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Trends in research on out-of-school learning environments in mathematics education: A systematic review

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Abstract

This study aimed to examine research on out-of-school learning environments in mathematics education from a holistic perspective through a systematic review and to identify prevailing trends. By comparing the general characteristics and methods of studies on out-of-school learning environments in mathematics education conducted at the national level in Türkiye and in the international arena, this study aimed to highlight their similarities and differences. Adhering to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 criteria, 36 studies were included in the analysis. The document analysis method was employed to analyze the selected studies. Within the framework of the analyses carried out, it was determined that qualitative studies were generally preferred, while quantitative and mixed-methods studies were relatively less common. Regarding the temporal distribution of the studies, it was observed that most national-level research was conducted from 2018 onward. When examining the study groups, it was found that both national and international studies primarily focused on middle school students. Furthermore, the findings indicate that existing studies broadly aim to assess the current state of out-of-school learning environments in mathematics education. However, there is a need for more research on designing effective out-of-school learning environments and developing activities to enhance mathematics learning.

Keywords: *Out-of-school learning environments, mathematics education, systematic review*

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Matematik eğitiminde okul dışı öğrenme ortamlarına yönelik yapılan çalışmaların eğilimleri: Bir sistematik derleme çalışması

Öz

Bu çalışmada matematik eğitiminde okul dışı öğrenme ortamlarına yönelik çalışmaların sistematik derleme yoluyla, bütüncül bir bakış açısıyla incelenip eğilimlerinin belirlenmesi amaçlanmıştır. Ulusal ve uluslararası literatürde matematik eğitimindeki okul dışı öğrenme ortamlarına yönelik çalışmaların genel özellikleri ve yöntemleri karşılaştırılarak bu alandaki çalışmaların benzer ve farklı yönlerinin ortaya çıkarılması hedeflenmiştir. Bu doğrultuda Sistematik Derleme ve Meta-Analiz Çalışmaları için Tercih Edilen Raporlama Öğeleri (PRISMA) 2020 ölçütleri dikkate alınmış ve 36 çalışma, araştırma kapsamına dahil edilmiştir. Çalışmaların analizi için doküman incelemesi yöntemi kullanılmıştır. Gerçekleştirilen analizler çerçevesinde çalışmalarda genellikle nitel araştırmaların daha çok tercih edildiği, nicel ve karma türündeki çalışmaların görece daha az olduğu belirlenmiştir. Çalışmaların yıllara göre dağılımına odaklanıldığında, ulusal düzeydeki çalışmaların büyük çoğunluğunun 2018 yılı ve sonrasında gerçekleştirildiği sonucuna ulaşılmıştır. Araştırmaların çalışma grubu incelendiğinde ise ulusal ve uluslararası alanda ortaokul düzeyindeki çalışmaların daha çok tercih edildiği görülmüştür. Bulgulardan hareketle matematik eğitiminde okul dışı öğrenme ortamlarına yönelik daha çok durum tespitine yönelik çalışmaların gerçekleştirildiği, matematik eğitiminde okul dışı öğrenme ortamlarının nasıl tasarlanacağı ve ne tür etkinliklerin matematik eğitiminde öğrenmeleri daha etkin kılacağına yönelik çalışmalar daha çok ihtiyaç duyulduğu görülmüştür. Bu çerçevede araştırmacılara yönelik birtakım önerilerde bulunulmuştur.

Anahtar kelimeler: *Okul dışı öğrenme ortamları, matematik eğitimi, sistematik derleme*

1. Introduction

In the age of technology, where information can be accessed through various means, individuals are expected to take advantage of these opportunities and actively engage in the education process. It is essential for individuals to actively participate in the educational process to develop not only cognitive skills but also psychomotor and affective skills [65]. Studies have shown that classroom learning activities in which students do not actively participate fail to achieve permanent and practical learning, resulting in limited outcomes [7]. For individuals interacting with their environment to acquire knowledge and achieve lasting and desired behavioural changes in both outcomes and processes, the settings for these interactions should be diverse [35]. In this context, the perspective that education should extend beyond the classroom and that schools should serve as a microcosm of real life becomes prominent [39].

Today, shifts in thinking about the role of schools, traditionally viewed as centers of knowledge transfer, are emerging. Societies striving to keep pace with the changing times place importance on raising individuals who are knowledgeable, competent, and aware of their national values. At this point, societies prioritize fostering permanent and effective student learning through process-oriented approaches and skill-based educational models in schools and institutions [57]. This intellectual shift observed in

institutions offering formal education highlights the need for teaching programs designed to provide a multi-dimensional perspective, a skill that requires direct interaction with the environment. Since in-school and classroom activities alone are insufficient to address this transformation, classroom education must be complemented by learning environments outside the school [31, 64].

The concept of out-of-school learning, also known as non-formal learning, is founded on the principle of integrating formal education with daily life experiences. Additionally, out-of-school learning highlights the importance of designing everyday spaces to align with experience-based activities. Out-of-school learning environments enable students to learn at their own pace and meet the objectives outlined in the curriculum [56, 13]. Utilizing spaces for informal learning, such as libraries, museums, natural areas, science and art centers, and zoos as tools for formal education, represents a foundational aspect of this approach [45]. Experiences in informal learning environments enhance students' interest, curiosity, and motivation in their studies while strengthening their cognitive abilities [51].

The fundamental characteristics of education within the framework of out-of-school learning environments are outlined as follows [77].

- Designed in accordance with the curriculum and educational philosophy.
- The places to be preferred should have a systematic design and be suitable for the students' readiness level.
- Include institutions outside the school related to the subject or concept to be taught.
- The mentioned areas allow students to develop social relationships outside the school boundaries.

The characteristics expected to develop in students who benefit from out-of-school learning environment activities that allow the use of different types of intelligence are emphasized as follows [24, 69].

- Being able to observe, infer, and predict.
- Being able to recognize and explain course-related materials.
- Problem solving.
- Adapting to group members.
- Learning by discovery and analytical thinking.
- Experiencing materials that cannot be encountered within school boundaries.

Considering the benefits they offer students, out-of-school learning environments clearly represent an essential education component. The 2023 Vision Document by the Ministry of National Education (MoNE) in Türkiye highlights the importance of integrating out-of-school learning environments into education and training. The 2023 Vision Document emphasizes that fostering creative thinking, research, inquiry, and discovery within the Turkish Education System can effectively be achieved beyond school boundaries [7]. Following the publication of the Vision Document in 2018, provincial directorates of national education across Türkiye initiated efforts in 2019 to establish recordable out-of-school learning spaces tailored to their specific needs. In the 2023 vision document, which emphasizes that every place that can be encountered in daily life can also be an education-training center, another noteworthy situation is that educational institutions should

provide learning environments where students can gain experience in cooperation with different institutions in the surrounding area [48].

Examining the curricula taught in Türkiye reveals evaluations of out-of-school learning environments. Several general objectives outlined in the curriculum published by MoNE in 2018 can be linked to out-of-school learning environments [39, 48]. In this context, some objectives related to the curriculum are as follows [48].

- Developing mathematical literacy skills and using them effectively.
- Understanding the relationship between people and objects and between objects and objects by using the language of mathematics effectively.
- Understanding mathematical concepts and using these concepts in daily life.
- Effectively managing one's learning process by developing metacognitive knowledge and skills.
- Developing a positive attitude towards mathematics through experience-based activities while learning mathematics and approaching problems confidently.
- Developing the skills to conduct research and produce and use the knowledge produced.
- Understanding the relationship between mathematics and art and aesthetics.

