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Message from the Editor,

I am very pleased to inform you that we have published the second issue in 2025. As an editor of International Online Journal of Primary Education (IOJPE), this issue is the success of our authors, very valuable reviewers who undertook the rigorous peer review of the manuscripts, and those of the editorial board who devoted their valuable time through the review process. In this respect, I would like to thank to all reviewers, researchers and the editorial board members. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to International Online Journal of Primary Education (IOJPE). For any suggestions and comments on IOJPE, please do not hesitate to send me e-mail. The countries of the authors contributed to this issue (in alphabetical order): Sweden and Turkey.

Prof. Dr. Nergüz BULUT SERİN

Editor in Chief

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THINKING SKILLS AND LEARNING STRATEGIES: USING THE MYSTERY APPROACH WITHIN PRIMARY EDUCATION

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Abstract

Early critical thinking and sustainability awareness development is crucial for equipping future generations to handle global issues in an increasingly complicated and interconnected society. This study examined how 9-year-old primary school students applied their knowledge through a collaborative Mystery assignment, demonstrating a Thinking Skill Learning Strategy within education for sustainable development. The Mystery Learning Strategy supported holistic and pluralistic educational approaches, fostering critical thinking, social interaction, and individual development within a socio-cultural framework. Inspired by lesson study principles and based on participatory observations, the findings revealed that while the Mystery approach is dynamic and engaging, it requires careful facilitation to be effective. The study demonstrated that collaboration and critical reasoning were fostered among students. By working in groups, sharing ideas, and building on one another's suggestions, students engaged in communication, active listening, and the integration of diverse perspectives. Future research could investigate the long-term effects of the mystery approach on developing critical thinking skills and enhancing sustainability awareness in younger students.

Keywords: Critical thinking, envisionment, learning strategies, play-based learning, primary education.

INTRODUCTION

Critical thinking transcends mere memorization, urging students to draw connections between concepts, solve problems, think creatively, and apply knowledge in innovative ways (Facione, 2009). These skills are essential not only for success in various academic disciplines but also for valuable functioning in everyday life (Simonovic et al., 2023). This study explores how young primary school students can actively apply their knowledge through an assignment that requires them to engage socially and practically with one another to solve a so-called Mystery. This assignment exemplifies a Thinking Skill Learning Strategy within the context of Education for Sustainable Development (ESD). The ability of critical thinking is most evident in situations where students are encouraged to make decisions based on the circumstances, content, or dilemmas they face (O'Reilly, 2022). Critical thinking is defined here as the capacity to identify the issue at hand, evaluate significant suggestions, and reason critically before arriving at a decision. One objective of education that fosters critical thinking is to enhance students' ability to analyze situations, make interdisciplinary connections, and understand how these abilities can be applied in real-life contexts (Simonovic et al, 2023). Vincent-Lancrin et al. (2019) describe critical thinking as a detective-like approach to thinking, emphasizing imaginative and creative aspects. Ennis (2018, p.166) defines it as "reflective thinking focused on deciding what to believe or do". The process of critical thinking involves several key skills, including being analytical, that is scrutinizing something methodically, predicting outcomes, recognizing patterns, questioning presented evidence, incorporating diverse perspectives, connecting disparate ideas, and envisioning various explanations (Facione, 2009; Simonovic et al., 2023; Ennis, 2018).

By engaging students in activities that require these skills, educators can help students develop a more profound and flexible approach to learning and problem-solving, including issues of sustainability, preparing them for the complexities of today's world.

In this study, I integrate Vygotsky's theoretical insights with Biesta's educational functions of qualification, socialization, and subjectification, and Judith Langer's theories of Envisionment to create a comprehensive framework. Vygotsky posits that individuals learn to navigate the future world through their ability to imagine. Practicing imagination is crucial for envisioning alternative futures. Imagination broadens an individual's experiences by enabling them to conceive of what is not present and to conceptualize others' narratives and experiences (Vygotsky, 1995). Imagination and fantasy build on elements of reality derived from previous experiences, making the richness of an individual's experiences essential for creative activities. Through envisioning, a person can picture various scenarios by combining prior experiences with enhanced knowledge and transformed elements of reality, such as when reading or hearing about events and places they have not personally witnessed. Emotions play a crucial role in these processes. Building on Vygotsky's theoretical insights, Biesta's (2020) framework of the three educational functions serves as a valuable tool for planning, conducting, and analyzing this study's specific activity. Qualification concerns the acquisition of knowledge, skills, and understanding that enable students to perform tasks and act. This function encompasses education's role in fostering development, growth, and cultural literacy. Socialization implies integrating individuals into established ways of thinking and behaving. It ensures the survival of culture and tradition by working to transmit particular norms and values.

Subjectification highlights the individuality and agency of humans. It represents the expression of personal independence from societal norms. Although subjectification can be seen as a counterbalance to socialization, emphasizing the individual's uniqueness rather than the group's collective identity, it remains a relational concept. Langer's theories of Envisionment further enhance this study by providing a specific approach to how students engage with content. Langer describes envisionments as "the worlds of knowledge in our minds that are made up of what we understand and don't about a particular topic or experience at any point in time" (Langer, 2011, p.17). Langer's five stances of Envisionment are used in the study's analysis.

This study aims to investigate the ways in which the Mystery Learning Strategy affects the critical thinking, interpersonal relationships, and personal growth of nine-year-old primary school pupils. Specifically, the study aims to examine how students engage in problem-solving activities, collaborate with peers, and develop a sense of agency through participation in simulated mystery scenario, including issues of sustainability. The study is guided by three questions: How does the Mystery Learning Strategy impact the development of students' critical thinking skills and problem-solving abilities (Qualification)? In what ways does participation in the Mystery learning activity influence students' social interactions and collaborative behaviors (Socialization)? How does engaging with the Mystery Learning Strategy contribute to students' sense of agency, identity, and personal growth (Subjectification)?

Mystery as a Method to Enhance Students' Critical Thinking Skills

The Mystery Learning Strategy enhances logical thinking and encourages students to take initiative. The intention is to enable students to apply their knowledge and abilities to various situations, identify potential solutions, and solve problems. Finding suitable answers is the goal of problem-solving, whereas selecting from a variety of options is the goal of decision-making.

Working with mysteries involves group work and cooperative learning, which helps broaden students' worldviews and exposes them to different methods of approaching and resolving issues (Ehlers et al., 2008). The aims of the Mystery Learning Strategy align well with a holistic/pluralistic approach to ESD (Jickling et al., 2018; UNESCO, 2020; Häggström & Schmidt, 2020; Tryggvason, 2023). The Mystery approach enhances students' creative abilities and imagination by engaging them in activities where they must observe clues, listen actively, and practice reflecting and reacting to what is said and visualized (Leat & Nichols, 1999). During a mystery session, students develop their communicative skills by reasoning, arguing, persuading, responding to, and sometimes agreeing with others' suggestions. Creativity—here defined as thinking in novel and creative ways—is a key component of critical thinking that is highlighted in a mystery exercise. This method promotes flexibility and open-mindedness in thought, as well as curiosity, the investigation of novel behaviors, awareness of one's environment, and meticulous attention to detail.

The strategy promotes several important skills that are often highlighted in ESD. These include collaborative skills and learning to value and integrate diverse perspectives. The iterative process of hypothesizing, testing, and revising theories within a mystery scenario mirrors scientific inquiry, thereby strengthening students' ability to engage in scientific reasoning. In the present study, the mystery was employed as part of a Storyline approach, where students have created characters. The mystery they need to solve was a specific incident, which required students to consider different perspectives and reason through various options, and collaborate to agree upon a solution to the problem.

Pedagogical Departure

The teaching and learning methodology of Ehlers et al. (2008), which is founded on the Thinking Skill Learning Strategies created by David Leat and Peter Fisher in the 1990s, served as the model for this study. These tactics' main goal is to change teachers' attention from giving "the right" response to helping pupils become more capable of learning on their own.. These skills include the ability to reflect on their own thinking and learning. By applying these strategies, it is anticipated that students will develop the competence needed to understand various subjects and societal changes related to ESD. Following Ehlers et al. (2008), thinking skills strategies have a five-step structure. The first is the planning phase, in which the specific thinking skill strategies are identified and defined. Then, the teacher presents the strategy for the students, revealing necessary information, putting emphasis on the procedures. Thirdly, the teacher leads the activities, monitoring the students while they work. If required, the teacher can guide the students by asking open and reflective questions. Here, the teacher takes notes from the evolving conversations, to be used in the debriefing. Fourthly, the debriefing starts, and the students talk about how they solved the tasks they have worked with, and specifically how they solved challenges that arose. The last step highlights how the students solve the whole task, contextualizing their findings, and connecting the knowledge to other fields and topics. The work is organized into small group activities, where dialogue is essential for student learning, and is concluded with a whole class debriefing session to consolidate understanding. In this study the first four steps in managing the TS learning strategies with the students were applied, in accordance with the specific assignment called the mystery with the missing plants.

Critical Thinking in Education: A Multifaceted Approach

There is a substantial body of research on critical thinking, encompassing various definitions and perspectives (Yuan et al., 2022; Vincent-Lancrin et al., 2019; Willingham, 2020; Cáceres et al., 2020). Most national curricula within OECD countries emphasize critical thinking as a key competency that students should develop as part of their education, underscoring the importance of fostering creativity and independent thinking (Vincent-Lancrin, 2023). In the Swedish curriculum, as in many others, this ability is linked to the goal of cultivating democratic citizens through experiential learning, understanding democracy by practicing it (National Agency for Education, 2022). This educational objective entails imparting fundamental knowledge about democratic processes and principles, particularly those rooted in Western democratic traditions. It gives pupils the chance to understand the fundamental principles of democracy and cultivate their capacity for democratic cooperation and thinking.. Such an approach is intended to enhance students' sense of agency, encouraging them to participate actively in their communities, voice their opinions, and become proactive citizens. The Council of Europe similarly emphasizes the role of education in preparing young people to be active societal participants and responsible individuals, especially in multicultural and rapidly changing societies, and during times of economic and political crises (Vincent-Lancrin, 2023). ESD integrates these critical thinking and democratic principles, aiming to equip students with the skills and knowledge necessary to address complex global challenges, fostering a sustainable and equitable future. However, achieving this democratic ideal in schools poses significant challenges, particularly regarding student participation. There exists a power imbalance between adults and children, and teachers and students, which affects students' independence and their reliance on teachers (Thornberg & Elvstrand, 2012). Thornberg and Elvstrand argue that the structural constraints of the school system limit students' autonomy, even as it expects them to act independently within these confines. Therefore, pedagogical practices are crucial in shaping students' opportunities for democratic experiences. The Thinking Skills Learning Strategy, the mystery approach, and ESD share similar aims, emphasizing the development of critical thinking, student agency, and the ability to engage meaningfully in democratic and sustainable practices.

Mystery approaches in education

The mystery was employed as a strategy for fostering and diagnosing relational thinking in Karkdijk's (2021) doctoral thesis, which investigated secondary students' geographical relational thinking. The results were intended to provide teachers with potential insights into strategies for enhancing this thinking skill among their students. Karkdijk highlights several advantages of using the mystery strategy. He claims that it can significantly positively affect students' relational thinking in geography by engaging them in active problem-solving and critical thinking. During the debriefing sessions, students provided more concrete explanations, indicating a deeper understanding of the relationships between geographical concepts. These explanations often involved linking specific geographical phenomena to broader patterns and processes, showing that relatively easy-to-establish relationships dominated their explanations.

In their descriptive article, Macchi and Ridle (2012) highlight the use of role-play and non-verbal communication in a mystery. This practice brings the concepts to life, as students observe and engage with the concepts being acted out by their classmates. Role-play and non-verbal communication offer several advantages over traditional teaching methods. By taking on different roles, students can explore multiple perspectives and develop empathy, which enhances their ability to grasp complex concepts and relationships (McNaughton, 2014). Through the engagement of several sensory modalities, nonverbal communication—such as body language and gestures—helps reinforce learning. It frequently takes direction from the instructor and more time to interact with the characters and the scenario when using characters to explore imaginary worlds.. These interactive strategies align closely with the principles of play-based learning, which emphasize the importance of exploration and creativity in the educational process.

Play-Based Learning

Play-based teaching and learning is a child-centered pedagogy that promotes children's development by harnessing their innate inquisitiveness and exploratory behavior (Hunter, 2019). Aiono (2015, p. 2) asserts, "In order for them to continue to grow this disposition, they must feel connected to their learning environment and confident in their abilities as a learner". However, play-based learning is often considered primarily a pre-school educational strategy, and its suitability for primary school settings has been questioned (Aiono, 2020; Briggs, 2012). In accordance with Aiono (2020, p. 8), play-based learning in this context is defined as "the adult facilitating and encouraging children's play while simultaneously aligning learning outcomes." This definition underscores the dual role of adults in guiding play activities and ensuring that these activities meet educational objectives. Aiono (2020) argues that the phrase "learning through play" recognizes play as a powerful medium for learning, where children can develop critical thinking, problem-solving skills, and social interactions within a structured yet flexible framework. Play-based learning is also recognized as a holistic pedagogical approach, addressing the comprehensive development of children by integrating cognitive, social, emotional, and physical growth. The integration of play-based learning in primary education can bridge the gap between the genuine learning tendencies of young children and the more structured learning environments of primary schools. Research indicates that play-based learning enhances academic outcomes by promoting active engagement, creativity, and motivation (Aiono, 2020; Bergen, 2009; Blucher, 2017). Similarly, Susanti (2024) demonstrates that incorporating stories and fairy tales with problem-based approaches and social interaction are effective strategies for enhancing critical thinking skills in primary school children. Susanti emphasizes that young students typically have limited attention spans and require engaging and enjoyable learning experiences. Therefore, educational approaches should be tailored to suit these characteristics to ensure effective learning. The task included in the study presented in this article is a play-based, small-scale mystery.

METHOD

The study was inspired by the principles of lesson study (Baumfield et al., 2022), which encompassed three distinct stages: 1) the preparation of a detailed lesson plan, 2) the observation of a live lesson, and 3) the subsequent analysis of the lesson. A comprehensive lesson plan was developed, incorporating specific learning objectives, instructional strategies, and anticipated student responses. The second stage involved the observation of the lesson as it was delivered in real-time, which facilitated the collection of empirical data on student interactions, engagement, and the effectiveness of the instructional strategies employed. The final stage consisted of a thorough analysis of the observed lesson. Participatory observations allowed for gaining a deep, nuanced understanding of the group by blending observation with active engagement (Pedersen Dalland et al., 2021). The empirical data comprises field notes, audio recordings, and photographs of the table setting, specifically excluding any images of students. Seven groups, each consisting of three to five students, participated in the study. Each event lasted between 20 and 40 minutes.

Reflexivity and Ethics

The study adheres to the core ethical principles outlined by Ethical Research Involving Children (ERIC, 2013) and complies with the requirements for research ethics in Sweden (Swedish Research Council, 2017) and the General Data Protection Regulation (GDPR), and the University of Gothenburg's recommendations. When conducting this kind of study, certain ethical aspects must be considered. Understanding the classroom culture and the specific dynamics of a group of 9-year-olds is essential. Ensuring a safe environment is paramount; the researcher must be vigilant about the physical and emotional safety of the children during participatory observations. Children might initially see the researcher as an authority figure. Engaging in activities at their level and showing genuine interest in their play helps build trust. With younger students, balancing participation and observation is critical. Too much involvement can influence their behavior, but too little can make it hard to gain meaningful insights. Extra considerations were taken according to the Mystery Method, role play, and play-based learning. Younger children often need more guidance and support during role play and play-based learning activities. As a researcher, I had to balance observation with providing appropriate scaffolding. The activities were designed to keep the children engaged and accounted for their shorter attention spans. Since children often communicate through non-verbal means such as gestures and facial expressions, carefully documenting these cues was crucial for a comprehensive understanding. Throughout the research process, the rights and interests of the students have been prioritized, ensuring their best interests and potential benefits are consistently considered. Data was anonymized to protect privacy.

Data Analysis

In this study, I employed a deductive qualitative method (Drisko & Maschi, 2015; Bingham, 2023) analyzing the empirical material through the theoretical lenses. This approach involved creating codes derived from the components of the theoretical framework. In addition to Biesta's three educational functions, Langer's five steps of envisionments served as an analytical framework:

1. **Being out and stepping into an envisionment:** Students relate new material to their prior experiences and knowledge, searching broadly without knowing exactly what they are looking for, thereby taking initial steps into envisionments.

2. **Being in and moving through envisionment:** Students become more immersed in the material, making connections and enriching their understanding through deeper engagement.

3. **Stepping out and rethinking what you know:** Students use emerging envisionments to enhance their understanding or rethink their prior knowledge, becoming aware of and questioning their own understandings.

4. **Stepping out and objectifying the experience:** Students distance themselves from their envisionments to analyze, evaluate, and synthesize their learning, reflecting on their process and comparing new knowledge to other contexts.

5. **Leaving an envisionment and going beyond:** Students apply their well-developed envisionments to new situations, moving from one learning experience to another and using their knowledge in new contexts.

The material was analyzed from a concrete level to a more theoretical one. The first phase consisted of a spontaneous analysis, sometimes including illustrative quotes from the data, to identify prominent themes and patterns emerging from the raw data. The final phase was the deductive analysis, where the data were examined through the pre-established theoretical framework. This allowed for a more structured and detailed interpretation, linking empirical findings to broader theoretical constructs. During the initial review of the data, broad topical categories of interest were established based on the research questions. Subsequently, the data were sorted into these predefined categories (see table 1.) allowing for a structured and systematic analysis directly related to the theoretical framework (see e.g., Bingham, 2023). By progressing from a spontaneous to a more structured deductive analysis, this approach ensured both the discovery of emergent themes and their alignment with existing theories, providing a robust and comprehensive understanding of the data.

Table 1. Examples of analysis of empirical material.

Categories	Example of sayings and doings	Interpretation	Theoretical note
Engagement and motivation	"Look at that! What is that? Can you move it?"	Showing excitement, talk and laugh and play.	Socialization Stepping in to envisionment
Critical Thinking and Problem-Solving Skills	"It cannot be them because there is no soil around them".	Analyze the whole situation, asking questions.	Qualification Moving through envisionment
Systems thinking	"It can be this person. She does not have a home. She was perhaps hungry and took the fruit".	Making interconnections between social, economic and environmental systems.	Qualification Socialization Stepping out and rethinking
Links to sustainability issues	"He was hungry and has no family".	Link to hunger and social exclusion.	Qualification Stepping out
Collaboration and communication	They resonate and build on each other's ideas.	Talking and listening to each other, developing new ideas.	Qualification Socialization Subjectification Objectifying
Creativity and Imagination	They resonate and build on each other's ideas.	Developing the story through play and envisionment.	Socialization Moving through envisionment
Roleplaying and storytelling	They change their voices.	Talk and act as their character.	Socialization Moving through envisionment
Empowerment and agency	They argue for their suggestions.	Taking initiative and decisions.	Subjectification Objectifying

The study context

This study was conducted at a non-profit primary school that emphasizes democratic pedagogical methods, as highlighted on its website. As part of this approach, all classes and teachers implement a Storyline every year, allowing students to actively influence their education. The school has maintained a strong environmental focus since 2014. The class involved in this study was a grade 3 class consisting of 27 students aged 9-10. The students represented a diverse mix of immigrant backgrounds from various parts of the world and came from different socio-economic, religious, and cultural backgrounds. There was an equal representation of girls and boys.

