the technical visits covered by the study and organizing an individual technical visit to this chosen environment. They were required to prepare museum guides and activity plans aligned with mathematical learning objectives from the Middle School Mathematics Curriculum (MoNE, 2018).

Teacher candidates actively participated in both attending and organizing planned non-formal learning environments. They collaborated both collectively and individually, planning inquiry-based experiential exploration. The pedagogy provided multiple roles for teacher candidates, encouraging them to engage in planning, practicing, and performing activities. They aimed for an authentic assessment of their contributions. Over a formal learning period of 10 weeks, teacher candidates engaged in activities such as small-group theory construction, critical reading and presentation in pairs, and large-group comparative discussions across five practicum sites attended by both students and the instructor. Large-group and small-group discussions during lesson plan preparation processes allowed for extensive group interaction. In the final phase of the research, the Out-of-School Learning Regulation Scale (OOSLRS) was administered for the last time, and reflective essays were collected from teacher candidates.

2.5. Data Analysis

The initial data from the pre-application of the Out-of-School Learning Regulation Scale (OOSLRS) by preservice teachers was organized and summarized using descriptive statistics. A paired samples t-test was used to compare the OOSLRS's pre- and post-applications. This test is commonly used to compare measurements taken at two different time points within the same group (Pallant, 2001), with a significance level set at .05 and results interpreted accordingly. Based on the results of the initial measurements, differences in preservice mathematics teacher candidates' abilities to organize outdoor learning varied by gender and their experience with planned outdoor learning environments during their student lives were examined using the Mann-Whitney U test.

In another phase of the study, pre-service math teachers' reflective essays were analyzed descriptively under specific themes. These themes included "the value of implementing outdoor learning environments in mathematics education, potential learning areas where these environments could be used, experiences within the program, and suggestions for more effective use of outdoor learning environments in mathematics classes". Analysis results were presented in the form of numerical data in frequency tables, directly quoting participants' responses. Student expressions were coded by gender (F for female, M for male) and student numbers when directly quoted.

3. FINDINGS

In research articles, findings should be given here and the above mentioned principles should be considered.

3.1. Pre-knowledge of Pre-service Mathematics Teachers on Organizing Out-of-School Learning

According to the OOSLRS administered before the application, pre-service math teachers' skills in organizing non-formal learning experiences are presented based on the sub-dimensions of knowledge, planning, implementation, and evaluation in Table 2.

Table 2. Pre-service math teachers' OOSLRS pretest scores

		average	sd
Dimentions	Knowledge	20.09	6.00
	Planning	19.03	6.57
	Implimentation	16.91	3.96
	Evaluation	19.94	4.45
Total point		75.37	18.82

When examining the data in Table 2, it is observed that pre-service math teachers' skills in organizing non-formal learning experiences were highest in the knowledge dimension before the application, followed by the evaluation and planning dimensions, with the lowest score in the implementation dimension. The Mann-Whitney U test results examining pre-service math teachers' preliminary knowledge of organizing non-formal learning experiences by gender (24 female students, 11 male students) are presented in Table 3.

Table 3. Description of OOSLRS Scores of pre-service math teachers based on gender

Dimentions		avrage	sd	s.e	p
Pretest score of knowlwdge	Male	18.27	5.72	1.72	0.29
	Female	20,92	6.05	1,23	
Pretest score of planning	Male	15.82	4.81	1.45	0.08
	Female	20.50	6.82	1.39	
Pretest of Implementation	Male	15,73	3.34	1.01	0.26
	Female	17.46	4.17	0.85	
Pretest of Evaluation	Male	19.09	3.91	1.17	0.90
	Female	19.46	4.76	0.97	
Pretest of Total point	Male	68.91	15.29	4.61	0.18
	Female	78.33	19.82	4.04	

When examining Table 3, it is evident that the arithmetic mean of OOSLRS pre-test scores for females is higher than that of males in all dimensions; however, the difference between groups is not statistically significant ($p = 0.05$).

The OOSLRS pre-test scores of pre-service math teachers were analyzed based on whether they had previous experience in organized non-formal learning environments during their educational careers. Among pre-service math teachers, 27 indicated they had not been in such an environment before with school, while 8 stated they had. Descriptive statistics of OOSLRS scores for pre-service math teachers based on their previous experience in organized non-formal learning environments and the significance of mean differences between groups are presented in Table 4 using Mann-Whitney U test results.