Considering these objectives in the curriculum, it is stated that educational activities should be directly related to daily life, prioritize socialization and personal development, and encourage students to engage in experience-based processes actively. Mathematics is one of the disciplines where out-of-school learning processes can be effectively applied. In this context, dedicated periods have been allocated for out-of-school learning activities in the 2024 Türkiye Century Education Model mathematics curriculum [49, 50].

When the studies in the literature on out-of-school learning environments are examined, it is noteworthy that the studies are predominantly in fields such as preschool, science, and social studies. Saraç [57] conducted a content analysis study on research on out-of-school learning environments in Türkiye. The study found that most of the research in Türkiye focused on the field of science. Studies also found that studies predominantly favoured nature practices, trips, museums, and science centers. Saraç, notes a lack of research on out-of-school learning in mathematics education in Türkiye. Many studies emphasize the insufficient research on out-of-school learning environments in mathematics education [8, 10, 37, 63].

Aydoğdu et al. [8] examined the opinions of 20 secondary school mathematics teachers regarding out-of-school learning environments in mathematics education. The study concluded that while teachers found such environments beneficial, they faced challenges due to economic, financial, and administrative constraints. Additionally, the research revealed that teachers had limited knowledge about out-of-school learning environments. Similarly, Kır et al. [39] explored mathematics teachers' perspectives on using out-of-school learning environments. Their study found that none of the 12 participating teachers had received training in these environments, concluding that mathematics teachers lack sufficient knowledge in this area.

Andersson and Johansson [2] and Sturm and Bogner [62] stated in their studies that out-of-school learning environments positively affect students' attitudes. Similarly, Bozdoğan [12], Bozdoğan and Yalçın [11], and Morag and Tal [47] reported that such environments

increase students' interest, while Çığrık and Özkan [20] noted their positive impact on students' motivation. Jarvis and Pell [29] found that out-of-school learning environments raise students' awareness and enhance their ability to connect mathematics to daily life. Genç et al. [27] also highlighted that these environments help develop 21st-century skills.

1.1. Purpose of research

Considering the new curriculum of the Turkish Century Education Model, it is emphasized that most mathematical skills are built on conceptual foundations, focusing on developing literacy skills [49, 50]. In both primary and elementary school levels of this curriculum, out-of-school learning activities are highlighted, and dedicated lesson hours are allocated for such activities [49, 50]. Mathematics teachers are, therefore, expected to implement practices that utilize out-of-school learning environments. However, Aydoğdu et al. [8] and Kır et al. [39] highlight that mathematics teachers lack sufficient knowledge about out-of-school learning environments. Additionally, Aydoğdu et al. [8], Kayhan-Altay and Yetkin-Özdemir [37], Bahadır and Hırdıç [10], and Temel [63] assert that research on out-of-school learning environments in mathematics education remains limited.

Given these circumstances, determining a clear framework for out-of-school learning in mathematics education and identifying effective activities and studies in this area are essential to supporting teachers and researchers working in the field. This study aims to systematically review research on out-of-school learning environments in mathematics education, providing a holistic perspective and identifying trends. Specifically, the study seeks to compare national and international research on this topic to uncover similarities and differences. Two primary outcomes are expected from the study: first, identifying trends and focus areas in research on out-of-school learning environments in mathematics education, and second, determining gaps in the literature to highlight the types of studies needed to advance the field.

1.2. Research problem

In line with the determined purpose, the research problem of the study was determined as follows:

What is the tendency (general situation) of studies on out-of-school learning environments in mathematics education?

1.2.1. Sub problems

National and internationally published studies on out-of-school learning environments in mathematics education;

Sub-Q1. What are the general characteristics (keywords, distribution by year)?

Sub-Q2. How is it distributed according to their methods (research design, sample, data collection tools, data analysis methods)?

2. Method

2.1. Research design

In this study, which examines trends in research on out-of-school learning environments within the scope of mathematics education, the systematic review method was selected as the preferred research approach. A systematic review is a research method designed

to summarize and synthesize the findings of studies conducted on similar topics [28]. This method not only integrates findings from studies in the chosen field but also provides a critical evaluation and addresses problems related to the field [26].

In recent years, systematic reviews have been increasingly utilized in education to simplify, synthesize, and make sense of complex, fragmented, or contradictory findings while also enhancing the generalizability of the results [71]. Known as a systematic review or systematic literature review, this approach was deemed appropriate for the present study because it examines all relevant published sources on the topic and reports the results comprehensively [32].

2.2. Data collection tools

Within the framework of examining studies on out-of-school learning environments in mathematics education, the ERIC, Web of Science, Google Scholar, and ULAKBIM TRDizin databases were utilized during the data collection process. The searches were conducted using keywords determined within the scope of the research. These keywords included: “okul dışı öğrenme ortamları”, “formal olmayan öğrenme ortamları”, “okul dışı öğrenme”, “matematik eğitimi”, “out-of-school learning”, “mathematics education,” and “out-of-school learning environments.”

The searches conducted in the databases based on these keywords are listed as follows:
"okul dışı öğrenme ortamları" matematik eğitimi
"okul dışı öğrenme ortamları" matematik
"okul dışı öğrenme" matematik
"formal olmayan öğrenme ortamları" matematik eğitimi
"sınıf dışı öğrenme" "matematik"
"out of school learning" math
"out of school learning" mathematics
Out of school learning environments
Non formal education topic mathematics

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 criteria were applied throughout the data collection process. The PRISMA 2020 checklist is a guiding framework for conducting systematic reviews and meta-analyses [53]. According to the PRISMA 2020 guidelines, systematic reviews should be presented in alignment with the checklist [32]. The reporting of studies identified through the screening process, following the PRISMA 2020 flow diagram, is as follows:

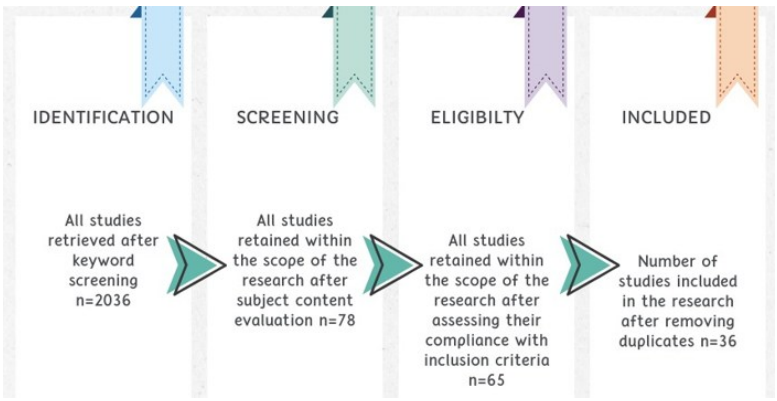


Figure 1. Steps followed in the literature review using the prisma 2020 flow diagram

Some inclusion criteria were determined to detect the studies to be included in the compilation within the diagram framework in Figure 1. The requirements determined during the inclusion process are listed as follows:

Table 1. Criteria for study exclusion and ınclusion

Included Studies	***Excluded Studies***
Open Access studies	Studies with no Access to Full Text
Article-type publications	Studies in the form of Master's and Doctoral Theses
Studies published in the Scope of Mathematics Education	Studies not within the scope of mathematics education
Studies published in the Scope of Out-of-School Learning	Studies not within the scope of mathematics education

2.3. Data analysis

Following the completion of the literature review, the studies to be included in the analysis were selected, and the document review method was chosen for their evaluation. Document analysis is a systematic research method used to examine the content of written materials [68]. To ensure a systematic approach during the document analysis, the selected studies were analyzed using the article review form [Appendix 1].

