Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education
Vol. 19, Issue 1, June 2025, pp. 84-112. ISSN: 1307-6086
Research Article

# The Connection between Children's Literature and Mathematics: Reflections from Problem Posing Situations of Prospective Mathematics Teachers*

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Received : 18.10.2024 Accepted : 23.01.2025

Doi: https://doi.org/10.17522/balikesirnef.1569647

*Abstract* – Utilizing interdisciplinary connections in teaching mathematics increases the quality of teaching and makes learning more effective and permanent. In this study, the connection between children's literature and mathematics was discussed and this connection was examined through problem posing. The relevant research was conducted with a case study design, which is one of the qualitative research methods. In this direction, 6-week tasks were carried out intermittently for prospective mathematics teachers regarding the connection between children's literature and mathematics. As a result of these tasks, prospective mathematics teachers were asked to pose as many problems as they could using a visual in a book of children's literature. 66 mathematical problems posed by 27 prospective mathematics teachers were evaluated descriptively with the problem posing evaluation criteria including the themes of "Content", "Mathematical Connection" and "Creativity", and the frequencies for the themes were presented in a table. As a result of the study, it was concluded that the connection between children's literature and mathematics positively affected the mathematical connection skills and creativity of the prospective teachers. At the same time, it was observed that the number of problem-solving strategies used in the problems posed by the prospective teachers was high and the most preferred problem-solving strategy was mathematical reasoning.

*Keywords*: Children's literature, connection, creativity, mathematics education, problem posing, prospective teachers.

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*This paper was presented as an oral presentation at the 16th National Science and Mathematics Education Congress in Edirne, in 2024.

## Introduction

Mathematical connections have an important place in mathematics teaching as a concept that is necessary for individuals to understand their environment, see the connection between relationships in daily life, be aware of the communication between different disciplines and structure mathematics better (Eli et al., 2011; Özgen, 2017). In the various mathematics teaching programs that we use in education and training today, it is clearly emphasized that making connections is one of the processes of learning to do mathematics (Özgen, 2013).

The members of the National Council of Teachers of Mathematics (NCTM, 2000), which develops standards to determine the content of mathematics curriculum, defines mathematics teaching as teaching that encourages students to communicate their mathematical ideas, emphasizes problem-solving and problem-posing skills, develops reasoning, and ensures the training of individuals who can show and use connections within mathematical subjects and between different disciplines. In the general objectives section of the Mathematics Course Curriculum, it is emphasized that students can understand mathematical concepts and establish relationships with each other, and that the relationships they establish can be used both in other disciplines and in daily life, and that mathematical connections are important (Ministry of National Education [MoNE], 2018; 2024). Ma (1999) also expresses mathematical connections as mathematical nodes that bridge important key concepts with mathematical thoughts. It is said that mathematical connections will have a supportive effect on the construction of mathematics teaching on a more solid foundation by hosting positive features such as creating meaning, doing mathematics, establishing a bridge between new information and old information, and ensuring permanent learning by increasing the continuity of many ideas in the mind, and for this reason, it is emphasized that connections are an important building block that can strengthen mathematics teaching in the learning-teaching processes (Ball et al., 2005; Özgen 2017).

The data presented by the Programme for International Student Assessment (PISA) exam results, which allow for the assessment of many mathematical skills along with the ability to make connections, indicate that mathematical literacy and reading skills are not at a sufficient level in Türkiye and are below the average of OECD (Organisation for Economic Co-operation and Development) countries (Özmusul & Kaya, 2014). In this case, the relationship between mathematical literacy, which expresses the usability of mathematics in daily life (Pugalee, 1999), and children's literature, which is considered a powerful tool for the

development of reading skills (Whitin, 1992), has begun to be addressed. In addition to developing students' reading skills, children's literature is also seen as a way to relate school mathematics to daily life. Drawing attention to mathematics in literature that covers daily life supports the emergence of mathematics inherent in human thought and communication about life experiences (Haury, 2001). However, it is thought that children's literature books can serve as an effective and important tool in using the daily life context in the process of teaching mathematical concepts (Van de Walle et al., 2016).