The mystery included in this study was part of a Storyline called The Park. All students created a character who would encounter various challenges as the story unfolded. During the mystery assignment, 8 groups of 3-5 students entered a room where a model of part of the park was set up on a table. On the table, a scene depicting a park with a small pond was arranged. On one side, there was a small forest area, and next to it lay a person covered with a plastic bag. On the opposite side, there was a park bench, next to which stood a bicycle with two shovels. A person sat on the bench, gazing out over the pond, where two birds were swimming. At one end of the park, two people were having a picnic, sitting on a blanket in the grass. To their left, there was a flower bed that appeared to have been vandalized, with all the bushes uprooted and soil scattered far beyond the bed. In the flower bed lay a ball and nearby was a football jersey. The event began with a brief introductory story about a peaceful morning in the park. However, something was amiss: someone had visited the park and uprooted the valuable fruit plants that the students' characters had planted the previous week. Who could it be, and why? What did they intend to do with the fruit? This mystery is what you are now tasked with solving. The students were then provided with several clues to investigate; traces of animals, a forgotten team jersey, an elderly man sitting on a bench who mentioned seeing a small work vehicle with two men carrying shovels, and a homeless person sleeping at the edge of the forest. After some time, the students' attention is directed to three buildings nearby to the park: a preschool, a youth center, and a store. They are asked to consider whether anyone from these buildings might have been involved in the incident.

RESULTS

This section presents the study's results in relation to the research questions, Biesta's three educational functions and to envisionment.

Development of students' critical thinking skills and problem-solving abilities (Qualification)

During the activity, students first surveyed the terrain, examining the park area, noting what was present, who was there, and speculating about the actions of these individuals. Their aim was to describe the scene and identify what might have caused the disturbance in the flowerbed. One student explained, "Look here, this guy brought a football, kicked it, and then ran off, just like, oh, oh dear. So, the ball ended up in the flowerbed. Then he hid here and threw it to someone else." Another student supported this explanation, seemingly eager for a quick resolution to the problem: "The homeless man was wearing a shirt, playing football, accidentally kicked the ball into the plant, got stressed, threw off his shirt, ate all the fruits, and then hid there! So, no one would see him."

After that, they looked for traces and other indicators that would point to a possible plant crime offender.. Many students considered soil outside the flowerbed a potential clue; where there was soil, the offenders might have moved. One student said, "It can't have been the pigs, because there's no soil around them." They also looked for other clues, like hair from the individuals or stains from the fruits.

In a deeper analysis, the students began discussing motives behind the act. Why would someone steal the valuable fruit plants? The students primarily identified two underlying reasons: to satisfy hunger or for economic gain, such as selling the plants for money. In their reasoning, the students tried to understand who reasons might have to commit these acts. Several students in different groups pointed to the homeless man as a potential candidate for the theft. "It's him, the homeless man!" said one student. "Yes, because he is lying so close to the flowerbed!" confirmed another student. "I think he was hungry," the first student replied.

Although there were no indications of the usual picnic supplies, such as cups, a picnic basket, or traces of bread or other food, the duo on the blanket was suspected in a few groups because they were enjoying a picnic.. One student explained, "They don't have a picnic basket, so they took the berries instead. There's a bit of soil on the blanket." Several students also pointed to the two pigs, since pigs are expected to root and dig in the soil and seem capable of eating almost anything. Some also believed that the duck or seagull might have eaten the berries, but they struggled to explain where the bushes had gone. Regarding the second motive, that someone stole the plants to sell them, the analysis did not progress to discussing the underlying reasons behind this motive. It seemed sufficient to assume that wanting money was a strong enough motive. The possible uses of the money, such as poverty driving the actions, were never discussed.

Students' social interactions and collaborative behaviors (Socialization)
The various groups exhibit different approaches after listening to the introductory story. Some groups quickly become excited and start searching for clues and traces around the park while conversing and sharing their ideas with each other. They engage in associative thinking and validate each other's thoughts and ideas, making most suggestions seem possible. This can be likened to a verbal mind map where all ideas are considered. Subsequently, they begin to argue for their own ideas. Occasionally, peers agree with the arguments presented. However, quite often, they counter with their own arguments without, it seems, fully listening to and considering each other's ideas. When the group was asked to agree on a suggestion about who they think is the most likely suspect, most groups once again offer different suggestions. They did not reach a consensus on rejecting some proposals or ranking them. The suggestions remained equally possible for the students.

There are also examples where students tried to reason why someone is a suspect. The following exchange exemplifies such a passage:

"Seagulls are always around when you have a picnic! So it could be them."

"But then it would be dirty!"

"The seagull might have bathed here afterwards (pointing to the pond)."

Seagulls don't usually go into the water. Do they?"

"Yes, they do!"

Some collaborative conversations focused on systematically solving the problem:

"We need to check, where is that thing you found earlier?"

"The hair?"

"Yes. We can take all the people and compare to see whose hair is most similar."

"This one isn't similar!"

"But it could actually come from the clothes. That guy over there has brown shoes."

"No, this is light brown."

"It's probably from another character."

Students' sense of agency, identity, and personal growth (Subjectification)
During the activity, students energetically engaged by searching for clues and sharing their ideas, demonstrating a sense of agency. Their excitement and positive behavior in investigating the mystery showed that they felt empowered to contribute to solving the problem. The process of proposing hypotheses and debating their validity indicates that students were exercising their decision-making abilities. As students took on different roles within the group (such as leaders, supporters, or skeptics), they were exploring and expressing aspects of their identities. The way they interacted and asserted their ideas reflects their individual personalities and how they see themselves in a group setting. Students' willingness to argue for their own ideas and hypotheses shows a sense of ownership and personal investment in the activity. The need to discuss, argue, and sometimes reach a consensus helped students improve their collaborative skills. Even though collaborative discussions were not always successful, the effort to work together shows growth in their collaborative skills.

Being out, stepping in, moving through an envisionment

The scenery and the introductory story facilitated the students' immersion into the activity. Some students were hesitant at first, needing time to understand the purpose of the activity and the type of rules that might apply in such an educational situation, as opposed to more traditional instruction. However, since all the students in the class had participated in two previous storyline projects and were now engaged in a third, I knew they were familiar with role-playing and play-based learning. In many groups, students fully embraced their roles as their created characters, which supported their immersion into the imaginative world. In some groups, play came naturally, allowing students to remain in the imaginative scenario for extended periods. They turned to me, indicating that I should assume the roles of some of the people present in the park. In one group, the students' characters became police officers on a surveillance mission to observe if anyone entered the park at night. Even though the students knew it was all pretend and that no outsiders would come, it became very exciting for them. They hushed each other and giggled, as if the surveillance was real. They altered their voices when interrogating those they deemed particularly suspicious. However, it seemed more challenging for them to step out of the imaginative world, take a step back, and discuss their proposals more objectively. Being in the fictional world appeared enjoyable, while distancing themselves and engaging in reasoning seemed more demanding.

DISCUSSION, CONCLUSION, and SUGGESTIONS

In summary, this activity, which was a minor part of a larger storyline project, aimed at enhancing students' awareness and knowledge about sustainability, was designed to develop students' thinking skill strategies. Consequently, the activity was considered one of the Storyline's key incidents and a method to address the aspects of thinking skill learning strategies outlined in this article. As such approach is viewed as a crucial component of ESD, the activity aimed at enhancing important abilities and competencies. The following section discusses key points of the results and concludes with final observations.

Critical Thinking Skills During the Activity

Implementing a mystery with 9-10-year-old students has its benefits and obstacles. Firstly, the emotional and affective aspects of working with a mystery at this age are crucial for students' motivation and engagement, which are essential for the learning process. When students find the teaching and learning activity enjoyable, fun, and appropriately challenging, they are likely to remain engaged (Aiono, 2015). The combination of cognitive and emotional aspects of the activity was prominent. Balancing is a keyword, particularly regarding play and reality, fiction and fact, being immersed in an envisionment, and stepping out again to reflect (Langer, 2011).

Play-based learning seems to work well with these students, but it is necessary to balance play with reflective work, or rather, learning through play and learning through discussion and reflection (Aiono (2020). It was important for students to recognize the learning aspects of both activities, which required scaffolding to help them identify these aspects. For instance, teachers can scaffold students by guiding them through questioning techniques and provide prompts that encourage deeper thinking (Ehlers et al., 2008). Thus, the question arises: What does it mean to learn something, and consequently, what is knowledge? This epistemological question is crucial for teachers to reflect upon before conducting a mystery, as it frames the educational objectives and outcomes of such activities.

So, what specific critical thinking skills are developed through this mystery? The results align with previous research on mystery-based learning as an effective tool for fostering critical thinking and problem-solving skills. Ehlers et al. (2008), Leat & Nichols (1999), and Karkdijk (2021) emphasize that mystery-based learning encourages students to engage in inquiry-driven exploration, guiding them to analyze evidence, formulate hypotheses, and refine their reasoning. The students' ability to observe details, generate multiple explanations, and apply logical reasoning reflects the iterative process of hypothesizing, testing, and revising theories, as noted by Karkdijk (2021). The integration of role-play, where students took on investigative roles, aligns with Macchi & Ridle (2012), who highlight how embodying different perspectives enhances reasoning and engagement. The play-based aspects of the activity, where students actively explored clues and debated their ideas, are supported by Hunter (2019), Aiono (2020), Briggs (2012), Bergen (2009), Blücher (2017), and Susanti (2024). These studies collectively underscore that structured play fosters deeper learning, cognitive flexibility, and motivation, all of which were evident in the students' ability to analyze clues, eliminate unlikely scenarios, and develop plausible explanations. The findings reinforce that mystery learning, role-play, and play-based approaches work synergistically to promote higher-order thinking and problem-solving in sustainability education. Even though several students brought up hunger and financial gain, it was more difficult to analyze the reasons behind the theft. By posing open-ended questions and bringing up points the students might otherwise overlook, the instructor can assist the students in this situation.

The development of these critical thinking skills through the mystery activity not only aligns with the objectives of the Thinking Skill Learning Strategy but also supports the goals of ESD (Jickling et al., 2018; UNESCO, 2020; Häggström & Schmidt, 2020; Tryggvason, 2023). ESD aims to equip learners with the knowledge and skills needed to promote sustainable practices and make informed decisions that benefit society, the economy, and the environment. By fostering critical thinking, problem-solving, and the ability to analyze complex situations, the mystery approach contributes to a holistic understanding of sustainability issues and prepares students to address real-world challenges. Having explored the development of critical thinking skills through mystery activity, it is essential to consider the didactic implications of this approach for broader educational practice.

Didactic Implications

The results indicate several aspects that are important to consider before conducting a mystery activity. It is likely that students need practice in engaging with a mystery to understand its purpose and what is expected of them. One such aspect is the ability to balance the enjoyable elements of play with the need for critical reflection and learning (Hunter, 2019; Susanti, 2024). According to Aiono (2020), play-based learning involves adults facilitating and encouraging children's play while aligning activities with educational outcomes. The results showed that students found it challenging to transition from being immersed in a fictional world to engaging in reflective and objective discussion, highlighting the importance of planning how to achieve this balance. Teachers need to ask themselves: What specific strategies can be used to facilitate play-based learning effectively, and how can they guide students without dominating the activity?

Another key point to discuss with students, as mentioned previously, is that learning and learning outcomes encompass more than just factual knowledge. Learning also involves enhancing skills, abilities, and competencies. This study evidenced that collaboration and reasoning were promoted. Students had to work in groups, share ideas, and build on each other's suggestions, which involved communication, listening, and integrating different perspectives. The process of students reflecting individually and collectively mirrors Vygotsky's notion of the Zone of Proximal Development (1978), where learners achieve higher levels of understanding through social interaction and scaffolding provided by peers and teachers.

Creativity and imagination are core aspects of the mystery approach (Ehlers et al., 2008; Leat & Nichols, 1999; Karkdijk, 2021), which teachers should highlight as important abilities for envisioning alternative futures. Some explanations, such as the homeless man getting stressed and eating all the fruits, demonstrate imaginative thinking. Creativity is a component of critical thinking that involves looking at problems in new ways and thinking outside the box. Vygotsky (1995) emphasizes the importance of social interactions and cultural tools in cognitive development, highlighting how imagination and creativity are cultivated through collaborative and socially situated activities. The results also indicate that these young students needed guidance and a highly present teacher. For example, pausing to reflect on the group's suggestions, sorting, and ranking them according to perceived credibility. Some students had difficulties listening to their classmates. All groups showed challenges in finding a common solution based on a critical discussion where they could present arguments and counterarguments to support their hypotheses. Such a critical discussion could help refine students' collective understanding of the situation, although reaching a consensus is challenging. The teacher could facilitate students in revisiting and reevaluating ideas based on new evidence or persuasive arguments. The difficulty in reaching consensus indicates the complexity of the problem and the students' varied perspectives. Being able to provide integrated, holistic explanations is mentioned as a way of thinking that makes thinking skill learning strategies powerful for young people.

Conclusions

In summary, the mystery approach, based on play-based learning, offers a dynamic and engaging educational method that can significantly benefit primary school students, by fostering intrinsic motivation for learning and supporting holistic development. This method is particularly suitable for ESD as it encourages active, engaged learning, and prepares students for future academic and personal success. However, this approach requires careful facilitation. In some groups, external guidance from the teacher was necessary to help students focus, reflect, and discuss effectively. The teacher's role in asking open-ended questions and pointing out clues is crucial for facilitating collective decision-making. Additionally, some students need scaffolding to fully embrace the play, adopt a character, and move seamlessly between engaging in the mystery and reflecting on its learning potential. This scaffolding might also include support for the teacher in managing these transitions.

Suggestions for researchers

Future research on the Mystery Learning Strategy could explore its long-term impact on critical thinking development and sustainability awareness in younger students, as well as its adaptability across different age groups, cultural contexts, and subject areas to promote interdisciplinary learning. Investigating teacher implementation challenges, such as the high level of guidance required for effective facilitation, would be valuable, particularly in larger or under-resourced classrooms where such support may be limited. Further studies could also assess student engagement, emotional involvement, and the role of playfulness, as well as explore technology-enhanced approaches to determine how digital tools might support or hinder the mystery approach in diverse educational settings.

Suggestions for practitioners

Teachers should facilitate students' transition between play and reflection by using open-ended questions to stimulate critical thinking. A balance of immersive play and structured discussions, reinforced by debriefing sessions, enhances learning. Group problem-solving fosters collaboration, while mystery scenarios addressing real-world sustainability challenges add relevance. Activities should offer diverse learning styles for accessibility. Encouraging student initiative fosters ownership, while varied assessment methods, such as self-reflection and peer evaluations, offer valuable insights. Professional development opportunities can support educators in effectively implementing the mystery approach.

Limitation of the study

This study is a pilot study, meaning that its findings are preliminary and should be interpreted with caution. One key limitation is the small sample size, as only a limited number of students (aged 9-10) participated. This restricts the generalizability of the results to broader educational settings and different age groups. The study was conducted in a specific school environment that emphasizes democratic pedagogical methods, which may not reflect the conditions of other educational contexts. Another limitation is the high level of teacher involvement required to facilitate the mystery-based learning activities effectively. Such targeted instruction might not be possible in classrooms that are larger or have fewer resources.. Furthermore, the study primarily relies on qualitative observations and participatory methods, which, while offering in-depth insights, lack the standardized measurements needed for broader comparative studies. Future research should include a larger and more diverse sample, incorporate longitudinal data to assess long-term effects, and explore alternative implementations of the mystery learning strategy in different educational contexts.

Ethics and Conflict of Interest

Certain ethical considerations were addressed to ensure a safe environment, both physically and emotionally, and to acknowledge the power imbalance between students and researchers. Demonstrating genuine interest in the students' play helped build trust. Balancing participation and observation were critical; excessive involvement could influence their behaviour, while insufficient involvement could hinder the collection of meaningful insights. Additional considerations were taken in accordance with the Mystery Method, role play, and play-based learning as younger children often require more guidance and support during these activities. As a researcher, I had to balance observation with providing appropriate scaffolding. The study adheres to the core ethical principles outlined by Ethical Research Involving Children (ERIC, 2013): respect, benefit, and justice. ERIC emphasizes the need for critical reflection, context-specific problem-solving, and transparency. The study also complies with the ethical requirements for research in Sweden (Swedish Research Council, 2017) and the General Data Protection Regulation (GDPR). Throughout the research process, the rights and interests of the students were prioritized, ensuring their best interests and potential benefits were consistently considered. Data was anonymized to protect privacy. No conflicts of interest are related to this work.

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DIGITAL CITIZENSHIP EDUCATION SUPPORTED BY BLENDED LEARNING IN PRIMARY SCHOOL

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Abstract

This study aims to reveal the impact of blended learning (BL) supported digital citizenship (DC) education on students' DC, digital literacy (DL), and information communication technologies (ICT) skills. In this context, the aim was to answer the question: How does BL-supported DC education impact primary school students' DC, DL, and ICT? This research was conducted using a quasi-experimental design, one of the quantitative research designs. The research study group consisted of 82 fourth-grade primary school students, divided into control and experimental groups. The research presented BL-supported DC education activities to the experimental group and DC education activities to the control group using the direct explanation method. DC education, as an intervention, was applied to the study group for 11 weeks. Data were collected through DC, DL, and ICT scales. The data obtained through the scales were analyzed with t-tests for dependent and independent samples. According to the results, the DC, DL, and ICT scores of the experimental group, which participated in the BL-supported education, among the two groups that received DC education, were higher than the control group who participated in the education given with plain instruction. BL students' digital skills were more affected. These results underscore the significance of BL-supported DC education.

Keywords: Blended learning, digital citizenship, digital literacy, information technologies, communication technologies.