Table 4. Description of OOSLRS Scores of pre-service math teachers based on previous experience in structured non-formal learning environments

Dimentions	Previous participation	average	sd	se	p
Pretest of Knowledge	Yes	18,89	5,807	1,118	0.01
	No	24,13	5,055	1,787	
Pretest of Plannig	Yes	18,11	6,053	1,165	0.15
	No	22,13	7,717	2,728	
Pretest of Implementation	Yes	16,37	4,208	0,810	0.10
	No	18,75	2,375	0,840	
Pretest of Evaluation	Yes	18,78	4,799	0,923	0.15
	No	21,25	2,375	0,840	
Pretest of Total Score	Yes	72,15	18,882	3,634	0.06
	No	86,25	14,907	5,270	

When examining Table 4, it is observed that pre-service math teachers who had previous experience in structured non-formal learning environments scored higher in all dimensions of OOSLRS in the pre-test compared to those who did not have such experience. According to the results of the Mann-Whitney U test conducted to determine the significance of the differences between groups, this difference was statistically significant only in the knowledge dimension (p=0.05).

3.2. Changes in Preservice Mathematics Teacher's Levels of Organizing Out of School Learning

Pre-service math teachers underwent the OOSLRS post-test after the implementation of the out-of-school learning environment program. The OOSLRS pre-test and post-test score averages were analyzed using a t-test, and the results are presented in Table 5.

Table 5. Pre-service math teachers OOSLRS pretest and post test score t test scores

	Average	ss	Sh	t	sd	p
Pretest of Knowledge	20.09	6.00	1,01	13,93	5.43	0.00
Posttest of Knowledge	32.89	3.94	0.66			
Pretest plannig	19.03	6.57	1.11	11,92	6.30	0.00
Posttest of Planning	31.74	4.73	0.80			
Pretest of Implementation	16.91	3.96	0.67	9.80	4.70	0.00
Posttest of Implementation	24.71	3.90	0.66			
Pretest of Evaluation	19.94	4.45	0.75	9.62	5.54	0.00
Posttest of Evaluation	28.37	4.15	0.70			
Total Pretest Score	75.37	18.82	3.18	13.36	18.74	0.00
Total Posttest Score	117.7	14.66	2.47			

When examining the final scores obtained by pre-service math teachers from the OOSLRS in Table 5, it is observed that they achieved the highest scores respectively in the knowledge, planning, evaluation, and implementation stages. Across all dimensions, there is a significant difference in favor of the post-test application between the pre-test and post-test scores among groups (p=0.05).

3.3. Teacher candidates' thoughts on nonformal learning

Pre-service math teachers were asked to write an opinion piece on "the value of implementing out-of-school learning environments in mathematics education, which learning areas could benefit from out-of-school learning environments, their experiences with the program, their views on the program, and suggestions for more effective use of out-of-school learning environments in mathematics lessons." Upon reviewing the students' opinion, all teacher candidates expressed that they found out-of-school learning environments valuable for mathematics education and stated that all learning areas could benefit from these environments. Three pre-service math teachers mentioned that out-of-school learning environments could be more effective in specific subjects. For example, pre-service math teachers with code K-6 expressed the following opinion:

"I believe that based on the excursions and activities we conducted during the course, focusing more on topics like patterns and symmetry would be more productive." K-6

When the reflections of pre-service mathematics teachers on their experiences in the program and their views and suggestions regarding the program were examined, it was observed that they were all satisfied with the program. Reading through qualitative data, passages are coded according to topic. According to thier statements their reflections emphasized themes such as "supporting mathematical relation, increasing student engagement by drawing their interest, and addressing the risks in implementation" regarding the use of out-of-school learning environments in mathematics instruction. The statements of pre-service teachers regarding these themes are presented in Table 6.