Many studies that included the connection between children's literature and mathematics teaching in international literature (Diakiw, 1990; Furner, 2018; Mink & Fraser, 2002; Raymond, 1995; Ward, 2005; Whitin, 1992; Zhang et al., 2023) and national literature (Ayvaz, 2010; Arslan-Başdağ & Dağlıoğlu, 2020; Demirci, 2023; Fırat & Dinçer, 2020; Kuş & Işık-Tertemiz, 2022; Yalçın et al., 2022) have revealed that this connection leads to positive results. When the literature is reviewed, it is seen that the connection between literature and mathematics; it has been observed that it supports understanding mathematical concepts and developing mathematical skills (Durmaz & Miçooğulları, 2021), directing students to think critically (Barnaby, 2015), developing a positive attitude towards mathematics (Van den Heuvel-Panhuizen & Boogaard, 2008) and realizing that mathematics is a part of daily life (Moyer, 2000). In addition, it has been stated that by integrating children's literature into the mathematics teaching process, students can more easily gain abstract thinking and problem-solving skills, which are seen as the most important elements of mathematical thinking (Aslan, 2019; Cankoy, 2011), that it will be useful for understanding the stated problem, which is the first step of the problem-solving stages (White, 2016) and that it is effective in helping to create an interesting problem model (Green, 2013). In this way, young children can develop their verbal and written skills to express themselves by reading storybooks, while at the same time they can have different opportunities to structure mathematical knowledge within themselves and discover new ways of learning (Edelman, 2017; Moyer, 2000).

Problem posing, which is thought to be at the heart of both mathematical and scientific research (Cai, 2003), is expressed as both the generation of new problems based on situations and the reformulation of given problems (Silver, 1994; Singer & Voica, 2015). Solving a problem requires the solver to use some degree of creativity or originality (Lenchner, 1983; Polya, 1957). Problem posing activities, which are closely related to problem solving, can also encourage flexible thinking, develop problem solving skills and sharpen students' understanding of mathematical content (English, 1996; Mallart et al., 2018; Ünlü, 2017;

Zhang et al., 2022). There is widespread agreement in mathematics education that students should be given opportunities to enhance their skills in mathematical problem-posing (Brown & Walter, 2005; NCTM, 2000). Therefore, problem posing, which is considered as a real mathematical task, maintains its important place in NCTM standards (Baumanns & Rott, 2022), and its importance in school mathematics has been emphasized to be widely accepted (Cai et al., 2016; Singer et al., 2013). Since the NCTM revealed that problem posing should be included in mathematics classrooms, the role of teachers in problem posing has become even more important (Lee et al., 2018).

Given the growing emphasis on problem posing within curriculum design and classroom teaching (Cai et al., 2015; Ellerton, 2013), it is crucial for teachers to not only understand students' perspectives on problem posing but also to effectively integrate this approach into their mathematics instruction (Cai et al., 2016). In particular, for teachers to successfully incorporate problem posing into their lessons, they must gain a deeper understanding of the cognitive processes students engage in when formulating problems. By anticipating students' responses to instructional tasks, teachers can plan and implement the most effective teaching strategies, thus optimizing the learning environment (Işık & Kar, 2012; Joaquin, 2023; Korkmaz & Gür, 2006; Xu et al., 2020). Moreover, problem posing serves not only as a tool for assessing student thinking but also as a strategy that enhances learning opportunities for all students (Cai & Hwang, 2020). Research has indicated that such tasks can alleviate students' anxiety, foster a more positive attitude toward mathematics, and contribute to improvements in their comprehension, problem-solving abilities, and relational skills (Barlow & Cates, 2006; Brown & Walter, 2005; Coşkun, 2013; Mersin & Akkaş, 2023; NCTM, 2000; Silver, 1994). Problem posing is considered one of the most effective methods in mathematical thinking and learning processes (Cai & Hwang, 2020). While significant progress has been made in problem-posing research (Cai et al., 2015), studies focusing on prospective teachers creating mathematical problems through the lens of children's literature are limited (Arslan & Kartal, 2023). This gap highlights the originality of the study and its potential to fill a crucial void in the existing literature.

One effective strategy for teachers to develop rich mathematical problems is by grounding scenarios in stories from children's literature. This approach enables educators to foster students' problem-posing abilities by incorporating literature into mathematics instruction (Young & Marroquin, 2006). In addition, integrating children's literature into mathematical reasoning not only enhances the relevance and engagement of mathematics

lessons but also provides prospective teachers with an opportunity to cultivate students' creativity and critical thinking skills. This dual benefit underscores the importance of incorporating literary elements into the teaching of mathematics, enriching both cognitive and problem-solving capacities.