INTRODUCTION

With technology becoming an essential element in every aspect of our lives, social structures have undergone a significant transformation; these changes have also brought about new concepts related to citizenship in the 21st century. One of the most critical concepts is the concept of digital citizenship (Dilek & Gürel, 2024), followed by blended learning (BL), which plays a vital role in modern education. As digital interactions increasingly shape daily life, new dimensions of digital citizenship continue to evolve. To keep up with the digital age and cope with its challenges, individuals need to have a strong understanding of digital literacy (IT) and the use of information communication technologies (ICT). In this context, blended learning (BL) supported digital citizenship education can facilitate individuals' ability to act safely and responsibly in online environments, ensuring adaptability to the complexities of the digital world.. In addition to traditional citizenship, digital citizenship includes the skills to act consciously and responsibly on the Internet, social media, and digital commerce.

This educational model supports modern society's adaptation to the digital age by offering learners the opportunity to make the most of the opportunities of the digital world while developing a conscious attitude towards online risks (Görmez, 2017; Tutar et al., 2024; Sevigen & Yılar, 2022). The education model can be integrated with the BL approach, providing an adequate basis for digital citizenship education. Therefore, this study aims to reveal the effect of BL-supported DC education. For this purpose, we discuss the conceptual information about the study in the context of the literature and emphasize its importance.

Changing Perceptions of Citizenship

In the classical sense, citizenship is expressed as being a party to a country and having some rights arising from this partiality (Cambridge, 2022). However, recently, different meanings have been attributed to citizenship. In the literature, ecological citizenship, environmental citizenship, energy citizenship, data citizenship, etc. It is seen that there are many citizenship works and expressions. One of these current citizenship concepts is the concept of digital citizenship. In parallel with technological developments, everyone from an early age to old age has an account on social networks. In addition, the spread of digital commerce and the increase in entertainment games in digital environments have made digital tools an integral part of our lives. Considering the risk areas of the Internet and online connections, many people are at risk from "piracy activities, hacking, phishing, cyber-attacks, ad fraud, child abuse, pornography, cyberbullying, privacy violations, drug dealing, bomb-making, illegal gambling, excessive consumption habits, etc." (Gleason & Gillern, 2018). Recently, the number of people who are defrauded, abused, and whose private images are stolen on the Internet has been increasing. Considering these risks, children must be trained early to use DC., DL, and ICT effectively (Hui & Campbell, 2018). It is suggested that children should be raised as digital citizens as digital citizens early. This way, we can help children with their DL and ICT use.

Conceptual Framework

DC, DL, and ICT are the basic concepts enabling individuals to exist effectively in today's digital world. DC emphasizes ethical and responsible behavior on the Internet, social media, and other digital platforms, allowing individuals to act according to social norms in the digital world. DL, conversely, makes individuals competent in accessing, evaluating, producing, and using information effectively in digital environments. In this context, ICT stands out as a tool that supports interacting and managing information in the digital world. When these concepts come together, individuals can adapt to the complexity of the digital world and can act ethically, safely, and effectively in his environment. These skills play a critical role in modern society's adaptation to the digital age, aiming to raise individuals as conscious, responsible, and influential citizens in the digital world. At this point, we aimed to reveal whether BL effectively teaches these concepts to children. This is because in DC and DL subjects, BL offers students opportunities to learn interactively about the digital risks and ethical responsibilities they may encounter daily (Hui & Campbell, 2018). By combining classroom interaction with digital platforms, BL can increase students' active participation and allow them to experience real-world applications. Thus, BL in DC, DL, and ICT issues can effectively educate individuals as successful, informed, and responsible citizens in the digital world.

Blended Learning (BL)

This research is based on the theoretically based BL (blended learning) concept. BL emerged by minimizing the disadvantages of face-to-face learning and online learning and combining the advantages of both (Erol & Kocakülah, 2024; Çakır & Bichelmeyer, 2016; Raşit et al., 2020; Monk et al., 2020). All types of education that include some aspects of face-to-face and online learning are defined as BL in the literature (Hrastinski, 2019). In other words, BL increases the effectiveness of the teaching process by taking advantage of face-to-face and online learning. In addition, the distance learning environment, a component of blended learning, provides students with flexibility and the opportunity to make arrangements according to their learning styles (Jost et al., 2021). BL applications can also be confused with technology-enhanced learning applications because they include online and face-to-face learning environments. However, BL applications include taking advantage of the strengths of different teaching approaches beyond technology to strengthen education (Tonbuloğlu & Tonbuloğlu, 2023). BL includes but is not limited to Flipped Classroom, Active Learning, Online eLearning, and Problem-Based Learning (Bouilheres et al., 2020). We can express BL as a flexible, inclusive, and helpful learning model in this context.

In the literature, many advantages of BL are listed, such as increasing learning opportunities, supporting course management activities such as communication, grading, and providing feedback, facilitating students' access to information and resources, motivating students with cooperation and interaction, and providing effective and efficient learning experiences (Smyth et al., 2012). When these benefits of BL are examined, they can be used effectively in digital citizenship education. Raising citizens suitable for the digital age will contribute to individuals knowing and protecting their rights. Providing digital citizenship education with technology-supported methods instead of traditional methods implicitly encourages students to use technology, digital literacy, digital access, etc., which will support these areas. BL will serve our purpose.

Digital Citizenship (DC)

Digital technologies have become essential to daily life and paved the way for forming digital societies (Schou & Hjelholt, 2018; Öngören, 2022; Öztürk, 2021). Thanks to ICT, millions of people can instantly transfer their information to each other through social networking sites (e.g., Twitter), video-sharing sites (e.g., YouTube), and blogs (Eid & Ward, 2009). In this process, the conceptual scope of citizenship was more comprehensive than the traditional one, and the concept of DC emerged (Tan & Merey, 2021; Karayakuyu & Ocak, 2024; Kim & Choi, 2018). DC is defined as an individual who uses the Internet regularly, can create digital content, and knows his rights and responsibilities effectively in the online environment (Aldemir & Avşar, 2020; Soriani, 2018; Thomas, 2018; Şen, 2025; Koç & Koç, 2021). In other words, DC means that people with access to information and communication platforms use these platforms to evaluate, criticize, and make moral decisions correctly. The common point of these definitions is that digital citizens must have internet access and digital devices that can access digital environments and must be able to use them actively and consciously (Karakuyu & Ocak, 2024). In today's conditions, where online technologies are rapidly growing, evaluating these platforms correctly and using them accordingly is essential.

DC has become essential to today's education because it requires individuals to exhibit responsible behavior in using technology (Martin et al., 2019). Because in digital environments where control is difficult, children and young people need to know their responsibilities (Saleem, 2018). DC education will guide children and young people at this point because children and young people need guidance to be responsible and respectful of the rights of others in the digital environment, where they spend most of their time using mobile technologies and social media platforms (Wang & Xing, 2018). In this regard, teachers and families have significant responsibilities. In this study, we aimed to improve the digital skills of primary school children with DC education covering DL and ICT.

Digital Literacy (DL)

With the spread of internet-based technologies, students have started to take more part in the digital world. Considering the risk areas of the Internet, students need to have some skills to use the Internet consciously. The most important of these skills is the DL skill. In our digital age, DL skills are skills that students must acquire (Stripling, 2010). DL refers to the use of technology, the process of learning and teaching about technology, individual awareness, attitudes and abilities about digital tools, access to digital resources, and the correct use of digital technology, communication tools, and networks to communicate with people. In other words, DL is defined as the competencies and skills required to navigate an information ecosystem (Blau et al., 2020). Ng (2012) defined the indicator of an individual's digital literacy as their adaptation to new or developing technologies.

DL skills are one of the most essential skills individuals must learn in the digital age. From this perspective, DL includes elements of information, media, and visual literacy (Martin, 2005). Because these skills are also necessary to survive in the digital age and to use digital technologies correctly. Meyers et al. (2013) stated that digitally literate individuals should know the appropriate use of technological tools and their skills and abilities. In this respect, DL offers a comprehensive framework to express the technological, social, and cognitive skills required in the digital environment. This shows that DL is a broader concept than ICT literacy and encompasses ICT. In this case, developing individuals' DL skills will contribute to individuals in many areas, including ICT (Mohammadyari & Singh, 2015).

Information and Communication Technologies (ICT)

Considering today's technological developments, keeping children away from technology is almost impossible. Therefore, it is necessary to equip children with 21st-century skills and prepare them for today's living conditions. At this point, students need to acquire ICT skills. ICT refers to technological tools and resources to transmit, create, disseminate, and manage information (Akinwale et al., 2017). ICT is an expression that requires the use of all computers and communication tools to create, transmit, store, interpret, and process information in various ways (Olutunu et al., 2015). ICT competence aims to understand information technologies better and develop new ICT skills and ideas rather than considering ICT from an instrumental perspective (Cha et al., 2011).

ICT, rapidly occurring in our social life, has also affected education and changed the known education methods (Wu et al., 2017). In education, when used appropriately, ICT can be an essential tool for developing students' skills by collaborating and working effectively with knowledge. When the results of the studies conducted in the literature are examined, it has been seen that high-level thinking skills, such as critical thinking, develop in students using ICT in the learning-teaching process. In addition, integrating ICT into teaching processes increases student success, improves higher order thinking skills, and increases education opportunities. According to Fu (2013), information and communication technologies, It is seen that they facilitate students' access to digital information, support student-centered learning through the constructivist education approach, and increase the quality of teaching. At this point, education to support ICT education needs to be increased. Today's individual, who has gained the freedom to obtain, produce, and disseminate information through ICT, has come to live with his citizenship rights and responsibilities in the virtual world. In other words, digital citizenship and ICT are closely related. At this point, we aimed to reveal the effect of DC-based education on ICT.

Current Study

We have briefly described BL, DC, DL, and ICT in the conceptual framework. The literature on these concepts has shown that these skills are also life skills in our age. Learning approaches that integrate technology should be used to support students' DL, DC, and ICT skills because teaching these skills in traditional ways in our age can make teaching skills difficult. Moreover, in the digital era, teachers often struggle to keep pace with rapid technological and educational advancements, making it difficult to incorporate these innovations into coherent classroom practices (Allen & Berggren, 2016). Ribble (2015) stated that the perception of DC should begin at a young age and that children of this age should be taught digital tools. In this teaching process, today's children, and young people, called digital natives, need guidance to apply citizenship principles in the digital world (Fingal, 2020).

Considering the explanations above, blended learning (BL) is an innovative educational approach that can significantly contribute to children's digital citizenship (DC) acquisition. While preserving the structured structure of traditional learning methods, BL integrates the flexibility and interaction opportunities digital technologies offer into educational processes. BL fosters engagement, interactivity, and personalization, ensuring students benefit from technology without disconnecting from traditional approaches. While the learning process in traditional methods can mostly remain teacher-centered and passive, in the BL approach, students are involved in a more active, questioning, and participatory learning process through digital tools. One of the most significant advantages of BL is that it personalizes the learning process by offering students learning opportunities independent of time and place. In addition, it allows students to develop their digital literacy (DL), digital competence (DC), and information and communication technologies (ICT) skills naturally.

In BL environments, students learn 21st-century skills such as problem-solving, critical thinking, and accessing information through digital means in a practical way. On the other hand, education processes carried out only with traditional methods may be insufficient in providing such skills because in-class activities are usually limited in time and not integrated with technology. In this context, the study's primary purpose is to examine the effect of BL-supported digital competence (DC) education on students' DC, DL, and ICT skills. In this context, two groups were created to reveal

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the BL approach's effects more clearly. The control group was given the content with traditional methods, and the experimental group was given the blended learning approach. Thanks to this comparison, the effect of BL on students was revealed.

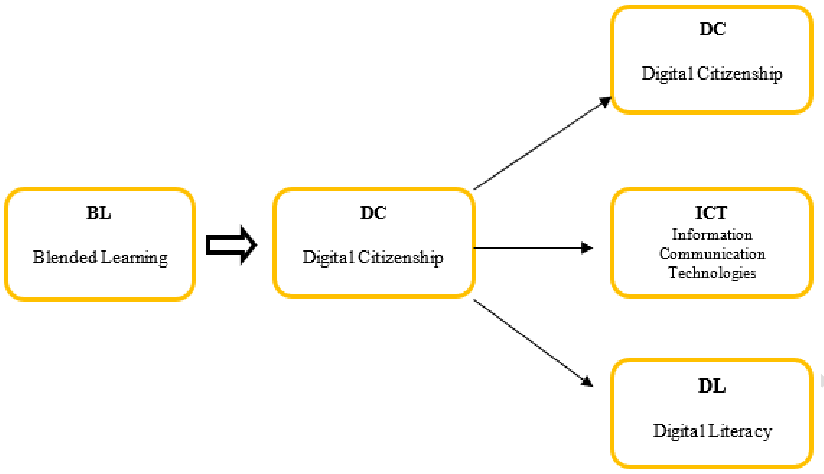

Figure 1. Conceptual model (BL supported DC education DC, ICT and DL).

METHOD

This study, which aims to reveal the effect of DC education on students' digital citizenship, DL, and ICT skills, was conducted using a quasi-experimental design with pre-post-test measurements and experimental and control groups.

Participants

The study group of this research consists of 4th-grade students studying at a public primary school in a province located in the northwestern part of Turkey in the fall semester of the 2022-2023 academic year. Participants were determined by a simple random sampling method. The average age of the students participating in the research is 8.6. There are 82 students in the study group, 41 in the control group, and 41 in the experimental group. Forty-three of the students are girls, and 38 are boys. Most students have low socioeconomic status and study in disadvantaged areas (Esenler district of Istanbul). No parents from the students' families are university or high school graduates. Additionally, the number of students who have their tablet or computer is only 4.

Data Collection Tools

Digital Citizenship Scale (DC): The researcher developed the scale for this research using data obtained from primary school students studying in Istanbul in the 2022-2023 academic fall semester. The relevant literature was scanned to develop the scale, and an item pool of 36 questions was created. The items were presented to expert opinion, five were revised, and the item pool was completed. The draft scale with 36 questions was applied to 240 primary school 4th-grade students, and exploratory factor analysis was conducted. As a result of the analysis, it was determined that the scale consisted of 3 factors and 24 items. These three factors explain 64.24% of the total variance. The factors of the scale are named "rights and responsibilities, security and ethics, communication and access, literacies" in the context of expert opinions and literature. The Cronbach Alpha reliability coefficient of the scale was calculated as .88. Sample items for the scale.

- I know my rights and responsibilities in the digital environment
- I use reliable information sources when doing research in digital environments

Digital Literacy Scale (DL): This scale was developed by Şahin et al. (2022). The research was conducted with two different study groups of 3rd and 4th grade primary school students studying in Kayseri city center in the 2020-2021 academic year. The study group determined for exploratory factor analysis (EFA) consists of 327 students, and the study group determined for confirmatory factor analysis (CFA) consists of 207 students. EFA and CFA were conducted to test the construct validity of the scale to be developed. As a result of EFA, it was concluded that the scale has a 3-factor structure. According to the EFA results, the developed DL scale explains 54.66% of the total variance, and the eigenvalue of each factor is greater than 1. This structure obtained by EFA was tested with CFA, and it was concluded that the model was compatible. The Cronbach Alpha reliability coefficient of the DL scale was calculated as .84. As a result of the study, a valid and reliable 3-dimensional DL scale consisting of 16 items was developed for primary school students. Sample items for the scale.

- I use digital devices to play games
- I do not share the password of my digital devices with anyone

Information Communication Technologies Scale (ICT): The researcher developed the scale for this research using data obtained from primary school students studying in Istanbul in the 2022-2023 academic fall semester. In developing the scale, an item pool of 27 questions was created by scanning the relevant literature. The items we created were presented to expert opinion, five were revised, and the item pool was completed. The 27-question draft scale was applied to 240 primary school 4th-grade students, and exploratory factor analysis was conducted. At the end of the analyses, it was determined that the scale consisted of two factors. The sub-factors of the scale are named "benefits of ICT" and "harms of ICT." The scale explains 58.78% of the total variance.

Additionally, the eigenvalues for each factor are more significant than 1. The analyses resulted in a scale with two factors and 12 items. The Cronbach Alpha reliability coefficient of the scale was calculated as .79. Sample items for the scale.

- I can do my work faster with technological tools
- My eyes hurt when I spend too much time with technological tools.

Procedure

In conducting this research, two study groups, control and experimental, were randomly formed from 4th-grade students studying in a primary school in the Esenler district of Istanbul. We created these two groups mainly to reveal the difference between the group that received education within the scope of BL and those with the direct explanation method. In other words, two groups were created to understand which group the methods applied to were more effective regarding DL, DC, and ICT acquisition. The experimental process was carried out simultaneously with the national education curriculum of the Republic of Turkey in December, January, and February for both the experimental and control groups. Eleven weeks of educational content were presented to the experimental and control groups, including pre- and post-tests. Information regarding the education applied to the groups is explained below.

During the design of the DC education program, general objectives and achievements were first determined. These general goals and achievements are as follows: a) use digital tools for their intended purpose, b) take security precautions while using digital tools, and c) use digital tools economically. In the context of these achievements, educational activities appropriate to the nature of BL have been prepared. After the achievements were determined, the program was structured in three stages. In the first stage, the literature was scanned to determine the needs (Casa-Todd, 2018; Dotterer et al., 2016; Godfrey, 2016; Hui & Campbell, 2018; Kim & Choi, 2018; Pedersen et al., 2018; Preddy, 2016; Ribble, 2015) and interviews were held with 4th-grade students, their teachers, and the children's families. The DC education program was designed to meet the determined needs in the second stage. In the third and final stage, the program was given its final form by taking expert opinions about the program. The program includes a total of 9 DC activities to be implemented weekly. These activities were prepared based on Ribble's (2015) DC citizenship dimensions. The contents and implementation stages of these activities are given in Table 1.

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Table 1. Education contents applied to groups.