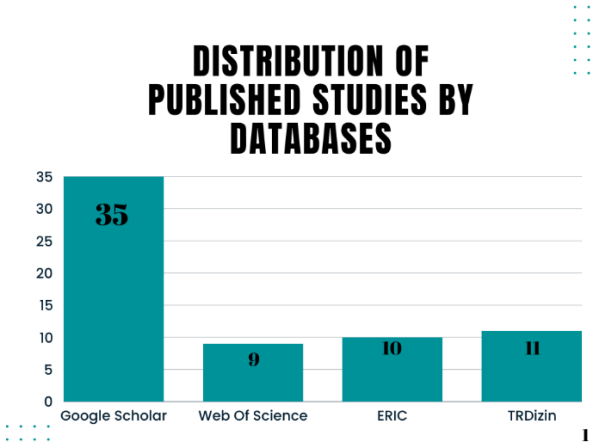
2.4. Validity and reliability

Each study included in the research was evaluated using the article review form. To ensure theoretical validity, it is recommended that evaluations involve experts other than the researcher [15]. Accordingly, the reliability of the analyses was enhanced by consulting experts with experience in out-of-school learning during the classification and analysis of the data. One method to increase the validity and quality of research is through detailed descriptions [70]. In this regard, each study stage was explained in detail, and introductory formats were provided to ensure validity. Clearly and comprehensively presenting the data analysis is also recognized as a method for enhancing the validity and reliability of research [18].

3. Findings

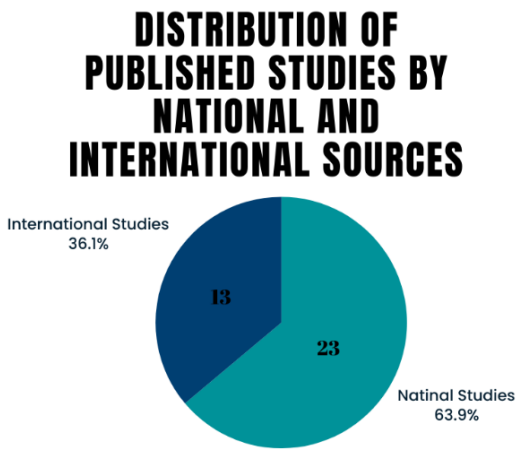
3.1. Findings regarding the first sub-problem

The findings related to the first sub-research question of the study 'What are the general characteristics (e.g., keywords, distribution by years) of the studies published nationally and internationally on out-of-school learning environments in mathematics education?' are as follows:



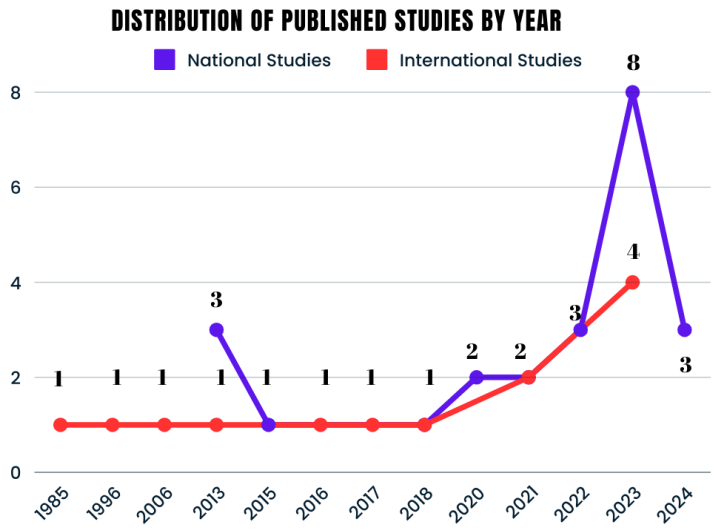
Graph 1. Distribution of published studies by databases

Referring to Graph 1, the distribution of studies obtained within the scope of the research across various databases reveals that 35 out of 36 studies (97.2%) are indexed in Google Scholar, 11 (30.6%) in TRDizin, 10 (27.8%) in ERIC, and 9 (14%) in Web of Science. The national and international distributions of the studies are presented in Graph 2.



Graph 2. Distribution of published studies by national and international sources

The distribution of published articles on out-of-school learning environments in mathematics education is presented in Graph 2. Of these studies, while 23 (64%) were published nationally, 13 (36%) were published internationally. A line graph was used to compare the yearly distribution of national and international studies included in the research. The distribution of these studies by years is as follows:



Graph 3. Distribution of published studies by years

An examination of Graph 3 reveals that studies published internationally on out-of-school learning environments in mathematics education date back to 1985. Although there was no significant increase in international studies after 1985, they continued sporadically until 2023, when a noticeable rise occurred compared to previous years. In the national context, the first studies began in 2013, with a marked increase observed from 2018 onward. Notably, the rise in national studies in 2023 mirrors the trend in international studies.

Another aspect examined in the research pertains to the sub-problem regarding the keywords of the studies. Figure 2 presents the findings derived from an analysis of these keywords. The figure was created using a 'Word Cloud' application that is available online.

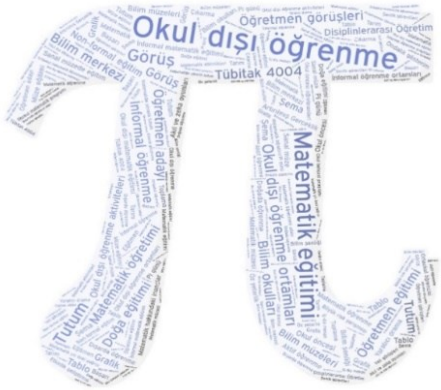


Figure 2. Word Cloud of keywords of the studies

When the keywords from studies on out-of-school learning environments in mathematics education included in the compilation were examined, 64 unique keywords were identified across 23 national studies. The most frequently used keywords were "Out-of-school learning" (n=16), followed by "Mathematics education" (n=13), "Out-of-school learning environments" (n=8), "Informal learning" (n=7), "Mathematics teaching" (n=5), "View" (n=3), and "Attitude" (n=3). The frequency of other keywords ranged between 1 and 2. The analysis revealed a scattered structure, with no specific keyword emerging as

the focal point of the studies published on mathematics education and out-of-school learning environments.

In international studies, the most commonly used keywords were "Out-of-school learning," "Mathematics education," and "STEM," each appearing four times. Other keywords included "Informal education" (n=2), "Funds of knowledge" (n=2), "Preservice teachers" (n=2), "Attitudes" (n=1), "Belief" (n=1), "Parental engagement" (n=1), "Parental involvement" (n=1), "Homework" (n=1), "Mathematical moments" (n=1), "Out-of-school environments" (n=1), "Caregiver-child" (n=1), "Symmetry" (n=1), "Constructionism" (n=1), "Multiple intelligence theory" (n=1), "Mobile technology" (n=1), "Seamless learning" (n=1), "Service learning" (n=1), "Creative problem solving" (n=1), and "Underrepresented students" (n=1).