In this context, the research problem was formulated as follows:

"How are the reflections of mathematics education practices connected with children's literature on the problem-posing situations of prospective mathematics teachers?"

The study aims to provide valuable insights into how these connections are reflected in the problem-posing tasks of future educators, potentially contributing to the development of innovative teaching methods. Additionally, it emphasizes the importance of adopting an interdisciplinary approach in mathematics instruction, offering students the opportunity to recognize connections between various fields and understand the role of mathematics in real-life contexts. The findings could guide stakeholders involved in developing educational policies and teaching strategies, providing recommendations on how to effectively incorporate children's literature into future mathematics education.

## Method

### Research Design

Due to the existence of a situation where the researcher collects detailed and in-depth information, this study was conducted with a case study design from qualitative research methods. A case study is a qualitative approach in which the researcher collects detailed and in-depth information about real life or situations with the support of multiple sources of information and describes the situation (Creswell & Poth, 2016). This design, which covers topics including community work, education, social problems and conflicts, has a very important role in facilitating the meaning of complex situations (Yin, 2009). Since the aim of this study was to examine in detail the reflections of mathematical tasks connected with children's literature on the problem-posing of prospective teachers, a case study design was considered appropriate.

### Participants

The study group of this research consists of 42 prospective mathematics teachers enrolled in the "Connections in Mathematics Education" course in the Primary School Mathematics Teaching program at a state university in Bursa during the spring semester of the

2022-2023 academic year. In the later stages of the research, based on the scope and nature of the collected data, prospective teachers who actively participated in the process were selected and the study was conducted in detail with 27 prospective mathematics teachers. In addition to this situation, it is known that only eight of the 27 prospective mathematics teachers took the "Problem Solving in Mathematics" course before these tasks. The prospective teachers who participated in the research were determined on a voluntary basis and were included in the process with the explicit consent of the participants. The identities of the participants were kept confidential throughout the research period and each participant was given codes as "S1", "S2", "S3" to ensure anonymity. The demographic characteristics of the prospective teachers in the study group are provided in Table 1.

**Table 1** Demographic Characteristics of the Prospective Teachers in the Study Group

| Grade Level | Age | Female | Male | Total |
|---|---|---|---|---|
| First-year undergraduate student | - | - | - | - |
| Second-year undergraduate student | 19 | - | 1 | 9 |
| | 20 | 5 | - | |
| | 21 | 3 | - | |
| Third-year undergraduate student | 20 | 3 | - | 15 |
| | 21 | 6 | 2 | |
| | 22 | 2 | 1 | |
| | 23 | 1 | 1 | |
| Fourth-year undergraduate student | 21 | 1 | - | 2 |
| | 22 | - | 1 | |
| Total | | 21 | 6 | 27 |

## Data Collection

The present study, mathematics prospective teachers participated in mathematics tasks integrated with children's literature as part of the "Connections in Mathematics Education" course. Since the content of the course covers various aspects of mathematics teaching, the implementation process was planned and conducted within a six-week training program, which was spaced over time. The main components of this training program include the role of children's literature in mathematics teaching, the effective use of children's literature works in line with teaching goals, and the selection of appropriate children's literature books. Throughout the training process, various children's literature works, addressing different cognitive developmental levels of each age group and containing a variety of content and themes, were used in tasks. Additionally, this process was meticulously planned to ensure that

the prospective teachers could learn by integrating mathematical concepts with children's literature in a hands-on manner, and was structured in harmony with various topics of the course. The selection of books was made in a way that reflected this alignment. The educational process is presented in Figure 1.

In this study, certain sections of the books "I Solve These Problems Quickly" and "Jayden's Rescue", which are thought to integrate children's literature and mathematics more strongly, were carefully examined during the course process and the problems in these books were solved by prospective mathematics teachers. During this process, special attention was paid to how the mathematical concepts presented in the books were integrated with children's literature, and efforts were made to ensure that the prospective teachers understood these connections. Later, in accordance with the course's aim to relate mathematics to daily life, specific sections of the books "Vicious Circles and Other Savage Shapes" and "Math Curse" were read, and tasks from these books were carried out. These books were carefully chosen for their ability to concretize mathematical concepts within daily life contexts and help the prospective teachers see how mathematics could be applied in real-life situations.