Weekly Topics	Activity Name	Description of the Event
Introduction of Education content and collection of pre-tests	------------	------------------
digital access	-My tablet	This activity taught students how to access digital networks and content. To ensure digital access, each student created an e-mail account.
digital commerce		In this event, affordable books were purchased for each student. The mistakes made in this process and what needs to be done are explained.
digital communication	-We research on the internet	Students were enabled to complete group assignments the teacher gave together through applications on the internet. During this process, students were informed about how to communicate in group studies on the Internet.
digital literacy	-I shop online	In this activity, students are taught how to access correct information from the Internet, transfer it, and determine its reliability.
digital ethics	-I do homework online with my friend.	This activity gave students a 47-page guide to using technology correctly. This guide explains to the students what needs to be done in detail. The guide includes the duties of families, society, and ourselves.
digital law	-I am doing research	It has been explained that every transaction we make in digital environments has an electronic responsibility and is sanctioned by law. News in the newspapers, such as the fight against cybercrime and internet fraud, were discussed in the classroom environment.
Digital rights and responsibilities	-A guide to using technology correctly	Students were explained what their rights and responsibilities were in digital environments.
digital health		It has been explained what kind of discomforts will be caused by constantly being dependent on technological devices and how it will affect our lives in the future.
digital security	-Digital culture	With these activities, students were taught how to avoid Internet risks. Every transaction we make on the Internet leaves a digital footprint, and we were told how to reduce this and ensure our security.
Evaluation of application effectiveness and application of post-tests	-What should we pay attention to in digital environments?	Before the post-tests were administered, students were asked to write about the positive and negative aspects of being a digital citizen. from students

This research was conducted in the 2023 academic fall semester. Before the experimental intervention, data collection tools were applied to the experimental and control groups to obtain pretest data. This application aims to demonstrate that the groups are statistically equal before the experiment and to make the necessary adjustments if the groups are not equal. After the pretest procedures, the education program prepared for 11 weeks was applied to the experimental and control groups. This program was presented to the experimental group within the scope of BL and to the control group with lecture administration. Upon completion of the DC education program education, the scales applied in the pretests to the children in the experimental and control groups were re-applied to obtain post-test data. Thus, the effectiveness of the experimental procedures was tried to be demonstrated. Assessments were conducted one-on-one with students in a quiet environment, with each test session lasting approximately 17 minutes per child. After the final testing phase, this study was concluded.

The application activities for the experimental group were administered directly by the researcher. The outcomes obtained during the process were shared with the class teacher at the beginning and end of the activities. Each week's activity was evaluated, the strengths and weaknesses of the activity planned for the next week were determined, and the effectiveness of the education increased. The

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application activities were applied to the control group by the classroom teacher. The researcher and the missing aspects constantly monitored the classroom teacher's teaching process were completed within the scope of teacher feedback.

Data Analysis

The data analysis obtained within the scope of this study was structured in seven stages: 1) The data were sorted, and the data were checked; 2) a data coding guide was created and transferred to the SPSS environment for the pre-and post-test, 3) the distribution of demographic information about the participants was determined, 4) the score of the measurement tools. The averages were calculated separately for the total and sub-dimensions, 5) the normal distribution assumption was examined, 6) the statistical technique was determined, and 7) the results were reported. First, it is necessary to determine the statistical method related to the research problem in analyzing the data obtained. The normality assumption was first examined to determine the appropriate technique. As a result of the analyses, it was determined that the normality assumption was met ($p>.05$). Normality was assessed using both skewness-kurtosis values and the Shapiro-Wilk test. The results showed that the assumption of normality was met in the intervention group and the control group as the skewness (-.85) and kurtosis (.75) values remained within the acceptable range (±1.5) (2013). The Shapiro-Wilk test was insignificant ($p>.05$). Accordingly, a t-test for dependent and independent samples was used to analyze the data.

RESULTS

This section presents the findings obtained in this study. We aim to reveal the effects of BL-supported DC education and DC education in which the direct instruction method is applied to the digital skills of primary school students.

Digital Citizenship (DC)

Pre- and post-test measures of DC scores were analyzed using t-tests for independent samples. Table 2 compares the scores obtained from the DC scale by the students in the experimental and control groups.

Table 2. Comparison of DC scale pre- and post-test scores of the experimental and control groups.

DL Scale	Groups	N	Mean	Std.Dev.	S.H	t	df	p	Effect Size
Total	Experiment Pretest		64.97	9.63	1.50	-1.116		.268	----
	Control Pretest		67.49	10.71	1.67				
Cognitive	Experiment Pretest		25.80	5.08	.79	-.768		.445	----
	Control Pretest	41	26.70	5.55	.86		80		
Affective	Experiment Pretest		24.02	3.74	.58	-1.371		.174	----
	Control Pretest		25.17	3.83	.59				
Operational	Experiment Pretest		15.15	2.69	.42	-.705		.483	----
	Control Pretest		15.61	3.24	.50				
Scale	**Groups**	**N**	**Mean**	**Std.Dev.**	**S.H**	**t**	**df**	**p**	
Total	Experiment Posttest		96.26	11.84	1.85	9.856		.000	2.17
	Control Posttest		71.92	10.47	1.63				
Cognitive	Experiment Posttest		39.68	5.02	.78	9.642		.000	2.13
	Control Posttest	41	28,87	5.12	.80		80		
Affective	Experiment Posttest		33,26	4.63	.72	7.228		.000	2.15
	Control Posttest		26.19	4.22	.65				
Operational	Experiment Posttest		23.31	3.65	.57	8.070		.000	2.55
	Control Posttest		15.14	2.68	.42				

Table 2 shows no statistically significant difference between the total and subscale pretest scores of the DC scale of the experimental and control groups. In other words, the DC scores of the control and experimental groups are equal before starting the application activities. However, the DC scale total and sub-dimensions post-test scores of the control and experimental groups show a significant

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difference in favor of the experimental group. In other words, BL-supported DC education affected students' DC scores more than direct instruction DC. The effect size values obtained for the total scores and all sub-dimensions of the digital citizenship scale are pretty high in the post-test comparisons. These results show that the implemented experimental intervention is quite effective in developing DC skills.

Digital Literacy (DL)

We analyzed pre-and post-test measures of DL scores using t-tests for independent samples. In Table 3, we compare the scores obtained from the DL scale by the students in the experimental and control groups.

Table 3. Comparison of DL scale pre- and post-test scores of control and experimental groups.

DL Scale	Groups	N	Mean	Std.Dev.	S.H	t	df	p	Effect Size
Total	Experiment Pretest	41	32.75	13.10	2.05	-.628	80	.532	----
	Control Pretest		34.51	12.18	1.90				
Information	Experiment Pretest		10.58	3.29	.51	-.505		.615	----
	Control Pretest		10.95	3.27	.51				
Purpose of usage	Experiment Pretest		14.04	6.46	1.01	-.785		.435	----
	Control Pretest		15.12	5.91	.92				
Privacy and Security	Experiment Pretest		8.1	3.89	.60	-.382		.703	----
	Control Pretest		8.43	3.61	.56				
Scale	**Groups**	**N**	**Mean**	**Std.Dev.**	**S.H**	**t**	**df**	**p**	
Total	Experiment Posttest	41	65.34	8.06	1.25	8.750	80	.000	1.93
	Control Posttest		42.00	15.05	2.35				
Information	Experiment Posttest		20.39	3.05	.477	9.329		.000	2.06
	Control Posttest		12.70	4.29	.671				
Purpose of usage	Experiment Posttest		28.58	3.96	.618	6.917		.000	1.52
	Control Posttest		19.02	7.91	1.23				
Privacy and Security	Experiment Posttest		16.36	2.10	.32	7.264		.000	1.60
	Control Posttest		10.27	4.94	.77				

Table 3 shows no statistically significant difference between the total and sub-dimensions pretest scores of the DL scale of the experimental and control groups. In other words, the DL scores of the control and experimental groups are equivalent before starting the application activities. However, the DL scale total and sub-dimensions post-test scores of the control and experimental groups show a significant difference in favor of the experimental group. In other words, BL-supported DL education affected students' DL skills more than plain-text DL. The effect size values obtained for the total scores of the scale and all sub-dimensions are at a very high level. These results show that the implemented experimental intervention is quite effective in developing DL. From an academic perspective, effects of this magnitude are statistically significant and provide practically meaningful and applicable results. Therefore, the study can be evaluated as strong evidence that reveals the effect of training programs on digital literacy.

Information and Communication Technologies (ICT)

We analyzed pre-and post-test measures of ICT scores using t-tests for independent samples. In Table 4, we compare the scores obtained from the ICT scale by the students in the experimental and control groups.

Table 4. Comparison of ICT scale pre- and post-test scores of control and experimental groups.

Scale	Groups	N	Mean	Std.Dev.	S.H.	t	df	p	Effect Size
ICT	Experiment Pretest Control Pretest		24.63 25.58	9.40 8.8	1.4 1.38	-.472		.638	----
Benefits of ICT	Experiment Pretest Control Pretest	41	10.58 10.80	3.29 3.20	.51 .50	-.306	80	.760	----
Harms of ICT	Experiment Pretest Control Pretest		14.04 14.78	6.45 6.10	1.00 .95	-.527		.600	----
Scale	**Groups**	**N**	**Mean**	**Std.Dev.**	**S.H**	**t**	**df**	**p**	
ICT	Experiment Posttest Control Posttest		48.48 31.41	6.20 11.34	.96 1.77	8.456		.000	1.86
Benefits of ICT	Experiment Posttest Control Posttest	41	20.66 13.04	3.12 4.47	.48 .69	8.929	80	.000	1.97
Harms of ICT	Experiment Posttest Control Posttest		27.82 18.36	3.89 8.20	.60 1.28	6.670		.000	1.47

Table 4 shows no statistically significant difference between the total and sub-dimensions pretest scores of the ICT scale of the experimental and control groups. The ICT scores of the control and experimental groups are equivalent before starting the application activities. However, the ICT scale total and sub-dimensions post-test scores of the control and experimental groups show a significant difference in favor of the experimental group. In other words, BL-supported DL education affected students' ICT skills more than plain-text DL. The effect size values obtained for the total scores of the scale and all sub-dimensions are at a very high level. These results show that the implemented experimental intervention is quite effective in developing ICT skills. It can be said that BL-supported DC training constitutes an important context in supporting the ICT skills of primary school students.

Control and Experimental Group Pre- and Post-test Comparisons

This heading presents t-test results for the dependent groups of the scores obtained by the study group from the DC, DL, and ICT scales. The purpose of these analyses is to reveal the change among the groups. In other words, this analysis was conducted to understand the effectiveness of the educational activities applied to the experimental and control groups.

Table 5. Comparison of DC, DL, and ICT scale pre-and post-test scores of the experimental group.

Scale	Groups	Tests	N	Mean	Std.Dev.	S.H	t	df	p	Effect Size
DC	Total	Posttest Pretest	41	96.26 64.97	11.84 9.63	1.85 1.50	14.374	40	.000	2.89
	Cognitive	Posttest Pretest		39.68 25.80	5.01 5.08	.78 .79	10.641		.000	2.75
	Affective	Posttest Pretest		33.26 24.02	4.63 3.74	.72 .58	13.731		.000	2.19
	Operational	Posttest Pretest		23.31 15.14	3.65 2.68	.57 .42	13.296		.000	2.55
DL	Total	Posttest Pretest		65.34 32.75	8.06 13.10	1.26 2.04	14.918		.000	2.99
	Information	Posttest Pretest		20.39 10.58	3.05 3.29	.48 .51	12.281		.000	3.09
	Purpose of usage	Posttest Pretest		28.58 14.04	3.96 6.45	.62 1.01	12.785		.000.	2.71
	Privacy and Security	Posttest Pretest		16.36 8.122	2.10 3.89	.33 .61	12.508		.000	2.63

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Table 5 (Continued). Comparison of DC, DL, and ICT scale pre-and post-test scores of the experimental group.

Scale	Groups	Tests	N	Mean	Std.Dev.	S.H	t	df	p	Effect Size
ICT	Total	Posttest Pretest	41	48.48 24.63	6.20 9.40	.97 1.46	14.087	40	.000	2.99
	Benefits of ICT	Posttest Pretest		20.65 10.58	3.12 3.29	.48 .51	11.168		.000	3.14
	Harms of ICT	Posttest Pretest		27.82 14.04	3.89 6.45	.61 1.01	16.812		.000	2.58

According to Table 5, there is a statistically significant difference between the pre-and post-test DC DL and ICT scales' total and subscale scores of the students in the experimental group. This significant difference favors post-test scores. BL-supported DL education increased students' DC, DL, and ICT scores. High effect size values were calculated in all scales and subdimensions in the experimental group. These results are important in showing the effectiveness of the activities carried out.

Table 6. Comparison of control group DC, DL, and ICT scale pre-and post-test scores.

Scale	Groups	Tests	N	Mean	Std.Dev.	S.H	t	df	p	Effect Size
DC	Total Puan	Pretest Posttest	41	67.49 71.92	10.71 10.47	1.67 1.63	-1.858	40	.070	------
	Cognitive	Pretest Posttest		26.70 28.87	5.55 5.12	.86 .80	-1.283		.207	------
	Affective	Pretest Posttest		25.17 26.19	3.82 4.22	.59 .65	-2.878		.006	.25
	Operational	Pretest Posttest		15.69 16.85	3.23 3.59	.50 .56	-3.104		.003	.33
DL	Total	Pretest Posttest		34.51 42.00	12.18 15.05	1.90 2.35	-2.938		.005	.54
	Information	Pretest Posttest		10.95 12.70	3.27 4.29	.51 .67	-2.467		.018	.45
	Purpose of usage	Pretest Posttest		15.12 19.02	5.91 7.91	.92 1.23	-1.736		.090	-----
	Privacy and Security	Pretest Posttest		8.43 10.26	3.61 4.94	.56 .77	-1.487		.145	-----
ICT	Total	Pretest Posttest		25.58 31.41	8.83 11.34	1.3 1.77	-2.270		.029	.60
	Benefits of ICT	Pretest Posttest		10.80 13.04	3.20 4.47	.50 .69	-1.977		.055	----
	Harms of ICT	Pretest Posttest		14.78 18.36	6.10 8.20	.95 1.28	-2.883		.006	.49

Table 6 shows a statistically significant difference between the pre-and post-test DC DL and ICT scores of the students in the control group. Although post-test scores increased compared to pretest scores, this difference is insignificant. In other words, the control group's science, technology, and society unit achievements only affected students' DC awareness and DL skills a little. However, when the Table is examined, it is seen that there is a significant difference between the pre-and post-test data of the control group students in favor of the post-test data, according to the ICT scale data. According to these data, the educational contents applied to the control group positively affected the students' ICT skills. Additionally, there is a statistically significant difference between the pre-and post-test DC, DL, and ICT scores of the students in the experimental group. In other words, the DC education contents received by the experimental group positively affected the students' DC, DL, and ICT skills.

DISCUSSION, CONCLUSION, and SUGGESTIONS

This study aims to reveal the effect of BL-supported DC education on students' skills in using DC, DL, and ICT. The BL-supported DC education we implemented for this purpose has positively increased students' DC, DL, and ICT scores. These findings show that BL-supported DC education is more effective in developing students' digital citizenship skills and produces more positive results than traditional teaching methods. BL's ability to provide flexible learning environments may have allowed students to develop DC skills more effectively. These findings may encourage more widespread adoption of BL-supported DC education in educational practice and contribute to studies in the field of digital citizenship education because BL provides flexibility to students, instructors, and educational institutions in sequential and simultaneous planning of the design and structuring of time, space, speed, and route (Tonbuloğlu & Tonbuloğlu, 2023). BL played an essential role in developing students' digital skills. On the other hand, DC education is practical in DL and ICT because DC covers DL and ICT (Buchholz et al., 2020). In this context, DC education can improve many students' digital skills. DC education is one of the most important ways to prepare students for the digital age.

The DC scale includes cognitive, affective, and action citizenship sub-dimensions. Therefore, the effect of BL education is positive on these sub-dimensions. BL-supported DC education statistically affected students' cognitive, affective, and action citizenship scores. These results support similar research results in the literature. For example, Holland (2017), in his DC perception study, found that DC activities contributed to students, especially in the dimensions of digital ethics, digital communication, and DL. Similarly, Gleason and Von Gillern (2018) educated DC students about social media. It has been determined that as students' online spending habits increase, they find, evaluate, and share information responsibly in online environments. In addition, efforts have been made to ensure effective communication with different people and their online participation in a safe, ethical, and legal manner. Finally, the study suggested that social media can improve both in-school and out-of-school dimensions of digital citizenship. This can be achieved by integrating it into the curriculum. Brandau et al. (2021) found in their study that approximately 60% of young people in the USA were harassed in virtual environments, and they aimed to develop an effective DC program to raise awareness of young people against these behaviors and encourage digital citizenship. As a result of the research, the average DC scores of the participants were statistically significant and increased by 2.96 points. As a result, they revealed a need for cost-effective programs that support social-emotional learning and digital citizenship. Martin et al. (2019) and Capuno et al. (2022) revealed that DC education is needed at the K-12 level and should be integrated into educational programs. Considering the findings we obtained in this study, BL-supported education programs may offer opportunities to support students' digital skills.

The DL scale includes sub-dimensions, such as information, intended use, privacy, and security. The ICT scale includes sub-dimensions, such as knowledge and purpose of use. Therefore, the effect of BL education on these sub-dimensions is positive. BL-supported DC education statistically positively affected students' knowledge and purpose of use scores. ICT skills in students can be supported through DC education. Hollandsworth et al. (2011) stated that because of the time young people spend in digital environments and their usage rates are increasing rapidly, they think too individually. They should be made aware of their responsibilities regarding their behavior. Thus, educational institutions should play an active role in imparting rights and responsibilities in digital environments and making students active members of the digital society (Krutka & Carpenter, 2017). Students should be encouraged to DC to ensure their correct behavior and safe daily life habits when using computer and communication technologies. Lauricella et al. (2020) stated in their study that with the widespread use of the Internet and technology at home, primary school students should be supported to become safer, more responsible, and more collaborative digital media users. Additionally, researchers emphasized that educational programs should be developed to support students' digital skills in primary school. In this context, the BL-supported DC education program developed in this study will contribute to this deficit. This study reveals essential results as it contributes to children's acquisition of ICT skills. In terms of teaching ICT, technology-supported learning and teaching methods such as BL provide more effective results than plain instruction.

Research results in the literature support these results. For example, Martinez et al.'s (2022) study emphasized that globalization, economic inequality, and the COVID-19 pandemic caused potential rifts among citizens. Their study revealed that while students are aware of these issues, they often lack the necessary skills to critically analyze and discuss them. At this point, schools have evaluated the usability of the BL method and DC curriculum to help students solve social dilemmas and engage in thoughtful dialogue. According to the research results, it was determined that students developed positive perceptions about the program by being exposed to social dilemmas and multiple perspectives through collaborative dialogue.

Additionally, it was emphasized that students with different perspectives build knowledge together and positively perceive conflict. These findings indicate that the BL method and DC curriculum can effectively teach students valuable skills. Considering the study of Blaj-Ward and Winter (2019), it was stated that students needed help to reconcile themselves with the concept of DC because they grew up in technology and only adapted. Although they used e-mail and social networks in lessons, it turned out that the digital native concept was not sufficiently associated with the concept of DC. In this context, it has been determined that university students see digital citizenship as an obligation and cannot reconcile participation in digital spaces with digital citizenship.

In conclusion, the findings of this study indicate that BL-supported DC education can be an effective tool in increasing students' digital skills and can create positive effects on both DL and ICT thanks to the broad scope of DC education. Such educational programs can improve the quality of the education system by preparing students for the needs of the digital age. All these findings emphasize that the BL method and DC curriculum can play an essential role in raising students' awareness about digital citizenship and that more efforts should be made in education in this field.