Table 6. The statements of pre-service teachers regarding these themes

Category	f	Student's explanation
To support mathematical relation.	6	"I believe mathematics topics should be connected with nature, daily life, and other concepts. For instance, relating butterflies in Butterfly Valley to the concept of symmetry and observing them would be highly beneficial for students." F-5 "Instead of constantly attending classes, it is important for students to explore different places outside the classroom to learn where mathematics is used in daily life. Thus, out-of-school learning environments are crucial." M-20 "Out-of-school learning prepares students for life."F-4 "I was particularly impressed by the Art and Sculpture Museum that I organized individually as part of my assignment, because I have a special interest and talent in art. This trip gave me more opportunities to think about how to relate mathematics to art."F-24
Attracting interest, increasing engagement	26	"I believe it will increase student participation because it will capture their interest and attention in class. Being in a social environment contributes to skill development. For example, during our museum visit, the answers given by the museum guide to my questions increased my interest in the class." F-10, F-12 "Apart from the routine learning environment, such environments will attract students' attention and increase their participation. Therefore, teachers should be particularly aware of this. I gained a lot of knowledge from this course. Therefore, this course should be taught as a mandatory course at university." M-13 "Out-of-school learning environments can attract even students who do not want to attend class. I think more areas for activities should be provided in out-of-school environments, and materials that can be used in these areas should be increased." F-14 "Out-of-school learning environments stimulate students' curiosity and promote active learning. Firstly, teachers and teacher candidates should be informed about this. The Ministry of National Education (MONE) should support schools in this regard." F-19 "It increases participation and interest. However, I believe permissions should be easier to obtain for feasibility, budget should be allocated for this purpose, trips should be organized in small groups, and technical trips should be organized with more than one teacher."F-22 "It increases student participation. Science centers and mathematics workshops can be increased, and teachers can be educated."F-23 "I think students' participation increases because they learn that they can discover new areas outside of school. I think there could be more mathematics museums."F-26 "It is important to organize an efficient trip with few people by dividing students into groups. It nurtures students' curiosity."F-27 "If the environment appeals to everyone's interest, it can increase students' participation by enhancing their common focus."F-31 "I was very impressed by the Ethnography Museum visit I organized individually. The museum building is magnificent, and I didn't know that Atatürk's temporary tomb was kept in the Ethnography Museum. This increased my curiosity and interest in the museum."F-3 "If school is confined within four walls, then freedom will be liberation from prison. Effective teaching requires breaking away from patterns."M-1
Risks in implementation.	3	"Despite the many advantages provided by out-of-school learning environments, they are costly and difficult to implement. Therefore, I believe there should be more state-supported arrangements." M-15 "Out-of-school learning is the least used type of learning by teachers due to financial reasons and unwillingness to take responsibility. For this, the Ministry of National Education (MONE) can provide financial support to each school. Alternatively, the use of out-of-school learning environments can be emphasized in the curriculum related to achievements."F-30 "During an individual trip I took, I encountered students who came with a school group. The students were quite scattered. Although we organized a planned trip, I realized that students' motivation is important during this process." F-6

When Table 6 is examined, it is observed that pre-service mathematics teachers emphasized the following themes the most in their evaluation of out-of-school learning environments in mathematics instruction: "increasing interest and student participation"(f=26), "enhancing mathematical connections" (f=6), and "addressing risks in implementation" (f=3).

4. DISCUSSION and CONCLUSION

In order for non-formal learning environments that offer learning opportunities to be fully utilized, it is crucial for teachers to possess skills in organizing such learning experiences. This study examines the changes in pre-service elementary mathematics teachers' skills in organizing non-formal learning environments after a 14-week applied course on mathematics instruction through non-formal learning. The study reveals that 78% of the pre-service mathematics teachers had not previously participated in planned non-formal learning environments with schools. A teacher candidate without prior experience in non-formal learning environments may have limited ability to benefit from such opportunities as a teacher. In relation to this, Falk and Dierking (2000) state that outcomes from visiting and interacting in non-formal learning environments result from personal and collective experiences, interests and motivations, social interactions, and the physical space itself. This indicates that teacher candidates may require guidance on non-formal learning environments during their undergraduate education. The study also shows a significant increase in the rate of pre-service mathematics teachers recognizing the value of utilizing non-formal learning environments in mathematics instruction, rising from 71% before the course to 100% after its implementation, highlighting the impact of the non-formal learning environments course on mathematics instruction.