In the final weeks of the process, books without direct mathematical content were intentionally selected. This conscious decision was made to help the prospective teachers develop their problem-posing skills using books that did not contain mathematical situations, as well as to creatively explore the relationship between these types of books and mathematical concepts. Thus, the prospective teachers were provided with the opportunity to assess their mathematical thinking skills and problem-posing abilities through children's literature.


**Figure 1** Children's Literature and Mathematics Integration Course Flow

As part of the tasks, the participants were asked to create as many mathematical problems as possible based on an image from a selected children's literature book. They were also expected to explain the features they considered while shaping the problems they created. This task enabled the participants to engage in a creative problem-solving process by relating mathematical concepts to children's literature works. The image used for the task considered in this study is presented in Figure 2.

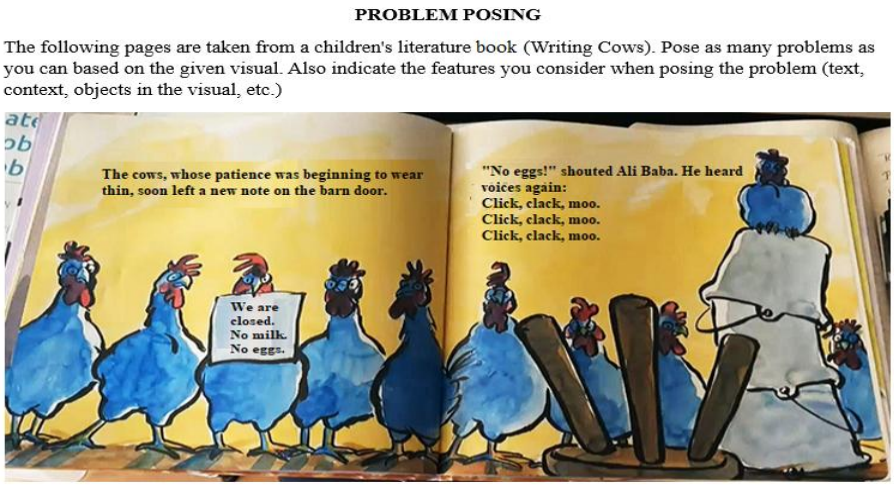


**Figure 2** Data Collection Tool

This research was conducted concurrently with the master's thesis by one of the researchers, where the prospective teachers underwent the same training; however, the research questions and data collected vary. In this study, the link between children's literature and mathematics is explored through the problems posed by prospective mathematics teachers.

**Data Analysis**

Descriptive analysis aims to organize, interpret, and present data to the reader (Baltacı, 2019). This approach allows data to be categorized according to specific themes (Kitzinger, 1995). Thus, data can be structured and presented based on the themes that arise from the questions within the data collection tool (Yıldırım & Şimşek, 2021). In this context, the mathematical problems created by prospective teachers within the framework of integrating children's literature and mathematics were subjected to descriptive analysis and thoroughly examined according to criteria determined by the researchers and expert opinions. The analysis focused on three main criteria: "Content", "Mathematical Connection", and "Creativity". The content criterion was further examined with the subcategories of "Learning Area", "Mathematical Problem-Solving Strategies" and "Context".

The learning area reveals which mathematical topics the prospective teachers chose to create problems, allowing for an evaluation of their subject knowledge and their ability to apply this knowledge. The learning areas were categorized according to the learning areas defined by the Ministry of National Education (MoNE, 2018). Mathematical problem-solving strategies indicate how the candidates prefer to solve the problems they encounter and which methods and tools they use, providing insights into the depth of their problem-solving abilities. Context refers to the life situations addressed by the created problems and the contexts chosen by the prospective teachers were classified according to the four main categories defined by the OECD (2003). These categories—personal, occupational, social, and scientific—help us understand how well prospective teachers can relate their mathematical thinking skills to real-life situations. Mathematical connection is an important criterion that assesses the candidates' ability to make meaningful connections between mathematics, daily life and other disciplines, offering insights into the complexity of their mathematical thinking processes. Finally, the creativity criterion highlights how candidates go beyond traditional solution methods, showcasing their ability to think innovatively and creatively. This serves as an indicator of how creative and innovative prospective teachers are in the process of problem creation and solving. All of these criteria allowed for a

multidimensional analysis of the problem-creation processes of prospective teachers and provided a more comprehensive evaluation of the effectiveness of the methods used in education. The "Evaluation Criteria for Posing Mathematical Problems" are presented in Figure 3.