Limitations and Future Directions

This study also has some limitations. It was primarily conducted in a primary school with a low socioeconomic level, and thus, the findings are limited to the characteristics of this specific working group. This contextual specificity may not reflect the broader student population, affecting the study's external validity. Moreover, the limited number of experimental group participants restricts the findings' generalizability to wider populations. Therefore, overgeneralization was deliberately avoided when interpreting the results. Another factor that may influence external validity is the experimental setting itself; ignoring the characteristics of the environment in which the intervention took place and generalizing the results to other educational settings may lead to inaccurate conclusions.

Several limitations that could affect external validity should be highlighted in more detail in this context. First, the socioeconomic background of the school may have influenced the students' familiarity with and access to technology, which could impact their responsiveness to the technology-supported educational content. Second, the study only involved a single school and a limited number of students, which may not capture the diversity of learning needs and contexts in other regions or educational levels. Third, the duration of the intervention was limited, and longer-term effects were not observed. These limitations reduce the extent to which the findings can be applied to other populations, settings, or timeframes.

To address these limitations in further studies, researchers could replicate the study with a more diverse sample that includes schools from different socioeconomic backgrounds and regions. Increasing the number of participants and conducting the study across multiple schools would enhance the generalizability of the findings. Additionally, longitudinal studies could be designed to assess the long-term impact of technology-supported interventions on students' digital citizenship

(DC), digital literacy (DL), and ICT competencies. Varying the experimental environments and including different educational levels (e.g., secondary or high school students) would further strengthen the external validity of future research. Furthermore, Choi (2016) emphasized that despite the growing importance of fostering socially responsible digital citizenship, especially in the Internet age, there is still a lack of research on how digital citizenship can be effectively defined and operationalized. The present study contributes to addressing this gap in the literature by exploring technology-supported education's role in developing digital competencies.

Based on this study's findings and limitations, we offer the following suggestions: Technology-supported educational content, such as blended learning (BL), can be further developed and used to enhance students' digital citizenship skills. Further studies could also integrate mobile learning and augmented reality tools into the curriculum to improve students' DC, DL, and ICT performance more comprehensively across different learning environments and student profiles.

This research shows that BL-supported DC education can be more effective than the traditional lecture method in the development of digital citizenship (DC), digital literacy (DL), and information and communication technologies (ICT) skills. Findings reveal that the BL approach further increases the acquisition of DC educational content. Also, BL facilitates educators' instructional processes and contributes to higher student performance outcomes. The analysis revealed that while direct explanation methods led to improvements in DC, DL, and ICT scores, the increase observed in BL-supported education was significantly higher. However, this increase was more limited than the increase in BL-supported education. Therefore, this study emphasizes the importance of BL-supported education and reveals that this method should be preferred to enhance students' digital skills. As a result, it was concluded that the digital skills children acquire can be developed more effectively with technology-supported education. This study's emphasis on applying BL technology in education is essential for future educational strategies because a technologically and pedagogically well-structured BL process will significantly reduce education inequalities (Bozkurt & Sharma, 2021).

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Ethics and Conflict of Interest
Research permissions were obtained from two institutions. The first permission was obtained from the Ethics Committee of Yıldız Technical University Rectorate. The permission was obtained from the Ethics Committee of Yıldız Technical University with the letter dated 29.07.2023 and numbered 2023.7. The author declares that they have no conflict of interest.

Data availability
The data that support the findings of this study are available on request from the corresponding author.

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THE RELATIONSHIP BETWEEN MATHEMATICS MOTIVATION AND MATHEMATICS PROBLEM-SOLVING SKILLS OF PRIMARY SCHOOL STUDENTS

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Abstract

This study investigated the relationship between primary school students' mathematics motivation and problem-solving skills in mathematics. A total of 429 students were selected through convenience sampling, using a relational survey model. Data were collected using the Mathematics Problem-solving Achievement Test and the Mathematics Course Motivation Scale using the relational survey model. The research results showed that fourth-grade primary school students' mathematics problem-solving scores were at the 'Needs Improvement' level although they have high motivation in mathematics. Secondly, their motivation towards mathematics did not differ regarding teacher turnover and the mother's educational status while, but it significantly differs concerning the father's education status. Namely, those whose fathers are graduates of primary school and university performed better than those whose fathers are graduates from middle school. It was also found that their mathematics problem-solving achievement scores did not differ regarding teacher turnover but differed significantly with respect to mothers' educational status (in favour of university graduates compared to middle school and high school graduates; in favour of primary school graduates compared to high school graduates) and fathers' educational status (in favour of university graduates compared to high school graduates). This study found a weak but statistically significant positive relationship between their motivation towards mathematics and problem-solving skills. Lastly, this study revealed that the mathematics motivation of fourth-grade primary school students accounted for 7% of the increase in mathematics problem-solving success scores.

Keywords: Mathematics, motivation, problem solving, primary school.

INTRODUCTION

Mathematics, rooted in the Greek term "máthema" (science, knowledge, and learning) equip individuals with essential skills, such as analytical thinking and problem solving (Koşar & Yılmaz, 2020). Although it plays a critical role in the development of children's academic and life skills (MoNE, 2018), some students may find mathematics boring and abstract and develop a negative perception (Hadi, Herman, & Hasanah, 2018). Tahiroğlu and Çakır (2014) proposed the concept of "mathematics motivation" for students to develop positive attitudes towards mathematics and enhance students' engagement.

The path to success in mathematics is linked to effective problem solving and NCTM (2000) recognizes problem solving as the foundation of school mathematics. In this context, it is of great importance to understand the factors affecting primary school students' problem-solving success, especially the role of mathematics motivation.

Many studies in the literature are based on the examination of mathematics motivation, parameters affecting mathematics achievement and factors affecting problem-solving skills. In a study conducted by Bozkurt and Bircan (2015), the relationship between mathematics motivation and academic achievement of 5th-grade students was investigated. A significant relationship was found between learning belief, self-efficacy, goal orientation and subject value and mathematics achievement. Türk (2021) examined the relationship between mathematics anxiety and motivation levels of 4th-grade primary school students and mathematics course achievement. It was concluded that there was a low-level relationship between intrinsic motivation, a motivation and mathematics achievement. Karaman and Mutluer (2023) examined the mathematics motivation of primary school 2nd, 3rd and 4th-grade students in terms of various variables. While a significant difference was found between mathematics motivation level and mother's education level, no significant difference was found with father's education level and gender. Baş and Şahin (2024) investigated the relationship between mathematics motivation, anxiety and self-efficacy levels of 3rd and 4th-grade primary school students. It was found that students had high levels of intrinsic motivation and self-efficacy, moderate levels of extrinsic motivation, and low levels of amotivation and anxiety. In'am and Sutrisno (2021) showed that the collaborative learning model significantly increased the mathematics self-efficacy and motivation of 8th-grade students. Mamola’s (2022) study found that online learning during COVID-19 negatively affected Filipino students' mathematics motivation and self-efficacy, not anxiety.

Kesici and Aşılıoğlu (2017) investigated the effect of mathematics attitude, motivation, anxiety and stress levels of 8th-grade primary school students on mathematics achievement. Their findings showed that attitude, motivation and stress had a positive effect on mathematics achievement, while anxiety had a negative effect. Sarı and Ekici (2018) examined the effect of motivation, attitude and anxiety on mathematics achievement of 4th-grade primary school students. It was found that motivation had no significant effect, attitude had a positive effect, and there was a negative relationship between attitude and anxiety. Kaya (2019) examined motivation, self-regulated learning strategies and metacognitive awareness as factors predicting mathematics achievement of 7th-grade students. It was found that self-regulated learning strategies and motivation showed significant relationships with metacognitive awareness. Külünk Akyurt (2019) examined the relationship between mathematics motivation, achievement and anxiety of primary school 4th-grade students. It was found that there were significant relationships between mathematics achievement and motivation and anxiety. Özdemir (2021) examined the relationship between mathematics self-efficacy perception, motivation and anxiety of 8th-grade students. A positive relationship was found between self-efficacy and motivation, and a negative relationship was found between motivation and anxiety. Kara and Özkaya (2022) investigated the relationship between 8th-grade students' mathematics motivation, attitudes and achievement. It was found that there was a positive and moderately significant relationship between the three variables. Studies emphasize that the likelihood of success increases when students' mathematics motivation, especially intrinsic motivation, is high. It also indicates that mathematics motivation is multifaceted and depends on various factors, and these factors may have direct or indirect effects on mathematics achievement. Hence, this study focuses on the variables that may affect or be related to mathematics motivation.

Ergen (2020) examined the non-routine problem-solving skills of primary school 4th-grade students and observed that students had difficulty in problem-solving even if they performed arithmetic operations correctly. The study emphasizes that students' problem-solving strategies should be improved. Tayfur (2022) examined the relationship between four operations skills and problem-solving achievement of 4th-grade primary school students. A moderate, positive and significant relationship was found between four operation skills and problem-solving achievement. Ramnarain (2014) showed that teaching problem solving strategies improved the problem-solving achievement of disadvantaged high school students. The study emphasizes the significance of strategy instruction. Al Shabibi and Alkharusi (2018) examined the relationship between meta-cognitive skills and problem-solving skills of 5th-grade students. They found that students with high academic achievement also had high problem solving and meta-cognitive skills. Pohan et al. (2020) found that problem-based learning had a positive effect on learning motivation and problem-solving skills of 5th-grade students. Habtamu et al. (2022) found that collaborative problem solving positively affected 9th-grade students' motivation to learn algebra. In general, although there is more evidence of a positive relationship between mathematics motivation and problem-solving skills, some studies do not support this relationship. In addition, it is seen that other variables are also effective on mathematics achievement and problem-solving skills. The above research results point to strategy use, metacognitive awareness and active learning environments rather than calculation for the development of problem-solving skills. It would be beneficial to include these elements in educational practices to increase mathematics achievement and strengthen mathematical thinking skills. Walle, Karp, and Bay-Williams (2021) state that problem solving is the heart of mathematics. Therefore, increasing mathematics achievement should be considered together with improving mathematics problem-solving skills. When this situation is evaluated together with the above studies pointing to the role of mathematics motivation in mathematics achievement, it shows that the relationship between mathematics motivation and mathematics problem-solving skills is an important issue that needs to be investigated.

Although many studies investigate the effect of mathematics motivation on mathematics achievement, it is observed that the number of studies in which this relationship is addressed especially at the primary school level and in the context of problem-solving skills is limited.

The main purpose of this study is to investigate in depth the relationship between mathematics motivation and mathematics problem-solving skills of 4th-grade primary school students. This study focuses on two main research questions: (1) Is there a significant relationship between mathematics motivation and problem-solving skills of 4th-grade primary school students? and (2) Does mathematics motivation significantly predict students' problem-solving skills? To answer these questions, a quantitative research method was adopted, and various analyses were conducted within the scope of this study.

Firstly, students' mathematics motivation and problem-solving levels were analyzed using descriptive statistics. Then, whether these variables differed in terms of demographic variables, such as teacher change status and parental education level were analyzed using parametric or non-parametric tests. Thus, the possible effects of demographic factors on motivation and problem-solving skills were analyzed

Finally, correlation analysis was used to determine the direction and strength of the relationship between mathematics motivation and problem-solving skills. Regression analysis was used to determine the predictive power of motivation on problem-solving skills. These analyses aim to provide more detailed information about the nature of the relationship between the two variables by revealing the magnitude and direction of the effect of motivation on problem-solving skills.

METHOD

In this section, the research model, population and sample, data collection tools and statistical analysis methods are discussed in detail.

Research Model

This study aimed to examine the relationship between mathematics motivation and mathematics problem-solving skills of 4th-grade primary school students. This study, which was conducted using the survey model, one of the quantitative research designs, according to Creswell (2014), the survey model allows for the quantitative description of the tendencies, attitudes or opinions in the general population through a sample selected from a population.

In this context, this study examined whether students' mathematics motivation levels and mathematics problem-solving skills differed in terms of demographic characteristics and the relationship between them, and the relationship between these variables was analyzed with the relational screening model.

Universe and Sample

The study population of this research included 4th-grade students in Kahramanmaraş province. The sample consisted of 429 primary school 4th-grade students studying in public schools in Onikişubat district of Kahramanmaraş province in the 2023-2024 academic year who did not participate in the achievement test development process. Sample selection was carried out by convenient sampling method, which is one of the non-random sampling methods. As emphasized by Gurbetoğlu (2018), convenience sampling method requires the selection of easily accessible units due to labour, cost and time constraints. In this study, convenience sampling method was preferred due to these limitations. The distribution of the population and sample group of this study is given in Table 1.

Table 1. Distribution of demographic characteristics of the participants.

Variables	n	%
Mother Education Level		
Primary School	87	20.28
Middle School	64	14.92
High School	133	31.00
University and Above	96	22.38
Unspecified	49	11.42
Father Education Level		
Primary School	46	10.72
Middle School	54	12.59
High School	151	35.20
University and Above	153	35.66
Unspecified	25	5.83
Teacher Replacement Status		
Did not change	260	60.61
Two Teachers	123	28.67
Three Teachers and More	46	10.72

Table 1 shows the distribution of demographic characteristics of the participants. There were 429 participants in total. When the education level of the mothers of the participants was analyzed, the rate of mothers who were high school graduates was the highest with 31%. This is followed by university and above graduates 22.38%, primary school graduates 20.28%, secondary school graduates 14.92% and those whose educational status could not be reached 11.42%. When the education level of the fathers was analyzed, the proportions of high school graduates and university and above graduates were almost the same. These were followed by secondary school graduates (12.59%), primary school graduates (10.72%) and those whose educational status could not be reached (5.83%). Finally, in terms of changing teachers, 60.61% of the participants did not change teachers. While the rate of those who changed two teachers was 28.67%, the rate of those who changed three or more teachers was 10.72%.

Data Collection Tools

Three data collection tools were used in this study.

- Demographic Information Form
- Maths Problem-solving achievement Test
- Mathematics Motivation Scale (Tahiroğlu & Çakır, 2014)

The Demographic Information Form prepared by the researcher includes variables, such as the educational level of the parents of the students in the study group and the status of changing teachers.

The Mathematics Problem-solving achievement Test was developed by the researcher and consists of 37 items. The test items were determined based on the learning outcomes of the Numbers and Operations learning area in the Ministry of National Education (2018) Primary Mathematics Programme. Within the scope of the test, gains related to the sub-learning areas of Natural Numbers, Four Operations in Natural Numbers and Fractions were measured with multiple-choice questions. An outcome-oriented specification table was created, and the test was prepared so that each outcome had at least two questions. The test was examined by two experts in classroom and mathematics education, two classroom teachers each with 20 years of professional experience, and one measurement and evaluation specialist. Revisions were implemented in accordance with their expert recommendations.

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The pilot application of the test was carried out with 36 4th-grade students in the 2023-2024 academic year. Then, the 64-question test was applied to 317 4th grade students in Onikişubat district of Kahramanmaraş province, but 4 students could not be included in the test process for various reasons. The data were analyzed using SPSS statistical software and item strength and discrimination indices were calculated and shown in Table 2.

Table 2. Item difficulty index and item discrimination power index values of trial mathematics problem solving achievement test.

Question Numbers	Item Difficulty Index (Pj)	Item Discrimination Power Index (rjx)
1	.78	.32
2	.82	.27
3	.77	.36
4	.51	.44
5	.31	.40
6	.75	.30
7	.89	.35
8	.88	.46
9	.86	.41
10	.53	.56
11	.72	.50
12	.50	.43
13	.64	.48
14	.71	.51
15	.76	.50
16	.57	.63
17	.62	.57
18	.75	.56
19	.78	.51
20	.51	.54
21	.72	.52
22	.69	.52
23	.54	.54
24	.75	.54
25	.72	.54
26	.44	.36
27	.57	.55
28	.55	.56
29	.54	.62
30	.48	.49
31	.53	.58
32	.55	.53
33	.39	.33
34	.73	.48
35	.90	.35
36	.46	.40
37	.28	.30
38	.55	.50
39	.33	.39
40	.58	.49
41	.50	.52
42	.56	.45
43	.33	.35
44	.42	.21
45	.32	.32
46	.40	.44
47	.53	.57
48	.49	.57
49	.38	.45
50	.31	.44
51	.42	.49
52	.43	.44

Table 2 (Continued). Item difficulty index and item discrimination power index values of trial mathematics problem solving achievement test.

Question Numbers	Item Difficulty Index (Pj)	Item Discrimination Power Index (rjx)
53	.27	.32
54	.24	.27
55	.21	.11
56	.21	.09
57	.28	.04
58	.29	.13
59	.29	.31
60	.31	.37
61	.26	.39
62	.33	.36
63	.23	.08
64	.18	.36

While determining the final achievement test, item strength indices and discrimination values were considered and 37 of 64 items were included in the final test. Of the 37 questions in the final test, 19 were routine problems and 18 were non-routine problems, and the correct answers given by the students were evaluated as 1 point and the wrong answers were evaluated as 0 points. The KR-20 reliability coefficient of the test was .91.

In addition, the Mathematics Course Motivation Scale was developed by Tahiroğlu and Çakır (2014) and used with permission. The scale, which consists of five sub-dimensions (Motivation for Being Appreciated; Motivation for Interests, Wants and Needs; Motivation for Developing Self-confidence; Motivation for Being Successful; Motivation for Goals) and is graded with a five- point Likert type, contains 32 items, and the range of points that can be obtained from the scale is between 32 and 160. While the Cronbach Alpha reliability coefficient of the related scale was .93, it was calculated as .91 in this study.

Data Collection

The data collection process was conducted in accordance with ethical rules and scientific methods. Firstly, permission was obtained from the developers of the scale used via e-mail, and then ethics committee approval was obtained from the authorised institution. In addition, official processes were completed by obtaining the necessary permissions from Kahramanmaraş Provincial Directorate of National Education.

The researcher interviewed school administrators and fourth grade teachers and informed them about the purpose and process of this study. The data collection process was carried out in the second semester of the 2023-2024 academic year. The application, each stage of which was carried out by the researcher, was completed during two 40-minute lesson hours in each class. This time was determined especially considering the fact that the maths problem-solving achievement test takes more time and it was sufficient in all classes where data were collected.

Data Analysis

The research data analyzed with the SPSS programme were examined whether the mathematics problem-solving achievement test scores and mathematics motivation scores were normally distributed in the subgroups of demographic variables. Accordingly, the skewness and kurtosis values of the dependent variables in each subgroup of the independent variables were determined. These values are presented in Table 3.

Table 3. Normality analyses of mathematics problem solving achievement scores.