3.2. Findings regarding the second sub-problem

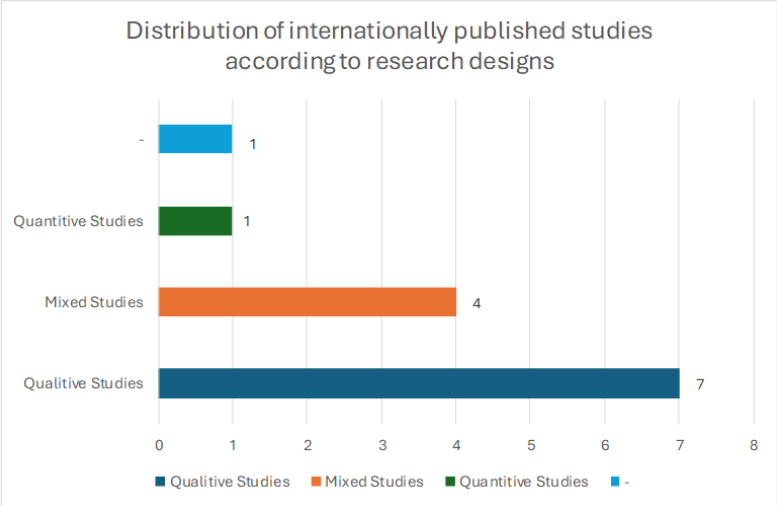
The second sub-problem of the research focuses on 'how studies conducted on out-of-school learning environments in mathematics education are distributed according to their methods (research design, sample, data collection tools, data analysis methods)'. In this context, national and international studies were examined based on their research designs, samples, data collection tools, and data analysis methods. The findings are presented below. Table 2 provides the distribution of studies on out-of-school learning environments in mathematics education at the national level, which is included in the scope of the research according to their research designs.

Table 2. Distribution of nationally published studies according to research designs

Type	Research Design	Frequency (*f*)	Percentage (%)
Qualitative Studies	Case study	6	26
	Phenomenology	2	9
	Phenomenography	1	5
	Phenomenological science	1	4
	Survey	1	4
	Unspecified	1	4
Total		12	52
Quantitative Studies	Quasi-experimental pre-post test	2	9
Total		2	9
Mixed Methodology	Purposive sequential design	1	4
	Unspecified	7	31
	Document analysis	1	4
Total		9	39
Overall total		23	100

Table 2 indicates that qualitative methods (f=12, 52%), quantitative methods (f=2, 9%), and mixed methods (f=9, 39%) were used as research designs in nationally published studies on out-of-school learning environments in mathematics education.

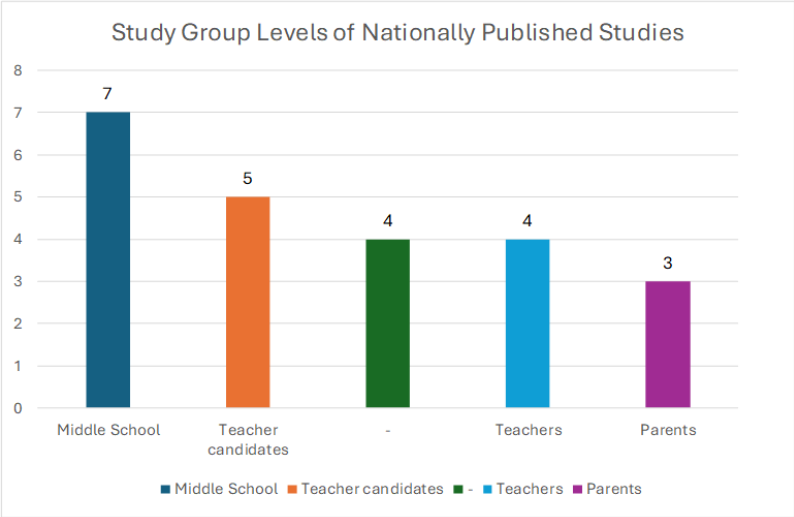
The distribution of international studies included in the research, based on their research designs, is presented in Graph 4:



Graph 4. Distribution of internationally published studies according to research designs

It was observed that the studies on out-of-school learning environments in mathematics education did not explicitly specify their research methods (qualitative, quantitative, or mixed). Upon examining Graph 4, it was found that approximately 70% of the studies (f=9) did not emphasize their research design. Additionally, two studies (15%) employed case studies, while another two studies (15%) utilized a mixed research method.

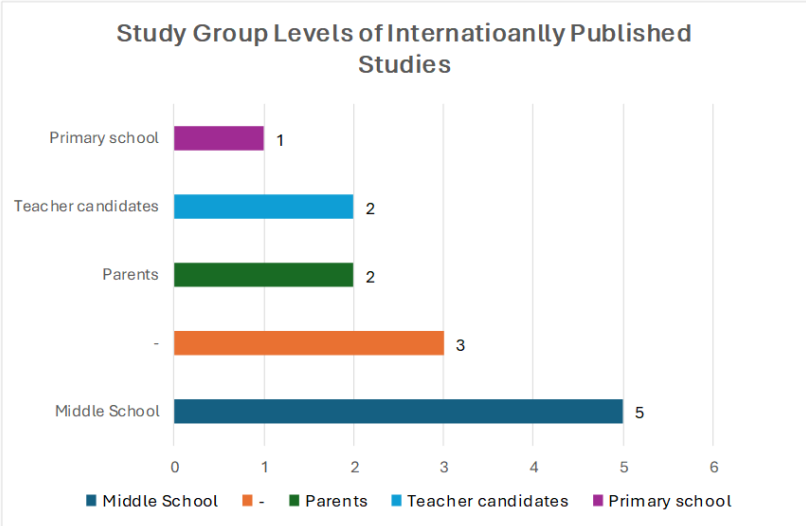
The study groups in the examined studies were analyzed to explore the distribution of research methods further. The distribution of the national studies based on study group levels is presented in the Graph 5:



Graph 5. Study group levels of nationally published studies

When Graph 5 is examined, it is observed that seven studies on out-of-school learning environments in mathematics education were conducted with middle school students additionally, five studies involved teacher candidates, four involved teachers, and three involved parents. The study group level was not specified in 4 of the studies.

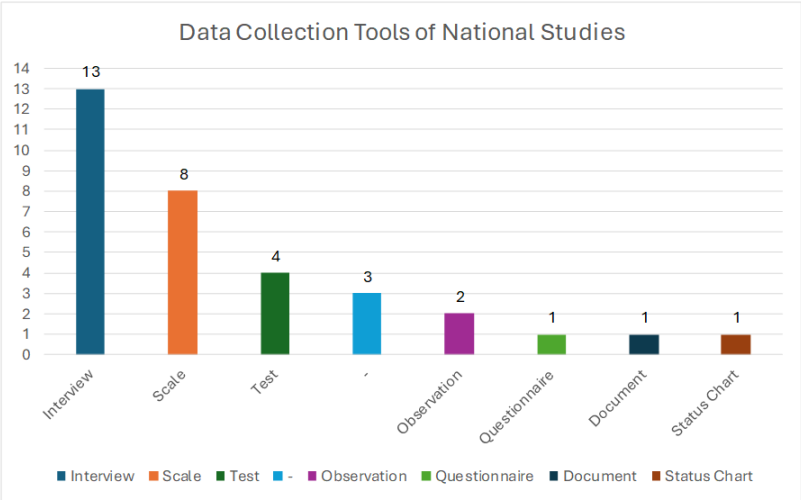
The distribution of international studies included in the research based on study groups is shown in Graph 6:



Graph 6. Study group levels of Internationally published studies

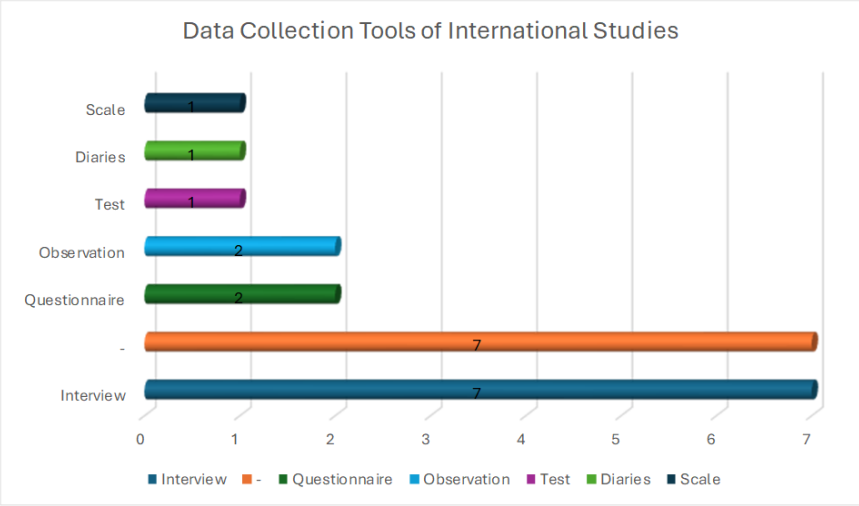
When examining the study group levels of international studies in Graph 6, it is observed that most studies focus on middle school students (f=5). Additionally, there are studies involving parents, teacher candidates, and primary school students. Notably, no studies on out-of-school learning environments in mathematics education were identified nationally or internationally for high school students, graduate students, or academicians.

Another criterion for analyzing the studies in terms of method is the data collection tools used. The distribution of national studies included in the research according to their data collection tools is as follows:



Graph 7. Data collection tools of national studies

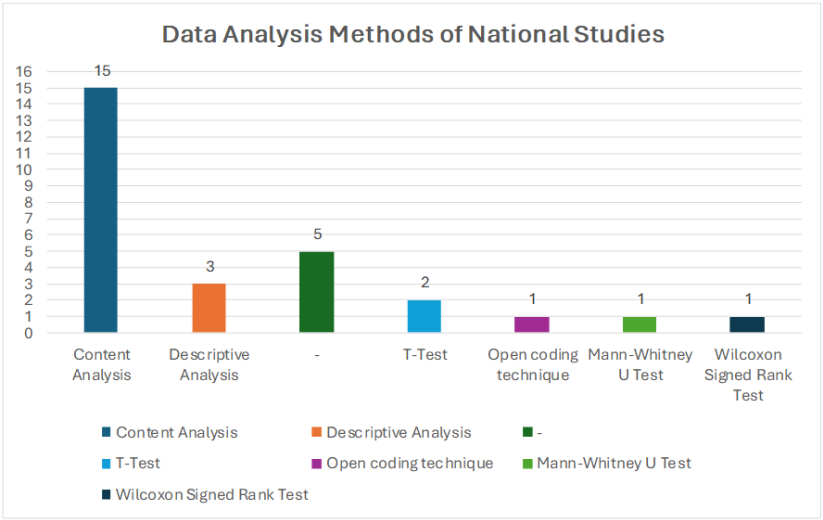
The distribution of the international studies examined according to data collection tools is given in graph 8:



Graph 8. Data collection tools of international studies

When examining the data collection tools used in international studies, interviews appear to be the most frequently preferred method (f=7). Tools such as surveys, observations, tests, diaries, and scales are also utilized. However, as shown in Graph 8, the data collection tools for seven studies are not specified.

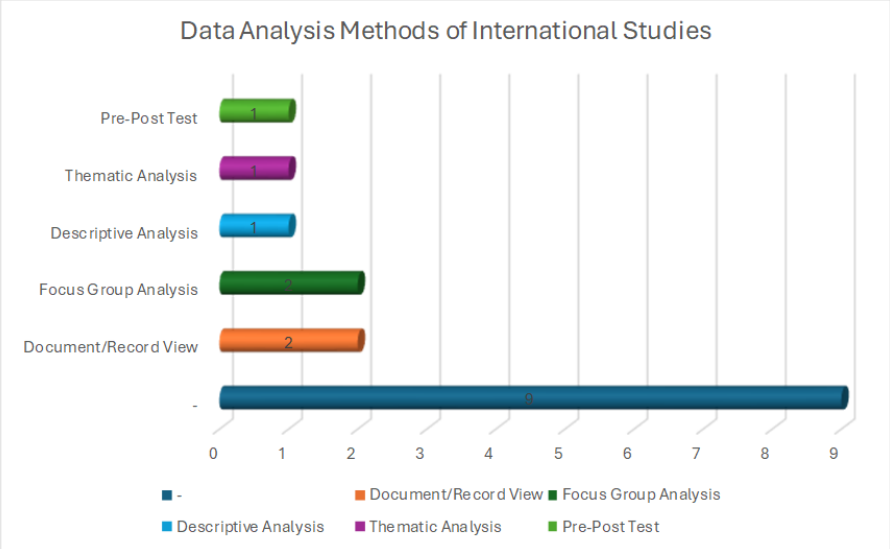
Another aspect examined to understand the methods used in studies on out-of-school learning environments in mathematics education is the data analysis methods employed. The distribution of national studies included in the research according to their data analysis methods is as follows:



Graph 9. Data analysis methods of national studies

When examining the data analysis methods used in studies on out-of-school learning environments in mathematics education, as shown in Graph 9, content analysis was found to be the most frequently preferred method (n=15). Other methods identified include descriptive analysis, t-test, open coding technique, Mann-Whitney U test, and Wilcoxon signed-rank test. However, it was determined that the data analysis method was not specified in four studies.

The distribution of international studies included in the research according to their data analysis methods is presented in Graph 10:



Graph 10 Data analysis methods of international studies

Among these studies, two utilized document review, and two employed focus group analysis. Additionally, one study used descriptive analysis, one employed thematic analysis, and another applied pre-test and post-test data analysis methods.

4. Discussion, conclusion and recommendations

This research aimed to systematically compile studies on out-of-school learning environments in mathematics education, analyze them holistically, and identify their trends. The study is significant for generating ideas and guiding future research on out-of-school learning environments within mathematics education. In this context, 36 studies published in national and international databases were included in the research.

Saraç [57], who conducted a content analysis of studies on out-of-school learning environments in Türkiye, highlighted the lack of research in this area within the field of mathematics education up to 2017. The findings of this study align with Saraç's observations, as national studies on out-of-school learning environments in mathematics education were primarily conducted after 2018. This increase is believed to be influenced by the 2023 Vision Document published by the MoNE in 2018 and the subsequent guides on out-of-school learning environments issued by provincial National Education Directorates.

The 2023 Vision Document [78] emphasizes that course activities aimed at fostering students' creative thinking, research, inquiry, and discovery skills can be conducted outside school boundaries [8, 39, 46]. An examination of international research reveals that studies on mathematics education and out-of-school learning environments date back to 1985 [73]. Although no significant increase occurred in subsequent years, such studies have continued sporadically. Overall, both national and international research on out-of-school learning environments in mathematics education suggests that this field remains underexplored.

An analysis of the keywords used in national studies on out-of-school learning environments in mathematics education, as included in this research, identified a total of 71 different keywords across 23 studies. The terms “out-of-school learning” and “mathematics education” were the most prevalent. However, other keywords appeared fragmented, indicating that the studies lacked a unified focus. Another notable observation is the frequency of the terms “view” (used 4 times) and “attitude” (used 3 times), suggesting that many studies in this area concentrated on exploring attitudes [9, 10, 22, 38, 39, 61, 67, 72].