| Themes | Codes | Analysis Detail |
|---|---|---|
| CONTENT | Mathematical problem solving strategy | Which problem solving strategy(ies) does the problem posed require in its solution?<br>Drawing a diagram, Solving a simpler related problem, Finding a pattern, Making an organized list, Mathematical reasoning, Writing an equation, Working backwards<br>Strategy types are limited to the strategy types preferred by prospective teachers. |
| | Learning Area | Which mathematical learning area is the problem set up for?<br>Learning areas preferred by prospective teachers are categorized according to the learning areas determined by the Ministry of National Education (2018).<br>Numbers and Operations, Algebra, Geometry and Measurement, Data Processing, Probability. |
| | Context | Which context was used when posing the problem?<br>Context is the vital situation in which the problems are dressed (Altun, 2020). The contexts used by the prospective teachers are categorized according to the context types determined by the OECD (2003).<br>The OECD (2003) considers real-world contexts in four categories.<br>Personal: Problems classified in the personal context category focus on the activities of the person himself, his family, or his peer group (OECD, 2003).<br>Occupational: Problems classified in the occupational context category focus on the world of work but must be accessible to the individual who will face the problem (OECD, 2003).<br>Social: It may include things such as voting systems, public transportation, government, public policies, demography, advertisements, national statistics, and economics (OECD, 2003).<br>Scientific: Problems classified in the scientific category may include areas such as weather, climate, ecology, medicine, space science, genetics, measurement, and the world of mathematics itself (OECD, 2003). |
| MATHEMATICAL CONNECTION | Connections Within Mathematics | Which mathematical topics or concepts have been associated with in the problem?<br>Percentage, Integer, Algebra, Divisibility, Fraction, Probability.<br>The specified concepts are limited to the concepts that prospective teachers use in problem-posing situations. |
| | Daily Life Connections | Daily Life Relation<br>How is the daily life relation addressed in the problem?<br>Exchange, Budget, Profit, Gift, Salary, Special Day, Raffle, Exchange.<br>The specified concepts are limited to the concepts used by prospective teachers in problem posing situations. |
| | Interdisciplinary Connections | Have interdisciplinary connections been used in the problems posed? |
| CREATIVITY | Convergent vs. divergent thinking | Is the problem posed convergent or divergent within the group it is in (compared to other problems posed)?<br>While new ideas are thought to be generated through divergent thinking within the scope of creativity, convergent thinking is generally associated with traditional ideas (Cropley, 2006). |
| | Fluency | How many problems did the prospective teachers pose for the given situation? What is the fluency score of the prospective teachers? 1-2-3 …. |
| | Flexibility | Are the problems posed by prospective teachers' problems that require the use of different problem-solving strategies? |

**Figure 3** Evaluation Criteria for Posing Mathematical Problems

The problems posed by the prospective mathematics teachers were coded independently by the researchers, adhering to the analysis details given above. A Microsoft Excel document was created for the data obtained from the 66 problems. Frequency, which is a descriptive statistic, was used in the analysis of the data obtained from the problem-posing situation, and the results were tabulated in an understandable and systematic way using frequency (f) values.

## Validity and Reliability

Validity and reliability are two criteria widely used in the credibility of study results, which are considered to be one of the most important criteria of scientific research (Yıldırım & Şimşek, 2021). In qualitative research, it is critical to report the data collected in detail and explain how the researcher reached the results in order to produce valid results. In this direction, in order to contribute to the validity of qualitative research, that is, to confirm the

accuracy of the results, receiving expert support at every stage, such as selecting the tools to collect data in the research, preparing these tools or interpreting the findings obtained, can have an increasing effect on the validity of the research (Denzin & Lincoln, 2008). In this context, another researcher who is an expert in the field of mathematics education was consulted regarding the "Evaluation Criteria for Posing Mathematical Problems" used in the evaluation of the mathematical problems posed by the prospective teachers.