	Problem Solving		Motivation	
	Skewness	**Kurtosis**	**Skewness**	**Kurtosis**
Mother Education Level				
Primary School	.369	-.790	-1.161	2.376
Middle School	.649	-.201	-1.253	2.327
High School	1.002	.477	-1.061	1.787
University and Above	.033	-1.055	-1.037	2.131
Unspecified	.699	.105	-1.487	4.141
Father Education Level				
Primary School	.627	-.205	-.922	.613
Middle School	.741	-.417	-.991	1.421
High School	.785	.136	-1.404	3.240
University and Above	.235	-1.033	-.949	1.168
Unspecified	.216	-.034	-.050	-1.011
Teacher Replacement Status				
Did not change	.573	-.521	-1.171	2.456
Two Teachers	.682	-.453	-1.304	2.103
Three Teachers and More	.554	-.369	-.353	-.819

As shown in Table 3, it was seen that the kurtosis and skewness values of the Maths problem-solving achievement test were in the range of +2-(-2) in all subgroups of demographic variables. According to the normal distribution criteria stated by George and Mallery (2010), this shows that the data are normally distributed. Therefore, it was deemed appropriate to use parametric tests in the analyses related to the mathematics problem-solving achievement test. In the same table, when the kurtosis and skewness values of the motivation scores were analyzed, it was found that at least one of the subgroups of the demographic variables had skewness and/or kurtosis values outside the +2-(-2) range. This situation indicates that motivation scores do not show normal distribution in at least one subgroup. Therefore, non-parametric tests were used in the analyses related to the motivation test. In the mathematics motivation scale scores where normal distribution was not provided, extreme values were determined by Boxplot graph for simple linear regression analysis. In the graph, seven outliers were below the lower limit line and these values were removed from the analysis and normal distribution was ensured. The presence of linearity between the variables, which is another assumption of simple linear regression analysis, was checked with the scatter diagram, and it was seen that there was a linear relationship between the variables. In addition, Levene's test was checked for the assumption of homogeneity of variances, and it was seen that the variances were homogeneous ($p \geq .05$).

Based on the assumption that the score ranges in the mathematics motivation scale were equal, arithmetic averages were calculated, and the results are presented in Table 4. Accordingly, the motivation scores of the participants were categorized as "Very Low, Low, Medium, High and Very High. "

Table 4. Evaluation range of arithmetic averages.

December	Option	Motivation Level
1.00-1.80	Completely Disagree	Very low
1.81-2.60	Disagree	Low
2.61-3.40	Moderately Agree	Centre
3.41-4.20	I agree	High
4.21-5.00	Completely Agree	Very High

Mathematics achievement test scores were graded based on the frequently asked questions guide prepared on the basis of the Ministry of National Education Measurement and Evaluation Regulation published in the official gazette dated 09.09.2023 and numbered 32304 and published by the Ministry of National Education (MoNE) (2023) and these grades are given in Table 5.

Table 5. Grades of achievement tests scores.

December	Option
0-54	Should be improved
55-70	Adequate
71-84	Good
85-100	Very good

In this study, the correlation analysis conducted to determine the relationship between the variables was evaluated according to the interpretation criteria suggested by Büyüköztürk (2012) and given in Table 6.

Table 6. Correlation analysis correlation coefficients and level.

Correlation coefficient	Relationship level
0- .30	Low
.31- .70	Centre
.71- .89	High
.90-1.00	Very high

As seen in Table 6, the relationship levels between the variables analysed were evaluated as "Low, Medium, High and Very High."

RESULTS

In this section, the findings showing the mathematics motivation and mathematics problem solving skill levels of 4th-grade primary school students, the differentiation of these two variables according to teacher change and parental education level, and the level of relationship between each other are presented.

Findings on mathematics motivation levels and mathematics problem-solving levels of 4th-grade primary school students

Information about students' mathematics motivation levels and mathematics problem-solving achievement scores are given in Table 7 respectively.

Table 7. Students' mathematics motivation levels and mathematics problem solving achievement scores.

	n	Mean	Dtd.Dev.	Min. Value	Max. Value
Maths Motivation	429	3.8770	.525	1.4375	4.8125
Maths Problem Solving Achievement Score	429	46.70	20.81	8.11	100

As presented in Table 7, it was seen that students' mathematics motivation levels are at the level of "high" (X= 3,8770), while their achievement scores for solving mathematical problems are at the level of "should be improved" (X= 46,70). Accordingly, it can be said that although students' mathematics motivation was high, their achievement scores in solving mathematical problems were low. This situation can be interpreted as an indication that maths problem-solving skills are affected by different variables besides motivation.

Findings of 4th-grade primary school students' mathematics motivation and mathematics problem-solving achievement scores related to teacher change status

The findings of mathematics motivation and mathematics problem-solving achievement scores related to teacher change status are given in Table 8 and Table 9, respectively.

Table 8. Kruskal Wallis H test result of mathematics motivation for teacher change status.

	Teacher Replacement Status	n	Rank Mean.	df	X^2	p
Maths Motivation	Did not change	260	208.23	2	2.089	.352
	Two Teachers	123	227.44			
	Three Teachers and More	46	220.00			

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Kruskal-Wallis H Test was applied to determine whether mathematics motivation differed significantly according to the students' teacher change. As a result of the test, it was found that there was no significant difference between the groups (X^2 (df = 2, n = 429) = 2.089; p ≥ .05). Accordingly, it can be said that students' mathematics motivation does not differ significantly according to the number of teacher changes.

Table 9. One-Way Analysis of Variance (One-Way ANOVA) test results of mathematics problem solving achievement scores for teacher change status.

	Teacher Replacement Status	n	Mean	Std.Dev.	df	F	p	Significant Difference
Maths Problem Solving Achievement Score	Did not change	260	47.88	20.36	2/426	1.24	.288	-
	Two Teachers	123	45.48	21.65				
	Three Teachers and More	46	43.30	20.92				

One-factor analysis of variance was performed to determine the differentiation of students' mathematics problem-solving achievement scores according to teacher change status. As a result of the test, it was found that the difference between the group means was not significant ($F_{2/426}$=1.249; p≥.05). Accordingly, it can be said that students' mathematics problem-solving achievement scores do not differ significantly according to the status of changing teachers.

The findings of 4th-grade primary school students' mathematics motivation and mathematics problem-solving achievement scores related to their parents' education levels

The findings related to the change in mathematics motivation according to mother and father's education level are given in Table 10.

Table 10. Kruskal Wallis H test results of mathematics motivation related to mother and father education level.

	Education Level	n	Rank Mean.	df	X^2	p	Significant Difference
Mum	Primary School (A)	87	216.59	4	4.4818	.344	-
	Middle School (B)	64	202.34				
	High School (C)	133	204.35				
	University and Above (D)	96	236.22				
	Unspecified (E)	49	216.04				
Father	Primary School (A)	46	245.03	4	14.550	.006	
	Middle School (B)	54	173.76				D-B; A-B
	High School (C)	151	201.78				
	University and Above (D)	153	235.08				
	Unspecified (E)	25	205.80				

A: Primary school; B: Secondary School; C: High School; D: University and Above; E: Unspecified

The relationship between mathematics motivation and parental education level was analysed using the Kruskal-Wallis H Test. As a result of the test, it was observed that there was no significant difference between the groups in maternal education levels (X^2 (df = 4, n = 429) = 4.481; p≥.05), while there was a significant difference between the groups in father education levels X^2 (df = 4, n = 429) = 14.550; p≤.05). As a result of the pairwise comparison test, a significant difference was found when the mean ranks were compared between secondary school graduates and primary school graduates and between secondary school graduates and university and above graduates. This significant difference was in favour of fathers with primary school graduation - university and above graduation.

The findings regarding whether the mathematics problem-solving achievement scores of the students differed according to their mother and father's education level are given in Table 11.

Table 11. One-factor analysis of variance (One-Way ANOVA) test results of students' mathematics problem-solving achievement scores related to mother and father education level.

	Education Level	n	Mean	Std.Dev.	df	F	p	Significant Difference
Mum	Primary School	87	49.45	20.70	4/183.14	7.23	.000	A-C; D-B D-C; D-E
	Middle School	64	43.91	17.07				
	High School	133	40.80	19.56				
	University and Above	96	55.65	23.81				
	Unspecified	49	43.96	15.74				
Father	Primary School	46	46.35	19.08	4/109.55	8.16	.000	D-C
	Middle School	54	45.24	19.64				
	High School	151	40.52	17.96				
	University and Above	153	53.98	22.81				
	Not specified	25	43.35	16.74				

A: Primary school; B: Secondary School; C: High School; D: University and Above; E: Unspecified

One-factor analysis of variance was applied to determine the differentiation of students' mathematics problem-solving achievement scores according to their mother and father education level. As a result of the analysis, it was seen that there was no homogeneity of variance (p≤.05). Thus, the Welch test was applied, and it was found that the difference between group averages was significant ($F_{4/183,14}$=7.239; p≤.05). According to this, it can be said that the mathematics problem-solving achievement scores of the students differed according to the level of mother and father education. According to the results of the Games-Howell test, according to the results of maternal education level, a significant difference was found between mothers with primary school graduation and mothers with high school graduation in favour of mothers with primary school graduation, between mothers with university and above graduation and mothers with secondary school and high school graduation in favour of mothers with university and above graduation. According to the father's education level results, a significant difference was found between the university and above graduates and high school graduates in favour of the university and above graduates.

The relationship between mathematics motivation and mathematics problem-solving skills

Spearman Correlation Analysis was performed to determine the relationship between students' mathematics motivation and their mathematics problem-solving achievement scores. The findings related to the analysis are given in Table 12.

Table 12. The relationship between mathematics motivation and mathematics problem solving achievement scores.

		Maths Problem Solving Achievement Score
Maths Motivation	Spearman's rho	.256*
	p	.000
	n	429

* Correlation is significant at p ≤ .05 level.

Spearman Correlation Analysis was applied to determine the relationship between mathematics motivation and mathematics problem-solving achievement scores. As a result of the analysis, a positive, weak (r=.256), significant (p≤.05) relationship was found. Accordingly, students' mathematics motivation and mathematics problem-solving achievement scores increase significantly together with a weak relationship. This relationship is shown in Figure 1

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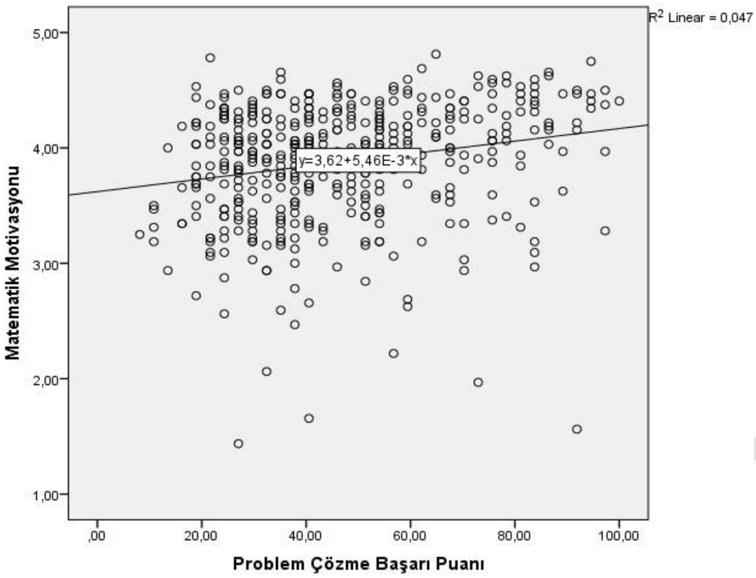

Figure 1. Maths problem solving achievement score

Mathematics motivation is a significant predictor of mathematics problem-solving skills

The results of the simple linear regression analysis for the prediction of students' mathematics problem-solving achievement scores are given in Table 13.

Table 13. Results of simple linear regression analysis for the prediction of mathematics problem solving achievement scores.

	B	Standard Error	Beta	t	p
Fixed	-.634	8.327		-.076	.939
Maths Motivation	12.090	2.115	.269	5.715	.000

Dependent Variable: Achievement Score in Solving Mathematics Problems

As seen in Table 13, as a result of simple linear regression analysis, it was found that mathematics motivation had a low level positive significant relationship with mathematics problem-solving achievement score (r=.26; r^2=.07; p≤.05). While this relationship is statistically significant, its practical effect size is limited. The increase in the maths problem-solving achievement score was explained by a factor that accounted for 7% of the variation in the data.

DISCUSSION, CONCLUSION, and RECOMMENDATIONS

This study aimed to examine the relationship between mathematics motivation and mathematics problem-solving skills among fourth-grade primary school students. In this context, the Mathematics Course Motivation Scale developed by Tahiroğlu and Çakır (2014) was applied and the Mathematics Problem-solving Achievement Test developed by the researcher was used. The findings are discussed below.

Results related to mathematics motivation levels

The findings of this study showed that the mathematics motivation of fourth-grade primary school students was at a high level. Students with high motivation are expected to show interest in the lesson and make an effort to be successful. Similarly, in studies conducted by Senemoğlu (2007), Bozkurt and Bircan (2015), Kılıç (2022) and Süren (2019), it was stated that high motivation level has a positive effect on student achievement. However, another study conducted by Külünk Akyurt (2019), concluded that students' mathematics motivation was at a medium level. Despite this variety of variables, it can be considered a positive situation that students' mathematics motivation was high in the study.

Results related to maths problem solving levels

According to the findings of this study, it was determined that the mathematics problem-solving scores of fourth-grade primary school students were at the level of "Should be improved". Accordingly, it can be said that students' achievement scores in solving mathematical problems are low. In support of this study, Artut and Tarım (2006) also concluded that the achievement level of secondary school students in non-routine problems was low. However, Al Shabibi and Alkharusi (2018) concluded that students' problem-solving skills were high. Low problem-solving skills can be explained by factors such as students not having sufficient problem-solving experience or not using problem solving strategies sufficiently.

It is a noteworthy finding that while students exhibit a high level of motivation in mathematics, their success in problem-solving is limited. This finding is consistent with the PISA 2018 and 2022 results, which revealed that even students with high mathematics achievement demonstrated lower than expected performance in problem-solving and application skills (OECD, 2012; 2015). Devetter and Çalışkan's (2015) findings also indicate that students who exhibit high levels of mathematics motivation may nevertheless demonstrate deficiencies in their conceptual understanding and problem-solving strategies. Abin et al. (2020) also found that motivational and affective variables did not play a significant role in mathematics achievement. The extant literature suggests that high motivation is important for successful outcomes, but additional factors such as conceptual depth and strategy development are more decisive in problem-solving skills. It can be concluded that mathematics motivation alone is insufficient for problem-solving success.

Results of mathematics motivation and mathematics problem-solving skills on students' change of teacher

The results of this study showed that mathematics motivation and mathematics problem-solving achievement scores of fourth-grade primary school students did not differ significantly according to their teacher change status. This finding reveals that the mathematics motivation and mathematics problem-solving skills of the students who changed teachers for different reasons in primary school were not affected by this situation. It is possible that this phenomenon may be attributable to the presence of other variables that exert an influence on mathematics motivation and mathematics problem-solving skills. Such variables may include high teacher morale and the establishment of a positive school culture and classroom climate.

Results related to the investigation of mathematics motivation according to students' mother and father education levels

The results of this study revealed that the mathematics motivation of fourth-grade primary school students did not differ significantly according to their mother's education level. This finding shows that the level of maternal education is not a determining factor in the mathematics motivation of primary school 4th grade students. The studies of Demir and Arıcı (2013), Kara and Özkaya (2022) and Külünk Akyurt (2019) also support this result. However, there are also studies in the literature that reach different results. In his study, Akdemir (2006) determined that the achievement motivation scores of students whose mothers graduated from primary school were higher than the scores of students whose mothers graduated from 4-year faculties. Özdemir (2021) found that the mathematics motivation of students whose mothers graduated from secondary school was lower than that of students whose mothers were illiterate and graduated from primary school. Karaman and Mutluer (2023) found that the mathematics identified extrinsic motivation levels of students whose mothers were illiterate, primary school graduates or only literate were significantly higher than those of students whose mothers were secondary school graduates.

On the other hand, it was found that students' mathematics motivation differed significantly according to their father's education level. It was determined that students whose fathers graduated from primary school had higher mathematics motivation than students whose fathers graduated from secondary school and students whose fathers graduated from university and above had higher mathematics motivation than students whose fathers graduated from secondary school. This result shows that fathers with both low education level (primary school) and high education level (university and above) are more effective in supporting their children's mathematics motivation. The possible reasons for this result may be that fathers who graduated from primary school want their children to receive more education than themselves and therefore support them more, while fathers who graduated from university are aware of the importance of the education they receive and motivate their children with this awareness. Similarly, in the study conducted by Yerlikaya (2014), it was found that mathematics motivation differed significantly according to the level of father education. However, there are also studies in the literature showing that father's education level has no significant effect on student motivation (Akdemir, 2006; Demir & Arı, 2013; Kara & Özkaya, 2022; Karaman & Mutluer, 2023; Külünk Akyurt, 2019; Özdemir, 2021). These different results may be due to the socio-cultural characteristics of the regions where the studies were conducted, the differences in the research groups or the diversity of the measurement tools used.

Results related to the investigation of mathematics problem-solving skills according to students' mother and father education levels

According to the research findings, it was concluded that the mathematics problem-solving achievement scores of fourth-grade primary school students differed significantly according to the level of mother's education. This significant difference was in favour of mothers who graduated from primary school and mothers who graduated from high school in favour of mothers who graduated from primary school, and in favour of mothers who graduated from university and above in favour of mothers who graduated from university and above in favour of mothers who graduated from secondary school and high school. This shows that the mathematics problem-solving achievement scores of the students whose mothers have primary school or university, and above graduation are significantly higher than the others. The findings of the study support the findings of Dursun and Dede (2004), Külünk Akyurt (2019) and Yenilmez and Duman (2008). It is hypothesised that the mathematical problem-solving achievements of students whose mothers have attained a university education are likely to be elevated. However, the finding that the mathematics problem-solving achievements of students whose mothers graduated from primary school are significantly higher than those whose mothers graduated from high school is unexpected. This phenomenon can be attributed to a variety of factors, including psychosocial elements such as the endeavours of mothers who have completed primary education to redress the limitations imposed by their own educational attainment through the accomplishments of their offspring.

According to the research findings, it was concluded that the mathematics problem-solving achievement scores of fourth-grade primary school students differed significantly according to their father's education level. Accordingly, it was determined that students whose fathers were university and above graduates were significantly more successful in solving mathematical problems than students whose fathers were high school graduates. This may be due to the fact that fathers with university and higher education are more likely to be able to guide students more accurately in solving mathematical problems. The findings of the study overlap with the findings of Külünk Akyurt (2019) and Yenilmez and Duman (2008).