When the study group levels of research on out-of-school learning environments in mathematics education are examined, it is observed that middle school levels are the most commonly studied. However, studies at the primary and preschool levels appear to be insufficient. This suggests that out-of-school learning activities are underutilized at the preschool and primary school levels. Considering that children's interactions with concrete objects support their understanding of abstract concepts [59], this is particularly significant in mathematics education, where abstract concepts are prevalent. Activities conducted in out-of-school learning environments that allow students to engage with concrete objects can enhance their abstraction skills. Therefore, there is a pressing need for more applications of out-of-school learning environments in mathematics education at the preschool and primary school levels.

Another aspect examined in this research is the design of studies on out-of-school learning environments. It is observed that the majority of these studies adopt qualitative research methods. Within this context, case studies are predominantly used, data is often collected through interviews, and content analysis is the most commonly employed data analysis method in qualitative research. The scarcity of quantitative and mixed-method studies highlights a significant gap in the field. There is a clear need for more quantitative and mixed-method research on out-of-school learning environments in mathematics education. Quantitative studies are almost non-existent at national and international levels, and experimental studies are similarly rare. The prevalence of case studies reflects the overall trend in the field but also underscores the lack of application-oriented research. This suggests a need for more process-oriented, exploratory, and planning-focused studies on out-of-school learning activities designed for these environments. Expanding the range of research methods to include quantitative, mixed-method, and phenomenological approaches, particularly those that offer models for out-of-school learning environments, would significantly contribute to the diversity and development of the field.

When the mathematics curriculum is examined, it is noted that students transition from concrete thinking to abstract thinking during the middle school years [48]. According to the findings, while studies on out-of-school learning environments and mathematics education predominantly focus on the middle school level, these studies often remain superficial due to their qualitative nature. During this critical period, where students transform concrete information into abstract concepts, utilizing out-of-school learning environments through various activities can facilitate a positive transition by enabling students to meaningfully connect the knowledge acquired in school with their surroundings [45].

The emphasis on out-of-school learning environments in the new Turkish Century Education Model mathematics curriculum published by the MoNE in 2024 is evident in

the statement: “The time allocated for lesson hours is the time allocated for out-of-school learning activities, research, and observation, social activities, project work, local studies, reading studies, etc.” [49, 50]. This highlights the importance of activity-based studies in mathematics education within out-of-school learning environments. However, while current research evaluates activity-based studies at a sufficient level, there remains a need for further investigation into how these activities impact students' academic success and attitudes. Additionally, the lack of adequate quantitative research in this area underscores the necessity for further studies exploring these effects.

Experimental and activity-based studies play a crucial role in supporting teachers with activities conducted outside the school environment. The study titled Mathematics Teachers’ Views on Out-of-School Learning Environments by Aydoğdu et al. [8] concluded that mathematics teachers lack sufficient knowledge about out-of-school learning environments. Experimental and activity-based research in this area can help mathematics teachers utilize these environments more effectively in line with the new curriculum. In this context, alongside studies that explore the current situation—such as those focusing on attitudes and opinions— it is equally essential to prioritize research that includes experimental, activity-based approaches, achievement-environment matching, and effective out-of-school teaching designs. Such studies can provide valuable insights into students’ attitudes, motivation, academic success, and perceptions of out-of-school learning environments in mathematics education.

Moreover, a notable gap is a lack of scale development studies in mathematics education for out-of-school learning environments. Addressing this deficiency through the development of scales and tools to assess variables such as attitudes, motivation, and academic achievements of teachers, prospective teachers, and students is essential. These efforts will help to establish a more comprehensive understanding of out-of-school learning environments and their impact on mathematics education.

References

[1] Alisinanoğlu, F., Kesicioğlu, O. S., & Mart, M., Evaluation of pre-school children’s development of geometric thought in the UK and Turkey according to van Hiele model, **International Journal of Education and Research**, 1(10), 1-10, (2013).

[2] Andersson, C., & Johansson, P., Social stratification and out-of-school learning, **Journal of the Royal Statistical Society Series A: Statistics in Society**, 176(3), 679-701, (2013).

[3] (*) Andreev, C., Of the nature of math and math in nature – A sequel about symmetry for children and adults, **Mathematics and Informatics,** 64(4), 425-437, (2021).

[4] (*) Andrews, J., & Yee, W. C., Children’s ‘funds of knowledge’ and their real life activities: two minority ethnic children learning in out-of-school contexts in the UK, **Educational Review**, 58(4), 435–449, (2006).

[5] (*) Ata Doğan, S., & Akman, B., Pre-school teachers’ views and practices on the use of indoor and outdoor in math activities, **Journal of National Education**, 52(238), 621-654, (2023).

[6] (*) Aydoğdu, M. Z., & Aydoğdu, A. S., Okul dışı öğrenme ortamlarında geometri öğretimi [Teaching geometry in out-of-school learning environments], (2023).

https://www.researchgate.net/profile/Mustafa-Aydogdu-5/publication/377117460_OKUL_DISI_OGRENME_ORTAMLARINDA_GEOMETRI_OGRETIMI_GEOMETRY_TEACHING_IN_OUT_OF_SCHOOL_LEARNING_ENVIRONMENTS/links/65968a370bb2c7472b320eee/OKUL-DISI-OeGRENME-ORTAMLARINDA-GEOMETRI-OeGRETIMI-GEOMETRY-TEACHING-IN-OUT-OF-SCHOOL-LEARNING-ENVIRONMENTS.pdf

[7] (*) Aydoğdu, A. S. E., Aydoğdu, M., & Aktaş, V., Virtual museum use as an educational tool in math class, **International Journal of Social Science Research**, 11(1), 51-70, (2022).

[8] (*) Aydoğdu, A. S. E., Aydoğdu, M. Z., & Aktaş, V., The opinions of mathematics teachers about out-of-school learning environments, **The Journal of Buca Faculty of Education**, (55), 60-78, (2023).

[9] (*) Aydoğdu, M. Z., & Aydoğdu, A. S., Preservice mathematics teachers' opinions on the out of school learning environments, **Cumhuriyet International Journal of Education**, 13(1), 1-15, (2024).

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

[11] Bozdoğan, A. E., & Yalçın, N., The effects of science centers on the change of "science interest" levels of primary education students and on their academic success: Energy park, **Ege Journal of Education**, 7(2), 95-114, (2006).

[12] Bozdoğan, A. E., Planning and evaluation of field trips to informal learning environments: Case of the' energy park,. **Journal of Theory & Practice in Education (JTPE)**, 4(2), 282-290, (2008).

[13] Braund, M., & Reiss, M., The nature of learning science outside the classroom. In M. Braund & M. Reiss (Eds.), **Learning science outside the classroom**, 1-12, (2004).

[14] (*) Celedón-Pattichis, S., LópezLeiva, C. A., Pattichis, M. S., & Llamocca, D., An interdisciplinary collaboration between computer engineering and mathematics / bilingual education to develop a curriculum for under represented middle school students, **Cultural Studies of Science Education**, 8, 873-887, (2013).

[15] Christensen, L. B., Johnson, R. B., & Turner, L. A. Research methods design and analysis, **Pearson**, (2015).

[16] (*) Civil, M., STEM learning research through a funds of knowledge lens, **Cultural Studies of Science Education**, 11, 41-59, (2016).

[17] (*) Çakmak Gürel, Z., Developing activity skills of preservice mathematics teachers for out-of-school learning environments, **Journal of Research in Informal Environments**, 8(2), 192-210, (2023).

[18] Çalık, M., & Sözbilir, M., Parameters of content analysis, **Education and Science**, 39(174), 33-38, (2014).

[19] Çepni, S., Araştırma ve proje çalışmalarına giriş [Introduction to research and project work] (8th ed), Celepler Matbaacılık, (2018).