For reliability, which is expressed as the repeatability of the results of the research in qualitative research, it can be stated that the study is reliable by taking into account the detailed explanation of the data collection process and data analysis (Miles & Huberman, 1994), supporting the research with various documents (Yin, 2009). In this context, the reliability formula recommended by Miles and Huberman (1994) was preferred for the reliability of the findings obtained from the mathematical problems posed by the prospective mathematics teachers using children's literature. Expert support was received to examine the problems posed and the percentage of agreement between the researcher and the expert for the problems examined was calculated. The formula is as follows;

$$\text{Reliability : Agreement Percentage} = \frac{\text{Number of Agreements}}{\text{Number of Agreements} + \text{Number of Disagreements}} . 100$$

The percentage of agreement between the researcher and the expert in the analysis of the posed problems was calculated as 91%. This value is shown as a sufficient level for the results to be considered reliable (Miles & Huberman, 1994). For the 9% of cases where the inter-rater agreement was not achieved, final decisions were made as a result of discussions between the researchers. During this process, both parts conducted a more in-depth analysis, taking into account different perspectives, and reached a consensus. As a result, decisions regarding the evaluation of the problems were based on a solid foundation of reliability and validity, thereby enhancing the robustness of the findings.

## Results

The findings of the problems posed by the prospective teachers regarding the code of "Mathematical Problem Solving Strategy" are given in Table 2 and Table 3.

**Table 2** Frequencies of Situations Requiring Strategy Use in Solving Problems Posed

| The solution to the problem posed requires the use of strategy | The solution to the problem posed does not require the use of strategy | Total |
|---|---|---|
| 46 | 20 | 66 |

When the posed problems were examined, it was determined that 46 out of 66 problems required the use of at least one problem-solving strategy. Table 3 presents detailed findings on the strategies required for addressing problems that involve the application of strategies.

**Table 3** Frequencies of Problems Requiring Strategy Use in Their Solutions Regarding the Code "Mathematical Problem Solving Strategy"

| Code | DD | SSRP | FP | MOL | MR | WE | WB | GC | Total |
|---|---|---|---|---|---|---|---|---|---|
| Mathematical problem solving strategy* | 12 | 2 | 6 | 1 | 30 | 14 | 1 | 7 | 73 |

*Limited to the types of strategies preferred by prospective teachers. If the problem posed includes more than one strategy, each strategy is reported with separate frequencies.
DD: Drawing a Diagram
SSRP: Solving a Simpler Related Problem
FP: Finding a Pattern
MOL: Making an Organized list
MR: Mathematical Reasoning
WE: Writing an Equation
WB: Working backwards
GC: Guess and Check

It is seen that the most preferred problem solving strategy in the problems posed by the prospective mathematics teachers is the "Mathematical Reasoning" strategy (f=30). Then, the strategies "Writing an Equation" (f=14) and "Drawing a Diagram" (f=12) were preferred. It was noticed that only one problem was posed for the use of the "Making an Organized List" and "Working Backwards" problem solving strategies. When we look at the problems posed in general, it is seen that eight different problem solving strategies are used. Different examples of the problems posed by the prospective teachers in terms of problem solving strategies are presented in Figure 4.

| S20 | S23 |
|---|---|
| There are 4 cows on Ali Baba's farm and the total amount of milk given by each cow in the last 4 days is noted as follows.<br>The 1st cow gave (x+3) liters more milk than the second cow.<br>The 3rd cow gave (2y+17) liters more milk than the 1st cow.<br>The 4th cow gave (3x-2) liters more milk than the 1st cow.<br>The second cow gave a total of x liters of milk in the last 4 days because she was sick.<br>Based on the information above, how much milk could Ali Baba collect from his cows in the last 4 days? | Of the three buckets that can hold 10 kg, 7 kg and 3 kg, one is full of 10 kg of milk. Can you divide the 10 kg of milk into two equal parts using these buckets (without using any other measuring tools)? |

**Figure 4** Different Examples of the Problems Posed by the Prospective Teachers in Terms of Problem Solving Strategies

While the prospective mathematics teacher with code S20 posed a problem that required the use of the writing an equation problem-solving strategy, prospective mathematics teacher with code S23 posed a problem that required the use of the mathematical reasoning problem-solving strategy.

The findings of the problems posed by prospective mathematics teachers regarding the code of "Context" are given in Table 4.

**Table 4** Frequencies Regarding the Code "Context" in the Problems Posed

| Code | Personal | Social | Scientific | Occupational | No context |
|---|---|---|---|---|---|
| Context | 14 | 1 | - | 43 | 8 |

When looking at Table 4, it is seen that the context most used by the prospective teachers in the problems they posed is the "Occupational" context (f=43). The second most used context is the "Personal" context (f=14). It was determined that only one problem was posed for the "Social" context and that there was no problem posed for the "Scientific" context.

The findings of the problems posed by the prospective teachers regarding the code of "Learning Area" are given in Table 5.