The pre-service elementary mathematics teachers' skills in organizing non-formal learning environments, as measured by their OOSLRS scores before implementation, show the highest scores in the knowledge dimension, followed by evaluation and planning, with the lowest scores observed in the implementation dimension. The higher pre-test scores in the knowledge dimension may stem from teacher candidates' prior experiences as visitors in non-formal learning environments. Conversely, the lower pre-test scores in the implementation dimension may be due to their lack of previous experience in organizing such outings. Indeed, it supports that pre-service mathematics teachers who had prior experience in planned non-formal learning environments during their educational careers scored higher in all dimensions of OOSLRS compared to those without such experiences, with the difference being statistically significant only in the knowledge dimension. When evaluating OOSLRS post-test scores across dimensions, scores in the implementation dimension are lower compared to other dimensions.

In the reflective essays produced by the pre-service mathematics teachers at the end of the program, concerns are expressed regarding the need for regulation and support from the Ministry of Education (MONE), as indicated by candidate M-15 mentioning "costliness and difficulty of implementation" and candidate F-30 highlighting "financial support and additional responsibilities" as challenges. Related to the implementation dimension, candidate F-6's statement, "During an individual trip I organized, I encountered students who came with a school group. The students were quite scattered. Despite our organized trip, I realized the importance of student motivation in this process," suggests a concern among teacher candidates about classroom management. This indicates that the content of classroom management courses in teacher training programs could include "classroom management techniques in non-formal learning environments."

When the OOSLRS pre-scores of pre-service elementary mathematics teachers are examined based on gender, it is observed that female teacher candidates have higher skills in organizing non-formal learning environments in every dimension compared to males. However, the difference between groups is not statistically significant (p= 0.05). Across all dimensions, there is a significant improvement in favor of the post-test scores compared to the pre-test scores (p = 0.05) for the pre-

service mathematics teachers. This indicates that the non-formal learning environments program in mathematics education has benefited teacher candidates in terms of organizing non-formal learning in the dimensions of knowledge, planning, implementation, and evaluation. Aydoğdu and Aydoğdu (2024) found similar results to this study, indicating that prior to university education, teacher candidates had no knowledge and had not participated in any non-formal learning activities. Nearly all teacher candidates expressed that they found non-formal mathematics education beneficial and believed that these environments positively influence students' attitudes towards the subject.

In this research, preservice math teachers emphasized several aspects regarding the evaluation of non-formal learning environments in mathematics education. They highlighted “enhancing interest and student engagement" the most (f=26), followed by supporting mathematical relation (f=6), being more feasible for specific topics (f=3), and acknowledging the risks in implementation (f=2). This experimental study reveals that the Mathematics Education in Non-Formal Learning Environments course provided teacher candidates with opportunities to become active participants in their learning. It also facilitated their ability to organize planned visits to non-formal settings within the framework of the Mathematics Teaching Program (MoNE, 2018; 2024), fostering their development in this regard and supporting their relational thinking skills.

In the social constructivist approach to teacher education presented here, teacher candidates develop non-formal learning organization skills (individually and in small and large groups) based on the information they have gathered from the world of practice. Based on these results, it has been suggested that out-of-school learning environments should be more integrated into teacher candidate’s education programme. This study is limited with experimental research method and 35 pre-service math teachers’ data. Additionally, it is recommended to conduct studies that delve deeper into the changes in teacher candidates' skills in organizing non-formal learning experiences using qualitative methods.

Acknowledgements

This study was supported by Kırıkkale University Scientific Research Projects Coordination Unit. Project number:2023/009

Ethics Committee Decision

This research was carried out with the permission of Kırıkkale University Publication Ethics Board with the session numbered 10 dated 18.10.2023.

5. REFERENCES

Akyüz, Y. (2013). *Türk eğitim tarihi. [Turkish history of education]* Pegem Academy Publishing.

Aydoğdu, M. Z., & Aydoğdu, A. S. (2024). Preservice mathematics teachers’ opinions on the out of school learning environments. *Cumhuriyet Uluslararası Eğitim Dergisi*, *13*(1), 1-15.

Aytaç, K. (1980). *Avrupa eğitim tarihi [Eurepion history of education]*. Dil ve Tarih- Coğrafya Fakültesi. [Faculty of Language and History-Geography].

Bahadır, E., & Hırdıç, K. (2018). Students' opinions about the learning activities in mathematics museum and their contributions to the mathematical process. *Journal of Turkish Studies*, *13*(26), 151-172.

Bolat, Y. & Köroğlu, M. (2020). Out-of-school learning and scale of regulating out-of-school learning: Validity and reliability study, *International Journal of Education Technology and Scientific Researches, 5* (13), 1630-1663.