[20] Çığrık, E., & Özkan, M., The effect of science center learning activities on students' science achievement and relationship with motivation level, **Journal of Uludag University Faculty of Education**, 29(2), 279-301, (2016).

[21] (*) Diaz, M. E., & Bussert-Webb, K., Latino youth "out-of-school math and science experiences: Impact on teacher candidates, **International Journal of Research in Education and Science (IJRES)**, 3(2), 624-635, (2017).

[22] Ata Doğan, S., & Akman, B., Pre-School Teachers Views and Practices on the Use of Indoor and Outdoor in Math Activities, **Milli Eğitim**, 52(238), 621-654, (2023).

[23] (*) Duatepe-Paksu, A., Kazak, S., & Çontay, E. G., Evaluation of mathematics activities performed in out-of-school environments: "Mathematics everywhere" project, **MSKU Journal of Education**, 9(2), 541-558, (2022).

[24] Eshach, H., Bridging in-school and out-of-school learning: Formal, non-formal, and informal education, **Journal of science education and technology**, 16(2), 171-190, (2007).

[25] (*) Evcan, S. S., Adilov, G., Eken, Z., Barut, S., Kemali, S., & Tınaztepe, G., The evaluation of the project entitled "Mathematics in our life: Agriculture" conducted for 7th grade students within the scope of TUBITAK 4004-nature education and science schools, **International Journal of Scholars in Education**, 3(1), 28-41, (2020).

[26] Farrow, R., Iniesto, F., Weller, M., & Pitt, R., GO-GN research methods handbook, **Global OER Gradate Network**, (2020).

[27] Genç, M., Albayrak, S., & Söğüt, S., Fen bilimleri öğretmen adaylarının okul dışı öğrenme ortamlarına ilişkin görüşleri [Opinions of science teacher candidates on out-of-school learning environments], In **International Congresses on Education 2010 Book of Proceedings** (pp. 233-239), Edugarden, (2019).

[28] Gökdemir, F., & Dolgun, G., Writing material & method section in qualitative, quantitative, systematic review, meta-analysis, and meta-synthesis studies, **Archives of health science and research (Online)**, 7(2), 189-195, (2020).

[29] Jarvis, T., & Pell, A., Factors influencing elementary school children's attitudes toward science before, during, and after a visit to the UK National Space Centre, **Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching**, 42(1), 53-83, (2005).

[30] (*) Jay, T., Rose, J., & Simmons, B., Why is parental involvement in children's mathematics learning hard? Parental perspectives on their role supporting children's learning, **Sage Open**, 8(2), 1-13, (2018).

[31] Kabapınar, Y., Sosyal bilgiler öğretim programlarında "okul dışı öğrenme "ye bakmak: "Bize her yer sınıf bize her yer öğrenme ortamı" [Looking at learning outside the school in social studies curriculum: hey place classroom for us, everywhere learning environment for us], In A. Şimsek and S. Kaymakcı (Eds.), **Okul dışı sosyal bilgiler öğretimi** [Teaching in Out-of-School Social Studies] (pp. 43-73), Pegem Academy, (2015).

[32] Karaçam, Z., Systematic review methodology: A guide for preparation of systematic review, **Dokuz Eylül University Faculty of Nursing Electronic Journal.** 6(1), 26-33, (2013).

[33] (*) Karataş, F. Ö., Cengiz, C., & Arslan, Z., Fun way of learning: effectiveness of science and technology festival, **Journal of Research in Informal Environments**, 5(1), 95-119, (2020).

[34] (*) Karamık, G. A., & Gümüş, F. Ö., A different application for teaching mathematics in the virtual museum and creative drama, **Gazi University Faculty of Education Journal,** 42(3), 1915-1957, (2022).

[35] (*) Karamustafaoğlu, O., & Pektaş, H. M., Developing students' creative problem solving skills with inquiry-based STEM activity in an out-of-school learning environment, **Education and Information Technologies**, 28(6), 7651-7669, (2023).

[36] Kassas, M., Environmental education: biodiversity, **The Environmentlist**, 22, 345-351, (2002).

[37] (*) Kayhan Altay, M., & Yetkin Özdemir, E., The use of museum resources in mathematics education: a study with preservice middle-school mathematics teachers, **Journal of Education for Teaching**, 49(4), 616-629, (2023).

[38] (*) Kesicioğlu, O. S., & Alisinanoğlu, F., The process of pre-school term children's out of school (informal) mathematics learning, **The Journal of Academic Social Science Studies**, 6(7), 671-685, (2013).

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

[40] Koçdemir, M., School participatory budgeting practice as a learning by doing activity, **Social Sciences Research Journal**, 10(4), 990-1007, (2021).

[41] (*) Kurtuluş, A., Informal (out-of-class) learning environment pi day: Example of jeopardy, **Journal of Research in Education and Teaching**, 4(1), 107-116, (2015).

[42] (*) Kuş, M., Pre-service mathematics teachers' perspectives on teaching mathematics in out-of-school learning environments, **Nevşehir Hacı Bektaş Veli University Journal of ISS**, 13(4), 2174-2195, (2023).

[43] (*) Kuş, M., Conceptualization of out-of-school mathematics education, **Journal of Education for Life**, 38(1), 245–257, (2024).

[44] (*) Masingila, J. O., & King, K. J., Middle school students' use of function ideas in everyday mathematics, (1996).

[45] Masingila, J. O., Muthwii, S. M., & Kimani, P. M., Understanding student's out-of school mathematics and science practice, **International Journal of Science and Mathematics Education**, 9, 89-108, (2011).

[46] Metin Göksu, M., & Sömen, T., Okul dışı öğrenme ortamlarının geliştirilmesi [Developing out-of-school learning environments], In A. Küçükoğlu, & H. İ. Kaya (Ed.), **Kuramdan uygulamaya okul dışı öğrenme ortamları** [From theory to practice in out-of-school learning environments], (pp. 88-137), Pegem Akademi, (2020).

[47] Morag, O., & Tal, T., Assessing learning in the outdoors with the field trip in natural environments (FiNE) framework, **International Journal of Science Education**, 34(5), 745-777, (2012).

[48] Ministry of National Education (MoNE), Matematik dersi öğretim programı (ilkokul ve ortaokul 1,2,3, 4, 5, 6, 7 ve 8. sınıflar) [Mathematics course curriculum (primary and secondary school 1, 2, 3, 4, 5, 6, 7 and 8th grades)], MEB Yayınları, (2018).

[49] Ministry of National Education (MoNE), İlkokul matematik dersi öğretim programı (1,2,3, ve 4. sınıflar) [Primary school mathematics course curriculum (1st, 2nd, 3rd and 4th grades)], MEB Yayınları, (2024a).

[50] Ministry of National Education (MoNE), Ortaokul matematik dersi öğretim programı (5, 6, 7, ve 8. sınıflar) [Elementary school mathematics course curriculum (5th, 6th, 7th and 8th grades)], MEB Yayınları, (2024b).

[51] Oktay, Ö., Ekinci, S., & Şen, A. İ., Investigation of middle school students' thoughts about a mobile planetarium activity, **Elementary Education Online**, 19(2), 695–717, (2020).

[52] Okul Dışı Öğrenme Ortamları Kılavuzları. (https://okuldisiogrenme.com/okulum-turkiye/).

[53] Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T., Mulrow, C., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D., The PRISMA 2020 statement: An updated guideline for reporting systematic reviews, **British Medical Journal**, 372, n71, (2021).