**Table 5** Frequencies Regarding the Code of "Learning Area" in the Problems posed

| Code | Numbers and operations | Algebra | Geometry and measurement | Data processing | Probability |
|---|---|---|---|---|---|
| Learning area* | 56 | 15 | 5 | 4 | - |

* If the problem posed includes more than one learning area, each learning area is reported with separate frequencies.

As seen in the table, the most preferred learning area in the problems posed by the prospective teachers was the "Numbers and Operations" learning area (f=56). No problem was encountered regarding the "Probability" learning area.

The findings regarding the "Connections Within Mathematics" code of the problems posed by the prospective teachers are given in Table 6.

**Table 6** Frequencies Regarding the Code of "Connections Within Mathematics" in the Problems Posed

| Code | Fraction | Pattern | Algebra | Percent | Graph | Average | Geometric shape | Area | Volume | Parity | Number line | Dozen | Absolute value | Ratio | Cluster | Table | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Connections within mathematics* | 8 | 5 | 5 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 40 |

* If the problem involves more than one connection within mathematics, each learning area it contains is reported with separate frequencies.

It is seen that the mathematical concept that prospective mathematics teachers mostly included by making connections in the posed problems is "Fraction" (f=8). It is followed by "Pattern" (f=5), "Algebra" (f=5), "Percentage" (f=4) and "Graph" (f=4). Example situations are given in Figure 5.

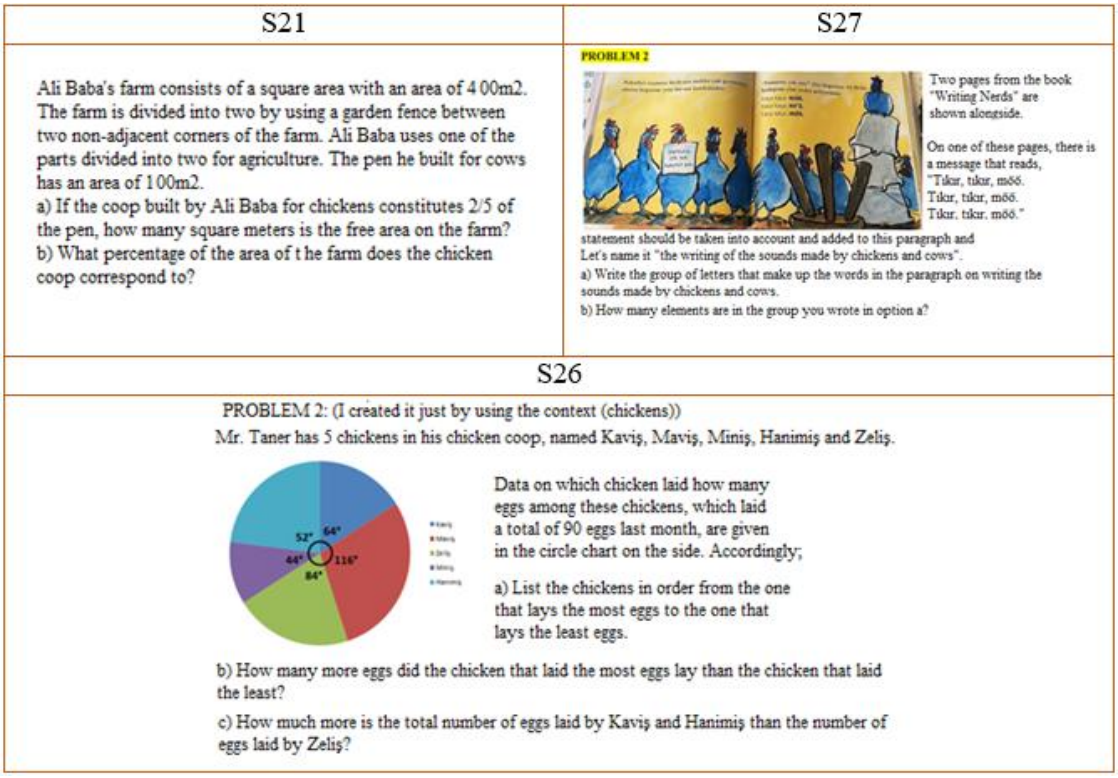


**Figure 5** Different Examples of the Problems Posed by the Prospective Teachers in Terms of Connections within Mathematics

When the table showing the problems posed by the prospective teachers is examined, it is seen that the prospective teacher with code S26 made a connection with the concept of angle in his problem, the prospective teacher with code S27 made a connection with the concept of sets, and the prospective teacher with code S21 made a connection with the concepts of fraction, area, and percentage.