Buyurgan, S. (2017). Verimli bir müze ziyaretini nasıl gerçekleştirebiliriz?. [How can we have an efficient museum visit?] *Milli Eğitim Dergisi*, *46*(214), 317-343.

Büyüköztürk, Ş., Kılıç-Çakmak, E., Akgün, Ö., Karadeniz, Ş., & Demirel, F. (2008). *Bilimsel araştırma yöntemleri [Scientific research methods]*. Pegem Academy Publishing.

Çiçek, Ö., & Saraç, E. (2017). Science teachers' opinions about experience in out of school learning environments. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 18*(3), 504-522.

Erentay, N., & Erdogan, M. (2009). Nature education in 22 steps: A model proposal. *Hands-on Science II*, *244*.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning*. AltaMira.

Fidan, N. (2012). *Okulda öğrenme ve öğretme [Learning and teaching at school]*. Pegem Yayınevi.

Gül, K., & Saz, İ. (2023). Öğretmenlerin okul dışı öğrenmeye ilişkin yeterlikleri [Teachers' qualifications regarding out-of-school learning]. *Premium e-Journal of Social Science, 7*(33), 695-704.

Kır, H., Kalfaoğlu, M., & Aksu, H. H. (2021). Mathematics teachers' opinions on the use of out-of-school learning environments. *International Journal of Educational Studies in Mathematics, 8* (1), 59-76.

Maarschalk, J. (1988). Scientific literacy and informal science teaching. *Journal of Research in Science Teaching, 25*(2), 135-146.

Metin Göksü, M. (2020). Sınıf dışı öğrenme ortamları: Köy enstitüleri örneği [Out-of-class learning environments: The case of village institutes]. *Turkish History Education Journal, 9*(1), 1-16.

Ministry of National Education. (2018). *Ortaokul ve imam hatip ortaokulu matematik uygulamaları dersi (5, 6, 7 ve 8. sınıflar) öğretim programı* [Curriculum for mathematical applications for middle and religious middle schools: Grades 5, 6, 7, and 8]. MoNE.

Ministry of National Education. (2024). *Ortaokul ve imam hatip ortaokulu matematik uygulamaları dersi (5, 6, 7 ve 8. sınıflar) öğretim programı* [Curriculum for mathematical applications for middle and religious middle schools: Grades 5, 6, 7, and 8]. MoNE.

Oğuzkan, F. (1990). *Köy enstitüleri öğretim programları [Village institutes teaching programs.]*. Retrieved March 3, 2019 from https://docplayer.biz.tr/37227150-Koy-enstituleri-ogretim-programlari-dr-a-ferhanoguzkan.html

Öner-Armağan, F., Ezberci-Çevik, E., & Köksal, E. A. (2023). Fen bilgisi öğretmen adaylarının sanal müze uygulamalarına yönelik görüşleri [Views of pre-service science teachers on virtual museum applications]. *Journal of Computer and Education Research, 11*(22), 459-481. https://doi.org/10.18009/jcer.1255607

Popovic, G. (2011). *Informal settings: Implications for secondary mathematics teachers' ability to recognize and apply mathematics* (Doctoral dissertation, Illinois Institute of Technology).

Rennie, L. J., & Johnston, D. J. (2004). The nature of learning and its implications for research on learning from museums. *Science Education, 88*(1), S4-S16.

Resnick, L. B. (1987). The 1987 presidential address learning in school and out. *Educational Researcher, 16*(9), 13-54.

Saraç, H. (2017). Researches related to outdoor learning environments in Turkey: Content analysis study. *Eğitim Kuram ve Uygulama Araştırmaları Dergisi, 3*(2), 60-81.

Sarıoğlan, A. B., & Küçüközer, H. (2017). Investigation of preservice science teachers' opinions regarded to outdoor school learning environments. *Journal of Research in Informal Environments, 2*(1), 1-15.

Vygotsky, L. (1986). *Thought and language.* MIT Press.

Wager, A. A. (2012). Incorporating out-of-school mathematics: From cultural context to embedded practice. *Journal of Mathematics Teacher Education*, 15, 9-23.

Xenofontos, C., & Hizli-Alkan, S. (2022). Prospective primary teachers' professional noticing in non-formal learning environments: The case of a mathematics fair. *Education Sciences, 12*(1), 55.