Results on the relationship between students' mathematics motivation and mathematics problem-solving skills

When the relationship between mathematics motivation and mathematics problem-solving skills was examined, a positive, significance but weak was found. This finding shows that mathematics motivation cannot fully explain students' ability to solve mathematical problems, the level of effect is low but it can be effective at a certain level. Kesici (2018) also reported a significant relationship between mathematics motivation and achievement.

Results related to the question of whether students' mathematics motivation is a significant predictor of mathematics problem-solving skills

Finally, according to the results of the regression analysis, mathematics motivation was a significant predictor of mathematics problem-solving achievement. However, considering that motivation explained only 7% of the variance in problem-solving achievement, other variables affecting problem-solving achievement should be examined.

Recommendations

Recommendations for researchers

In this study, mathematics problem solving skill levels should be improved, i.e. they were low. In further studies, the reasons for the low scores observed in students' mathematics problem-solving skills can be investigated.

This study found that mathematics problem-solving achievement scores differed significantly according to father and mother education variables. To better understand these effects, qualitative studies involving both mothers and fathers as participants are recommended.

This study found a weak but positive relationship between mathematics motivation and problem-solving skills. Further research could examine this relationship across different student samples.

Recommendations for teachers

In this study, it was concluded that students' success in solving mathematical problems was at the level of ‘should be improved.’ Accordingly, teachers can be recommended to use different strategies, methods and techniques that can improve these skills of students.

As a result of this research, a weak positive relationship was found between students' mathematics motivation and their mathematics problem-solving achievement. Accordingly, it can be suggested to teachers that discourses and practices that will increase students' mathematics motivation will not be sufficient to increase their mathematics problem-solving success, and that they should consider other variables that will increase their mathematics problem-solving success.

Ethics and Conflict of Interest

The permission was obtained from the Ethics Committee of Kahramanmaraş Sütçü İmam University with the letter dated 11.11.2022 and numbered 172202. The authors declare that they have no conflict of interest. This article was produced from the master's thesis conducted by the first author under the supervision of the second author.

Author Contribution

All authors contributed equally to the research.

Data availability

The data that support the findings of this study are available on request from the corresponding author.

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PRE-SCHOOL TEACHERS' OPINIONS ON THE USE OF OUT-OF-SCHOOL LEARNING ENVIRONMENTS IN THE MATHEMATICS TEACHING

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Abstract

This research was conducted to examine the views of preschool teachers regarding out-of-school learning environments for mathematics activities and their usage of these environments. The research was conducted out using a phenomenological design, one of the qualitative research methods. The study group consisted of 42 preschool teachers working in preschool education institutions affiliated with the Ministry of National Education, determined on a voluntary basis. The research data were collected through a semi-structured interview form created by the researchers. The analysis of the obtained data was done by content analysis method. The research results revealed that preschool teachers have sufficient knowledge about out-of-school learning environments where mathematics activities can be implemented and that they use various out-of-school learning environments. The preschool teachers participating in the research stated that they found out-of-school learning environments beneficial for math activities but faced various difficulties during the implementation process. Positive teacher opinions were found regarding out-of-school learning environments increasing children's interest in mathematics and developing their problem-solving skills. It was revealed that teachers use these environments most often for reasons such as connecting with daily life (making it concrete), learning by doing and experiencing, permanent learning, and being engaging.

Keywords: Preschool, mathematics, activity, out-of-school learning.

INTRODUCTION

The preschool period is a critical time for children, marked by accelerated cognitive, linguistic, social, and emotional development, alongside intense brain development. Children exhibit a natural inclination towards learning during this stage, and the skills they acquire during this time serve as the foundation for their future academic success and lifelong learning (Magnuson et al., 2004). High-quality preschool education programs are instrumental in fostering children's creativity, problem-solving skills, and critical thinking abilities, while simultaneously supporting their social and emotional development (Barnett, 2008; Yoshikawa et al., 2013). Therefore, investments in preschool education hold immense significance for the future of individuals and societies. Creating a stimulating environment rich in learning opportunities that cater to all developmental domains is crucial for nurturing a positive attitude towards learning in children (Yazlık & Öngören, 2018). Mathematics activities are a key component of preschool education programs, supporting all developmental areas, especially cognitive development. In early childhood, these activities not only bolster cognitive growth but also cultivate essential skills such as problem-solving, analytical thinking, and number sense. Research on number and counting skills demonstrates that the mathematical foundations laid during these formative years pave the way for understanding more complex mathematical concepts later on (Oktay & Unutkan, 2003). Furthermore, mathematics activities are known to enhance children's learning motivation and facilitate easier comprehension of mathematical concepts. For instance, play-based mathematics activities provide valuable opportunities for developing both academic and daily life skills. The diversity of methods employed by teachers in mathematics activities plays a vital role in structuring children's mathematical thinking. Therefore, collaboration between teachers and curriculum developers in developing research-based and practical activities is essential for effective preschool education (Björklund et al., 2020). Play-based mathematics activities, in particular, are highly effective in supporting children's understanding of key mathematical concepts and developing their problem-solving skills (Ginsburg & Golbeck, 2004). Research on early mathematical thinking and learning highlights the important role teachers play in supporting children's mathematical development (Björklund et al., 2020). In this context, it is imperative for teachers to employ effective strategies in mathematics instruction and support the development of children's mathematical thinking skills (Ginsburg & Golbeck, 2004).

Teachers enrich learning environments in preschools by assessing children's mathematical knowledge and skills and utilizing appropriate methods and techniques in their activities. Creating a classroom environment and selecting materials that encourage exploration and hands-on experiences is crucial in this process (Clements & Sarama, 2020). Children should be exposed to a wide range of methods and materials and provided with ample opportunities for free exploration. Limiting mathematics activities to traditional methods can hinder children's interaction with the world around them and impede their understanding of concepts (Björklund et al., 2020). Therefore, teachers should not confine their mathematics activities to the classroom but also leverage out-of-school learning environments. Out-of-school learning environments are described as "Places where educational activities are carried out to enable students to discover the production, culture, art, and geographical capacity of their own regions in line with the subjects and achievements within the scope of education/training programs; to get to know plant and animal species, local characteristics, games, and folklore; and to learn by doing and experiencing as an integrated or extracurricular activity" (MoNE, 2019, p.4).

Out-of-school learning environments are gaining increasing importance within the Turkish education system, particularly in the context of innovative practices. This is evident in the goals set by the Ministry of National Education (MoNE) in its 2023 Education Vision for both primary and secondary education levels. Following this vision, the MoNE prepared the "Out-of-School Learning Environments Guide." This guide aims to help teachers and students in preschool, primary, and secondary schools affiliated with the MoNE to more effectively utilize out-of-school learning environments such as museums, science centers, art centers, historical and cultural sites, libraries, natural protected areas and archaeological sites, technoparks, industrial facilities open to visitors, and universities, by linking them to educational programs. It also aims to familiarize them with these environments and contribute to students' learning by doing and experiencing (MoNE, 2019).

In out-of-school learning environments, students actively participate in activities involving real-life situations. Research indicates that natural environments offer unique opportunities for developing children's mathematical thinking skills (Björklund et al., 2020; Yıldız, 2022). Implementing math activities in out-of-school environments during preschool allows children to experience mathematical concepts in a more concrete and meaningful way. For example, observations made in a park or measurement and classification activities carried out in a garden facilitate children's acquisition of basic mathematical skills such as shape recognition, measurement, and comparison (Björklund et al., 2020; Yıldız, 2022). Moreover, out-of-school learning environments enable children to establish connections between mathematics and daily life, making learning more permanent (Kelton, 2015). For instance, having children count different types of leaves during a nature walk or asking questions related to symmetry and patterns during a museum visit deepens their mathematical understanding. Research also indicates that out-of-school learning environments have positive impacts on areas such as problem-solving, self-confidence development, and self-care skills, and that such experiences positively influence children's attitudes towards mathematics and help them better understand mathematical concepts (Yıldız, 2022). Extending math activities beyond the classroom increases children's learning motivation and allows them to connect mathematics with their surroundings in a more meaningful way (Buchholtz, 2023). Research shows that while teachers believe out-of-school learning activities are important in preschool education, teaching primarily takes place in classroom settings (Ernst, 2014; McClintic & Petty, 2015). Ernst (2014) noted that preschool teachers recognize the positive impacts of using natural outdoor spaces as learning environments on children's environmental awareness and problem-solving skills, but logistical obstacles, time constraints, and safety concerns limit the implementation of such activities. Similarly, McClintic and Petty (2015) state that while teachers believe outdoor play and out-of-school learning activities are essential for children's social and emotional development, they often prefer classroom activities due to planning and implementation challenges.

Similar findings have been observed in studies conducted in Turkey. While teachers express positive views regarding the importance of out-of-school learning environments in preschool education, it has been determined that children do not experience these environments frequently enough (Karakuş & Aktın, 2023; İnce & Akcanca, 2021). Yıldız (2022) found that preschool teachers use out-of-school learning environments less frequently due to insufficient financial resources and transportation options, difficulties in classroom management, unfavorable weather conditions, and lack of parental permission. Likewise, a study by Karakuş and Aktın (2023) indicated that teachers' frequency of using out-of-school learning environments is low, and the main reasons for this include lack of time, safety concerns, and the complexity of official procedures.

Despite this situation, there are limited studies in Turkey that examine teachers' views on the usage of out-of-school learning environments and identify the related problems (Ay, Anagün & Demir, 2015; Ocak & Korkmaz, 2018; Yazlık & Öngören, 2018; Dere & Çifçi, 2022; Yıldız, 2022; Ergin Aydoğdu, Aydoğdu & Aktaş, 2023). Moreover, although there are studies in national and international literature on preschool teachers' views and practices regarding the implementation of math activities (Thiel, 2010; Baki & Hacısalihoğlu Karadeniz, 2013; Pekince & Avcı, 2016; Koç, 2017; Orçan-Kaçan & Karayol, 2017; Hsieh & McCollum, 2018; Kılıç & Özcan, 2020; Tantekin Erden & Tonga, 2020; Li, 2021; Karakuş and Aktın, 2023; Ata Doğan & Akman, 2023), there is very limited research on the use of out-of-school learning environments in mathematics teaching. Recognizing the limited research in this area, the current study aims to make significant contributions to the field of preschool education. By systematically examining preschool teachers' views on the use of out-of-school learning environments in mathematics teaching, this research seeks to provide valuable insights. These insights can guide the design of more effective pedagogical approaches, enrich teacher training programs, and inform the development of curricula that better incorporate real-world contexts into early mathematics learning. Ultimately, understanding teachers' experiences and perspectives is crucial for fostering an educational environment where out-of-school settings are utilized more effectively and frequently to enhance young children's mathematical understanding and engagement, thereby strengthening the overall quality of preschool mathematics education. Therefore, this research aimed to investigate preschool teachers' views on their knowledge levels regarding out-of-school learning environments for math activities, their usage of these environments, and the challenges they encounter in using them. Within this scope, the research sub-problems are as follows:

1. What are the knowledge levels of preschool teachers regarding out-of-school learning environments for math activities?
2. What are the views of preschool teachers on the usage of out-of-school learning environments where math activities can be conducted?
3. What challenges do preschool teachers face while conducting math activities in out-of-school learning environments?

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METHOD

Research Model

In the study, since it was aimed to determine the views of preschool teachers on the out-of-school learning environments used in preschool education in terms of mathematics activities and the use of these environments, phenomenology (phenomenology) design, one of the qualitative research methods, was preferred. This method provides an in-depth examination to understand individuals' perceptions, feelings, and thoughts about a phenomenon (Creswell & Poth, 2018). In the phenomenological design, as a result of the interviews with the participants, their experiences about the phenomena emerge (Moustakas, 1994). These phenomena include events, situations, experiences, perceptions, orientations or concepts that participants encounter in daily life (Yıldırım & Şimşek, 2013).

Participants

The study group of the research consists of 42 preschool teachers who work in different institutions in various districts of Izmir, Türkiye Province and who voluntarily agreed to participate in the research. The participants were selected by the convenience sampling method, which is among the purposeful sampling techniques. Convenience sampling involves researchers working on a situation or sample by reaching the most accessible participants (Büyüköztürk et al., 2019). Twelve of the participants were male and 30 were female. In addition, the professional experience of the teachers participating in the study ranged between 5 years and 27 years.

Data Collection and Analysis

The data of the study were obtained through a semi-structured interview form consisting of 18 questions (10 questions measuring demographic features) prepared by the researchers to determine the views of preschool teachers on the out-of-school learning environments used in preschool education in terms of mathematics activities and the usage status of these environments. The interview form consists of three parts; the first part of the form includes demographic questions describing the personal characteristics of preschool teachers, the second part includes short-answer and open-ended questions prepared to determine the views of preschool teachers on the out-of-school learning environments used in mathematics activities and the use of these environments. In the third part of the form, there are questions about the difficulties that preschool teachers face in out-of-school learning environments. The prepared questions were presented to three expert researchers. As a result of the expert opinions, the number of questions was changed. Using the final version of the form, interviews were conducted with five teachers to check the comprehensibility of the questions. The questions that were not clearly understood through the pilot application were revised and semantic corrections were made. Thus, the interview form was finalized.

A semi-structured interview form was used to collect the data obtained in the study. The questions in the form were prepared by the researchers by reviewing the literature on out-of-school learning environments and the experiences of the researchers on this subject. There are 8 open-ended questions in the interview form and these questions are given below:

1. What are the out-of-school learning environments where mathematics activities can be carried out?
2. What are the characteristics of out-of-school learning environments where mathematics activities can be carried out? What do you think these environments contribute to students?
3. Do you use out-of-school learning environments in mathematics activities? If so, what are your reasons for using these environments?
4. What are the out-of-school learning environments you use in activities related to mathematics course? How often do you use out-of-school learning environments?
5. What kind of mathematics activities do you perform in out-of-school learning environments?
6. What can be done to make out-of-school learning environments more efficient in terms of mathematics activities?

7. What are the difficulties you encounter while performing mathematics activities in out-of-school learning environments?
8. What are your suggestions for solutions to these difficulties?

In the study, content analysis was used to determine teachers' views on out-of-school learning environments in terms of mathematics activities. The numerical values of the categories obtained in the analysis of the data are given in the tables, and in order to support the data, the answers given by the participants in the study were also included directly.

Teachers' opinions were given with direct quotations and the findings were interpreted. The aim is to present the findings to the reader in an organized and interpreted form and to increase the consistency of the research. After the end of the implementation process of the research, the interview recordings were listened to by the researchers and turned into a written document. Codes were created by two researchers using the common answers given by the teachers and the teacher responses were categorized according to these codes. For reliability, the coder reliability suggested by Miles and Huberman (1994) was examined. Accordingly, when the consensus correlation coefficient was calculated with the formula of (Consensus/(Consensus+Disagreement))×100, it was seen that the resulting value was 92.4%. The fact that this value is more than 80% indicates that reliable results were obtained. In this study, internal validity was ensured by making use of expert opinions at the stages of preparing the interview questions and analyzing the data. In addition, care was taken to ensure external validity by expressing the research design, data collection tools and data analysis process in a clear and understandable way. In order to protect ethical principles in the research, teachers were coded as T1, T2, ..., T42.

RESULTS

In this section, the findings obtained from preschool teachers' views on out-of-school learning environments in terms of mathematics activities are presented under sub-problems. The numerical values belonging to the categories obtained in the analysis of the data are given in the tables, and in order to support the data, the answers given by the participants in the research are also included directly.

Results related to the first sub-problem

The findings obtained from the interview questions related to the first sub-problem *"What are the knowledge levels of preschool teachers about out-of-school learning environments in terms of mathematics activities?"* are presented.

Preschool teachers were asked what out-of-school learning environments are and the distribution of the answers given is given in Table 1.

Table 1. Out-of-school learning environments.

Teacher Responses	f
School Playground	24
Playgrounds	20
Nature (Forest, Garden)	16
Mathematics Village	13
Everywhere Outside the Classroom	9
Museums	6
Science Centers	5
Ruins	3
Streets and Alleys	3
Library	2
Home	1
Courses	1

When Table 1 is examined, it is seen that the most frequently mentioned out-of-school learning environment for mathematics teaching is the school garden. Teachers also cited playgrounds, nature, mathematics village, outside the classroom, museums, and science centers as examples of out-of-school learning environments where they could carry out mathematics activities. The least frequently mentioned out-of-school learning environments were libraries, home environment and courses. This distribution suggests that teachers primarily associate out-of-school mathematics learning with immediately accessible and less formal outdoor spaces like school playgrounds and general playgrounds. The relatively high mention of 'Nature' and 'Mathematics Village' indicates an awareness of more structured or specialized environments, though their practical application might be less frequent compared to school-based outdoor areas. The lower frequencies for environments like libraries or homes might imply that teachers perceive these as either less directly applicable for formal math activities they would lead, or perhaps more within the realm of parental involvement rather than teacher-led excursions.

Teachers were then asked about the characteristics of effective out-of-school learning environments for teaching mathematics. Teachers' responses are given in Table 2.

Table 2. Characteristics of effective out-of-school learning environments for mathematics teaching according to teachers.

Teacher Responses	f
It Should Be Suitable for Learning Goals	19
It Should Be Safe	15
It Should Be Student-Centered	15
It Should Be Suitable for Learning by Gaming	13
It Should Be Suitable for the Age Group	5
It Should Be Attention-Grabbing	4
It Should Support Learning by Doing and Living	4
It Should Provide the Opportunity for Concretization	3
It Should Be Planned	2
It Should Be Suitable for the Use of Technology	2
It Should Be Economical	2

When Table 2 is examined, it is seen that the characteristics of effective out-of-school learning environments in terms of teaching mathematics are most frequently expressed by teachers as “appropriate to learning objectives”, “safe”, “student-centered” and “suitable for learning through gamification”. The least frequently expressed by teachers are “planned”, “suitable for technology use” and “economical”. The opinions of the teachers are given below:

T11: “… The environment that can be created should be equipped with mathematical materials appropriate for the children’s age, and the determined activities should be determined according to the children’s interests and needs…”

T24: “… It should be in line with the learning objectives, it should be planned, it should allow the child to concretize, it should be eye-catching…”

T41: “… It should be safe, it should allow children to learn by playing. It should be student-centered…” These findings indicate that teachers prioritize pedagogical alignment, safety, and child-centric approaches when considering the effectiveness of out-of-school environments. The strong emphasis on 'learning goals' and 'student-centered' learning, coupled with 'safety' and 'gaming,' reflects a modern understanding of early childhood pedagogy. The lower frequency of 'planned' might suggest a preference for flexibility within these less structured settings, or perhaps it reflects the perceived difficulty in detailed pre-planning for such environments. Similarly, 'economical' being less emphasized could imply that while a practical concern, it's not seen as a primary determinant of effectiveness compared to pedagogical suitability and safety.