[54] (*) Poçan, S., Altay, B., & Yaşaroğlu, C., Parents' opinions on the use of mobile technology in teaching mathematics, **Inonu University Journal of the Faculty of Education**, 22(1), 500-532, (2021).

[55] (*) Poçan, S., Altay, B., & Yaşaroğlu, C., The effects of mobile technology on learning performance and motivation in mathematics education, **Education and Information Technologies**, 28(1), 683-712, (2023).

[56] Salmi H., Science Centre Education. Motivation and Learning in Informal Education Research Report 119 [Unpublished dissertation], University of Helsinki, (1993).

[57] Saraç, H., Researches related to outdoor learning environments in Turkey: Content analysis study, **Journal of Education, Theory and Practical Research**, 3(2), 60-81, (2017).

[58] Senemoğlu, N., Gelişim, öğrenme ve öğretim kuramdan uygulamaya [Development, learning and teaching from theory to practice.], (21st ed). Pegem Akademi Yayıncılık, (2012).

[59] Skemp, R. R., The psychology of learning mathematics, Hillsdale, NJ: Lawrence Erlbaum, (1987).

[60] (*) Simpson, A., Zhong, Q., & Maltese, A., Spontaneous mathematical moments between caregiver and child during an engineering design project, **Early Childhood Education Journal**, 51(2), 211-222, (2023).

[61] (*) Sözer, Y., Investigation of the effects of an outdoor summer math. camp on high school students through the students' views, **Adnan Menderes Üniversitesi Eğitim Fakültesi Eğitim Bilimleri Dergisi**, 4(2), 1-18, (2013).

[62] Sturm, H., & Bogner, F., Learning in workstations in two different environments: A museum and a classroom, **Studies in Educational Evaluation**, 36(1-2). 14-19, (2010).

[63] (*) Temel, H., The Effect of the out-of-school learning environments course in teaching mathematics on the opinions of teacher candidates, **Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education**, 17(Special Issue), 553-592, (2023).

[64] Tösten, R., Okul dışı eğitim ve öğrenme [Out-of-school education and learning], In A. Küçükoğlu and H. İ. Kaya (Ed.), **Kuramdan uygulamaya okul dışı öğrenme ortamları** [From theory to practice in out-of-school learning environments], Pegem Akademi. (2020).

[65] (*) Tutak, T., Nayıroğlu, B., & Özer, T., Evaluation of the "My mind cuts mathematics" project for secondary school students within the scope of TUBITAK 4004, **Journal of Anatolian Education Research**, 7, 12-17, (2023).

[66] Türkmen, H., İnformal (sınıf-dışı) fen bilgisi eğitimine tarihsel bakış ve eğitimimize entegrasyonu [Historical perspective on informal (outside-class) science education and its integration into our education], **Çukurova Üniversitesi Eğitim Fakültesi Dergisi**, 3(39), 46-59, (2010).

[67] (*) Usta, N., Gürçay, S., Sakioğlu, Ş. N., & Demir, F., The effect of out-of-school-learning environment applications on students' mathematics achievement and

their opinions on the application, **Journal of Education for Life**, 37(3), 711-733, (2023).

[68] Wach, E; Ward, R.; & Jacimovic, R., Learning about qualitative document analysis**, IDS Practice Paper In Brief,** 13, (2013).

[69] Worth K., Science in early childhood classrooms: Content and process, Early Childhood Research and Practice, **SEED Conference**, (2010).

[70] Yaşar, M., Qualitative problem in qualitative research, **MSKU Journal of Education**, 5(2), 55-73, (2018).

[71] Yılmaz, K., Systematic review, meta evaluation, and bibliometric analysis in social sciences and educational sciences, **MANAS Journal of Social Studies**, 10(2), 1457-1490, (2021).

[72] (*) Yıldırım, Y., & Güler, B., Parents' and students' views on mind and intelligence games in out of-school environments, **Journal of Interdisciplinary Education: Theory and Practice**, 6(1), 15-33, (2024).

[73] (*) Weidman, J. C., & LeMahieu, P., Parent involvement in children's out-of-school learning: The MAP-AT-HOME program, (1985).

[74] (*) Zhou, L., Suazo-Flores, E., Sapkota, B., Mbewe, R., & Newton, J., Image of mathematics in- and out-of-school: A case study of two original participants in an afterschool STEM club–Girls Excelling in Math and Science (GEMS), (2021).

[75] (*) Ürey, M., Çepni, S., Köğce, D., & Yıldız, C., An investigation on the effects of the interdisciplinary school garden program developed within the scope of free activities course on mathematics objectives, **Journal of Turkish Science Education**, 10(3), 37-58, (2013).

[76] Şentürk, E., & Özdemir, Ö. F., The effect of science centres on students' attitudes towards science. **International Journal of Science Education**, Part B, 4(1), 1–24, (2012).

[77] Şimşek, A., & Kaymakçı, S., Okul dışı sosyal bilgiler öğretiminin amacı ve kapsamı [The purpose and scope of out-of-school social studies teaching], In A. Şimsek and S. Kaymakcı (Eds.), Okul dışı sosyal bilgiler öğretimi [Teaching in Out-of-School Social Studies] (pp. 1-10), Pegem Academy, (2015).

[78] MEB Vizyon Belgesi. https://baklan.meb.gov.tr/www/meb-2023-vizyon-belgesi/icerik/330

*The studies that are part of the systematic review are marked with an asterisk (*).

Appendices

Appendix 1 : Article Classification Form (TR)

<table>
<tr><td colspan="5">MAKALE SINIFLAMA FORMU</td></tr>
<tr><td>MAKALENİN ADI</td><td colspan="4"></td></tr>
<tr><td>YAZARI</td><td colspan="4"></td></tr>
<tr><td>YAYIN YILI</td><td colspan="4"></td></tr>
<tr><td>DERGİSİ</td><td colspan="4"></td></tr>
<tr><td rowspan="2">ARAŞTIRMA YÖNTEMİ</td><td>NİTEL</td><td colspan="2">NİCEL</td><td>KARMA</td></tr>
<tr><td>☐ Durum çalışması
☐ Olgubilim
☐ Örnek olay
☐ Teori oluşturma
☐ Fenomenoloji
☐ Tarama
☐ Diğer …….</td><td colspan="2">☐ Deneysel
☐ Yarı Deneysel
☐ Zayıf Deneysel
☐ Tek Denekli
☐ Karşılaştırmalı
☐ Korelasyonel
☐ Diğer ……..</td><td>☐ Açıklayıcı
☐ Keşfedici
☐ Çeşitleme
☐ Gömülü</td></tr>
<tr><td>ÖRNEKLEM</td><td colspan="2">☐ Okul öncesi
☐ İlköğretim
☐ Ortaöğretim
☐ Lisans
☐ Lisansüstü</td><td colspan="2">☐ Öğretmen
☐ Yönetici
☐ Veliler
☐ Diğer …….</td></tr>
<tr><td rowspan="2">VERİ TOPLAMA ARAÇLARI</td><td rowspan="2">☐ Anket
☐ Başarı testi
☐ Algı/Tutum/Yetenek/Kişilik Testi
☐ Görüşme
☐ Gözlem
☐ Günlük
☐ Diğer ……</td><td colspan="2">VERİ ANALİZ YÖNTEMLERİ</td></tr>
<tr><td colspan="2">☐ İçerik Analizi
☐ Betimsel Analiz
☐ T- testi
☐ Korelasyon
☐ ANOVA/ANCOVA
☐ MANOVA/MANCOVA
☐ Faktör Analizi
☐ Regresyon
☐ Non Parametrik Testler
☐ Diğer ……</td></tr>
</table>