Then, the teachers were asked about the contributions of out-of-school learning environments to children for teaching mathematics, and the distribution of the answers given is in Table 3.

Table 3. Contributions of preferred out-of-school learning environments for teaching mathematics to students according to teachers.

Teacher Responses	f
Concrete Experience	19
Problem Solving Skills	15
Establishing Cause-Effect Relationships	15
Developing a Positive Attitude Towards Mathematics	13
Questioning Skills	5
Creative Thinking Skills	4
Permanent Learning	4
Communication Skills	3
Research-Analysis Skills	2
Acquiring Motor Skills	2
Self-Confidence Development	2

Some of the teachers' opinions on the contributions of effective out-of-school learning environments for teaching mathematics to students are as follows:

T20: "…It definitely provides students with concrete experiences, and students' problem-solving skills increase. I also think it will make them like mathematics more…"

T33: "…I think it supports children's ability to establish cause-effect relationships, creative thinking and questioning skills…"

T2: "…It reinforces permanent learning because it attracts their attention more than the classroom environment. It allows students to work in communication with each other…"

The data in Table 3 clearly demonstrate that teachers perceive significant cognitive and affective benefits from using out-of-school environments for mathematics. The high emphasis on 'Concrete Experience' underscores the value teachers place on making abstract mathematical concepts tangible for young learners. Furthermore, the strong association with developing 'Problem Solving Skills,' 'Establishing Cause-Effect Relationships,' and fostering a 'Positive Attitude Towards Mathematics' suggests that teachers view these environments as catalysts for deeper conceptual understanding and positive engagement with the subject, going beyond mere content delivery.

Results related the second sub-problem

The findings obtained from the interview questions regarding the second sub-problem, *"What are the views of preschool teachers on the use of out-of-school learning environments where mathematical activities can be carried out?"* are presented in tables in this section. First, the teachers were asked whether they used out-of-school learning environments for mathematical activities and the distribution of the answers given is presented in Table 4.

Table 4. Teachers' use of out-of-school learning environments in mathematics activities.

Teacher Responses	f
Yes, I use it	32
No, I don't use it	10

As seen in Table 4, the majority of teachers stated that they used out-of-school learning environments in mathematics activities. Some of the teachers' opinions are as follows:

T8: "*…I use it as much as it is economical and safe because I know its benefits for students…*"

T37: "*…I don't use it outside of the schoolyard. Dealing with the procedures is tiring…*"

Then, teachers were asked about their reasons for using out-of-school learning environments for mathematics activities. These teachers' opinions are given in Table 5.

Table 5. Reasons for teachers to use out-of-school learning environments in mathematics activities.

Teacher Responses	f
Relating to Daily Life (Concretization)	17
Contributing to the Problem Solving Process	15
Making Teaching Fun	13
Increasing Interest and Motivation in the Course	8
Permanent Learning	5

Some of the teachers' opinions regarding the reasons for using out-of-school learning environments are as follows:

T4: *"…Students learn better outside of school. I think learning is permanent. Students' interest is quite high…"*

T28: *"…It allows the lesson to be associated with daily life. Students solve the problem being worked on more easily…"*

The reasons cited by teachers for using these environments, as shown in Table 5, align closely with established principles of effective early childhood education. The emphasis on 'Relating to Daily Life' and 'Concretization' reinforces the desire to make mathematics relevant and understandable. The focus on 'Problem Solving' and 'Making Teaching Fun' indicates that teachers utilize these settings not just for content delivery but also to foster critical thinking and enhance student engagement and motivation, which are crucial for sustained learning.
Then, teachers were asked which out-of-school settings they use for math activities. The results are shown in Table 6.

Table 6. Out-of-school learning environments used by teachers for mathematics activities.

Teacher Responses	f
School Playground	18
Nature (Forest, park)	12
Library	8
Science Center	4
Museums	2
Ruins	2

Some of the teachers' views on the out-of-school learning environments used by teachers for mathematics activities are as follows:

T19: *"... I use the school yard, both for safety and economic reasons. Also, you don't bother for permission. ..."*

T36: *"...I took my students to the museum. They tried to solve some problems by playing an escape game. But I can't take them too often, the procedures are tiring. ..."*

Table 6 reveals a practical trend in the actual use of out-of-school environments. The 'School Playground' and 'Nature' are the most frequently utilized, likely due to their accessibility, lower logistical demands, and minimal bureaucratic hurdles, as alluded to by teacher T19. The less frequent use of 'Museums' and 'Ruins', despite their potential, probably reflects the challenges associated with organizing such excursions, including permissions and resources, as hinted by teacher T36. This suggests that while teachers may be aware of a broader range of environments (as seen in Table 1), practical considerations heavily dictate their actual choices.

The teachers participating in the study were asked how often they make use of out-of-school learning environments in mathematics lessons and the data obtained are presented in Table 7.

Table 7. Frequency of teachers' use of out-of-school learning environments for mathematics activities.

Teacher Responses	f
2 or 3 times a year	15
1 time per year	13
Rarely	4
Never Used	10

Some teachers' views on the frequency of using out-of-school learning environments for mathematics activities are as follows:

T13: "... I used it once this year. We took the children to the museum ..."

T21: "...Obviously, I find it difficult to complete the lessons, so I do not prefer to use it ..."

Following this question, teachers were asked what kind of mathematics activities they carried out in out-of-school learning environments and the distribution of the answers is shown in Table 8.

Table 8. Mathematics activities performed by teachers in out-of-school learning environments.

Teacher Responses	f
Game	20
Creating Geometric Shapes	17
Measuring the Length of Shapes	15
Pattern Creation	13
Matching, Sorting, Grouping Activities	10
Addition-Subtraction	8
Observation-Forecast	5
Building with Foundation Blocks	4
Creative Drama	2

As seen in Table 8, teachers stated that they used out-of-school learning environments for teaching mathematics mostly for games, creating geometric shapes, measuring the lengths of shapes and creating patterns, respectively. Some teacher opinions are given below.

T1: *"...I usually use it for game purposes. Playing games that reinforce what we have learned in the school garden provides permanent learning..."*

T18: *"...I make them do activities such as counting leaves in nature, creating patterns according to their colors. They also learn the names of geometric shapes..."*

T22: *"...I make them do environmental and field activities. Sometimes we do addition and subtraction activities with stones or leaves we collect from nature..."*

Table 8 illustrates the types of mathematical engagement teachers facilitate in these settings. The prevalence of 'Game' as an activity underscores the commitment to play-based learning, a cornerstone of early childhood education. Activities such as 'Creating Geometric Shapes,' 'Measuring the Length of Shapes,' and 'Pattern Creation' demonstrate that teachers are applying fundamental mathematical concepts in these environments. This indicates a practical application of early math skills, leveraging the real-world context to make learning more tangible and engaging, as supported by the teacher quotes.

The teachers participating in the study were asked what could be done to make out-of-school learning environments more productive in terms of mathematics activities and the data obtained are given in Table 9.

Table 9. Teachers' opinions and suggestions.

Teacher Responses	f
Organizing School Gardens	21
Dissemination of Mathematics Museums and Workshops	17
Reducing Legal Procedures	16
Budget Provision (Transportation Support, Ruins Entrance Fee)	14
Creating Virtual Museums	7
Providing Training to Teachers	4
Creating Guidebooks for Teachers	2

Some teacher opinions are given below.

T17: *"...First of all, school gardens should be organized. It is both safe and does not require a permit. Apart from that, economic support is absolutely necessary..."*

T26: *"...I believe that legal procedures should be reduced first. Or alternatively, virtual museums can be increased..."*

T40: "...*The number* of mathematics museums and various workshops can be increased. Guidebooks explaining how and in which subjects teachers can benefit from these places can be created..."

The suggestions provided by teachers in Table 9 offer clear directions for enhancing the utility of out-of-school mathematics learning. The strong call for 'Organizing School Gardens' highlights a desire for accessible, well-equipped, and teacher-friendly spaces that minimize logistical burdens. Simultaneously, suggestions for the 'Dissemination of Mathematics Museums and Workshops,' coupled with calls for 'Reducing Legal Procedures' and 'Budget Provision,' point towards a need for both more specialized resources and the removal of systemic barriers that hinder access to more elaborate off-site locations. These suggestions reflect a practical understanding of current limitations and a vision for more robust support structures.

Results related the third sub-problem

The findings obtained from the interview questions related to the third sub-problem, *"What are the difficulties that preschool teachers face while performing mathematics activities in out-of-school learning environments?"* are presented.

Table 10. Challenges faced by teachers.

Teacher Responses	f
Crowded Classrooms	25
Children's Inability to Pay Attention	16
Material Deficiencies	14
Failure to Ensure Children's Safety	9
Loss of Materials	5

Some of the teachers' views on the difficulties encountered during the implementation of the mathematics activity related to out-of-school learning environments are as follows:

T6: *"...The most common difficulty I experience is to keep the children's attention. There are also security concerns. ..."*

T15: *"...Crowded classes are an important problem. It is very difficult to take care of the students, especially if the place (archaeological site, museum) is crowded. Some of our materials were lost in the activities we did in the garden..."*

Table 10 sheds light on the practical impediments teachers face. The most frequently cited challenge, 'Crowded Classrooms,' is a significant structural issue that undoubtedly complicates managing children effectively outside the traditional classroom setting. Difficulties like 'Children's Inability to Pay Attention' and 'Failure to Ensure Children's Safety' are likely exacerbated by larger group sizes and the novel, less controlled nature of out-of-school environments. 'Material Deficiencies' also points to logistical hurdles. These challenges provide a compelling context for why, despite acknowledging the benefits, teachers may use these environments infrequently (as seen in Table 7).

Based on teachers' opinions, it can be stated that teachers face difficulties in implementing mathematics activities in out-of-school learning environments, particularly in managing groups, maintaining children's attention, and addressing material shortages. Teachers were asked to suggest possible solutions to the challenges they face when implementing mathematics activities in out-of-school learning environments, and the findings obtained from the analysis of their responses are presented in Table 11.

Table 11. Solution suggestions for the difficulties encountered by teachers.

Teacher Responses	f
Reducing Class Sizes	19
School Administration Support	13
Teacher and Parent Support	9
Providing Sufficient Time for Activities	3
Material Support	2

Some teachers' opinions on the solution suggestions are as follows:

T4: *"…It would be good if class sizes were reduced. At least if there is support from the administration and parents when using out-of-school learning environments, the class size could be divided in half. Or, several teachers from the same branch could be hired…"*

T36: *"…The support of the administration is definitely very important. Because security needs to be ensured. In the workshops or museums that are visited, students need to be given enough time because they are young…"*

The solutions proposed by teachers in Table 11 directly address the challenges identified previously. The predominant suggestion, 'Reducing Class Sizes,' underscores its critical importance as a foundational step to make out-of-school learning more manageable and effective. The call for 'School Administration Support' and 'Teacher and Parent Support' highlights the understanding that successful implementation requires a collaborative, systemic approach rather than being solely an individual teacher's burden. These suggestions largely point towards the need for institutional and resource-based changes to facilitate better use of these valuable learning environments.

DISCUSSION, CONCLUSION, and SUGGESTIONS

This research investigated preschool teachers' knowledge levels regarding out-of-school learning environments for math activities, their usage of these environments, and the challenges they face in utilizing them. The first sub-problem of the research addressed preschool teachers' knowledge levels of out-of-school learning environments for math activities. It was observed that teachers listed various spaces with different functions where all kinds of learning can take place as out-of-school learning environments. The research results indicate that preschool teachers have sufficient knowledge about out-of-school learning environments for mathematics teaching. The most frequently mentioned out-of-school learning environment for mathematics teaching by teachers was the schoolyard. Teachers also cited playgrounds, nature, math villages, outside the classroom, museums, and science centers as examples of out-of-school learning environments where they could conduct math activities. The least mentioned out-of-school learning environments by teachers were libraries, home environments, and courses. Similarly, in the study by Kır et al. (2021), it was found that mathematics teachers mostly used environments such as the surrounding area, shopping malls, and historical and cultural places as out-of-school learning environments. Likewise, in the study by Karakuş and Aktın (2023), it was stated that preschool teachers mentioned nature, museums, historical sites, and science centers as out-of-school learning environments. Teachers described the characteristics of effective out-of-school learning environments for mathematics teaching as "suitable for learning objectives," "safe," "student-centered," "suitable for gamified learning," "planned," "suitable for technology use," and "economical." At the

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same time, teachers stated the contributions of out-of-school learning environments to students for mathematics teaching as providing concrete experiences, developing problem-solving, research, inquiry, creative thinking, communication, and empathy skills, developing a positive attitude towards mathematics, establishing cause-and-effect relationships, developing motor skills, improving self-confidence, and supporting language development. Therefore, the current research results indicate that preschool teachers are aware of the significant contributions of out-of-school learning environments to children's development in various areas. Supporting the current research findings, various studies have also found that out-of-school learning environments enhance preschool children's cognitive, language, social-emotional, and motor skills (Ata-Doğan & Boz, 2019; Davies & Hamilton, 2016; Çıtak & Arabacı, 2017, Hunter et al., 2020; Jidovtseff et al., 2021; Karamustafaoğlu et al., 2018).

The second sub-problem of the research examined preschool teachers' views on the usage of out-of-school learning environments where math activities can be conducted. The results of the current research show that the majority of teachers use out-of-school learning environments in their activities. Teachers specifically stated that they use schoolyards, nature, libraries, science centers, museums, and historical sites. This finding suggests that teachers focus on accessible areas outside the classroom where the subject matter can be applied practically. Similar to the findings of the current study, Ocak and Korkmaz (2018) found that teachers use a wide variety of out-of-school learning environments in their studies. Teachers utilize out-of-school learning environments to connect with daily life, contribute to problem-solving processes, make learning fun, increase interest and motivation in mathematics, and ensure permanent learning. There are studies supporting these findings. Çepni and Aydın (2015) stated that out-of-school learning environments increase the permanence of information and make learning enjoyable. Similarly, Bostan Sarıoğlan and Küçüközer (2017) stated that out-of-school learning activities are effective in permanent learning. When the frequency of preschool teachers' use of out-of-school learning environments was examined, it was found that nearly half of the teachers stated that they use these environments once a year or more. Similar to the result of this research, Yıldız (2022) concluded in their research that the vast majority of preschool teachers actively use these environments and attributed this to the fact that most teachers consider the schoolyard as an out-of-school learning environment. When the math activities carried out by teachers in out-of-school learning environments were examined, it was seen that they conducted activities such as games, creating geometric shapes, measuring length, creating patterns, matching, sequencing, grouping, addition and subtraction operations, observation-estimation, constructing with basic blocks, and creative drama. Similarly, Anders and Rossbach (2015), in their study with preschool teachers in Germany, found that teachers have a high tendency to include mathematical concepts in game activities. Preschool teachers, especially in math activities they conduct in the schoolyard and nature, aimed to contribute to students' learning by utilizing natural materials. Karamustafaoğlu et al. (2018) stated in their studies that teachers conduct math activities in out-of-school learning environments. To make out-of-school learning environments more productive in the context of mathematics lessons, participants argued for the widespread implementation of out-of-school learning environments such as math museums and math workshops. In addition, it was stated that virtual math museums should be created, necessary training on out-of-school learning should be provided to teachers, and guidebooks should be prepared for teachers. The results of this research are consistent with the results of the study conducted by Ergin Aydoğdu, Aydoğdu & Aktaş (2023). Teachers also stated that the schoolyards, which they use most frequently as out-of-school learning environments, should be improved, legal procedures should be reduced, and a budget should be provided for transportation and entrance fees to historical sites. Similarly, other studies conducted with teachers have mentioned problems with time, budget, organization, preparation, and transportation related to out-of-school learning environments (Kır et al., 2021).

The third sub-problem of the research examined the challenges faced by preschool teachers while conducting math activities in out-of-school learning environments. Teachers mentioned overcrowded classrooms, difficulty in keeping children's attention, lack of materials, difficulty ensuring children's safety, and loss of materials. Similar to the findings of the current research, Jidovtseff et al. (2021) revealed in their study that despite having a positive attitude towards out-of-school learning environments, teachers carry out limited outdoor practices due to class size, organizational constraints, lack of materials, and low supervision rates. Similarly, İnce and Akcanca (2021) stated in their research that problems such as the teacher's inability to attend to each child due to the large number of children in out-of-school learning environments, economic problems, and discipline and control difficulties were experienced. Teachers suggested solutions to prevent these problems, such as reducing class sizes, school administration support, teacher and parent support, providing sufficient time for activities, and material support. In their research, Karamustafaoğlu et al. (2018) revealed that the reasons why preschool teachers do not prefer practices related to out-of-school learning environments stem from restrictive regulations, time constraints, lack of resources, lack of knowledge and confidence, reasons originating from some colleagues, administrators, and parents, especially the lengthy permission process and the challenging situations encountered during this process. Although the teachers participating in the research generally agreed that out-of-school learning environments would contribute positively to math lessons, it was concluded that they conducted their lessons in out-of-school learning environments to a limited extent due to various challenges they faced/would face. Based on the results obtained in the research, it is possible to make some recommendations. Accordingly, considering the contributions of out-of-school learning environments, these environments should be used more frequently and integrated into preschool education. In addition, the chosen out-of-school learning environment should be appropriate for the children's developmental characteristics and the program's learning outcomes. The Ministry of National Education could publish an advisory guide explaining how preschool teachers can conduct math activities in out-of-school learning environments with sample activities. With the support of school administration and parents, necessary conveniences can be provided to teachers regarding the use of out-of-school learning environments. Furthermore, necessary precautions should be taken by relevant institutions to ensure the safe and pedagogically appropriate use of out-of-school learning environments such as math museums and workshops, science centers, and historical sites. This way, teachers' concerns about safety, maintaining student attention, and completing math activities can be addressed. Due to the limited number of studies in the mathematics education literature regarding out-of-school learning, there is a need for in-depth research on this topic. This research was conducted to examine the views of preschool teachers on out-of-school learning environments and their usage for math activities. A similar study can be conducted with parents and students.

Ethics and Conflict of Interest

This research was conducted with the permission obtained from the Ethics Committee of Dokuz Eylül University Legal Counsel, dated 01.04.2024 and numbered E-87347630-659-956012. Furthermore, all publication ethics were adhered to at every stage of the research. The authors declare that they have no conflict of interest.

Author Contribution

All authors contributed equally to the research.

Data availability

The data that support the findings of this study are available on request from the corresponding author.

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