The findings regarding the code of "Daily Life Connections" of the problems posed by the prospective teachers are given in Table 7.

**Table 7** Frequencies Regarding the Code of "Daily Life Connections" in the Problems Posed

| Code | Shopping | Product quantity | Number of animals | Food | Living space | Time | Total |
|---|---|---|---|---|---|---|---|
| Daily life connections | 16 | 13 | 9 | 5 | 2 | 1 | 46 |

*If the problem involves more than one daily life connections, each learning area it contains is included in separate frequencies.

It is seen that the situation that is most frequently included in the daily life connections of the prospective mathematics teachers in the problems posed is "Shopping" (f=16). "Product Quantity" (f=13), "Number of Animals" (f=9), and "Food" (f=5) follow this order. Example situations are given in Figure 6.

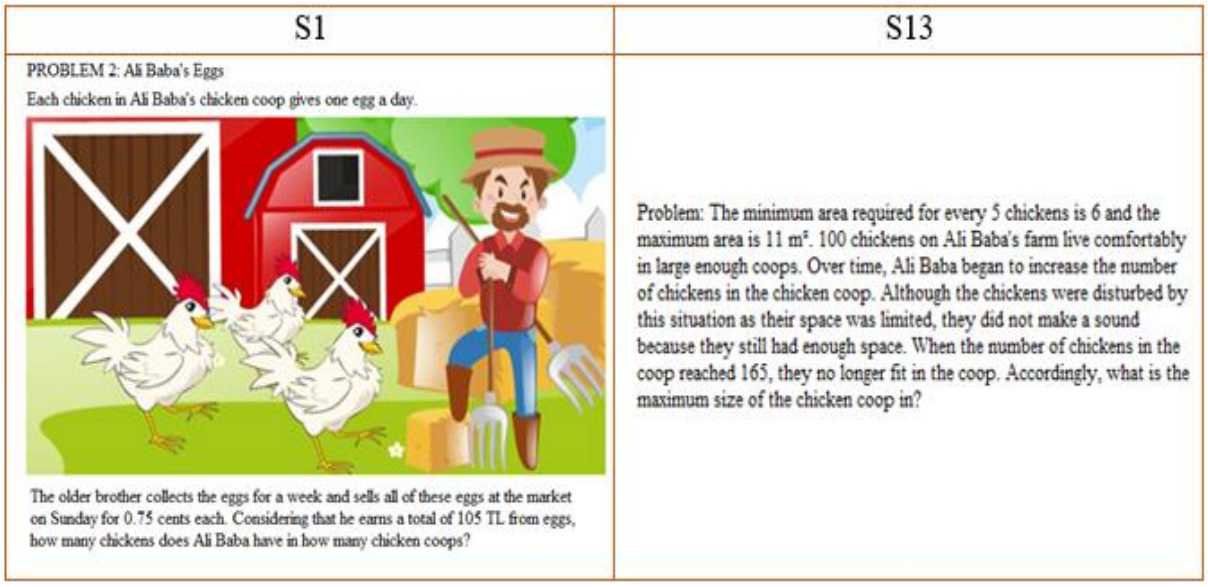


**Figure 6** Different Examples of the Problems Posed by the Prospective Teachers in Terms of Daily Life Connections

When the situations in which prospective mathematics teachers included daily life context in the problems they posed were examined, it was determined that the participant

coded S1 used the "Shopping" context, and the participant coded S13 used "Product Quantity" context.

The findings regarding the code of "Interdisciplinary Connections" in the problems posed by prospective teachers are given in Table 8.

**Table 8** Frequencies Regarding the Code of "Interdisciplinary Connections" in the Problems Posed

| Code | Literature | | | Music | Total |
|---|---|---|---|---|---|
| | Poem | Story | Riddle | | |
| Interdisciplinary connections* | 2 | 1 | 1 | 1 | 5 |

*If the problem involves more than one interdisciplinary connections, each learning area it contains is included in separate frequencies.

When the problems posed were examined, it was determined that there were only five problems that made interdisciplinary connections. In four of these five problems, a connection with literature was used, and in one, a connection with music was used. Example situations are given in Figure 7.

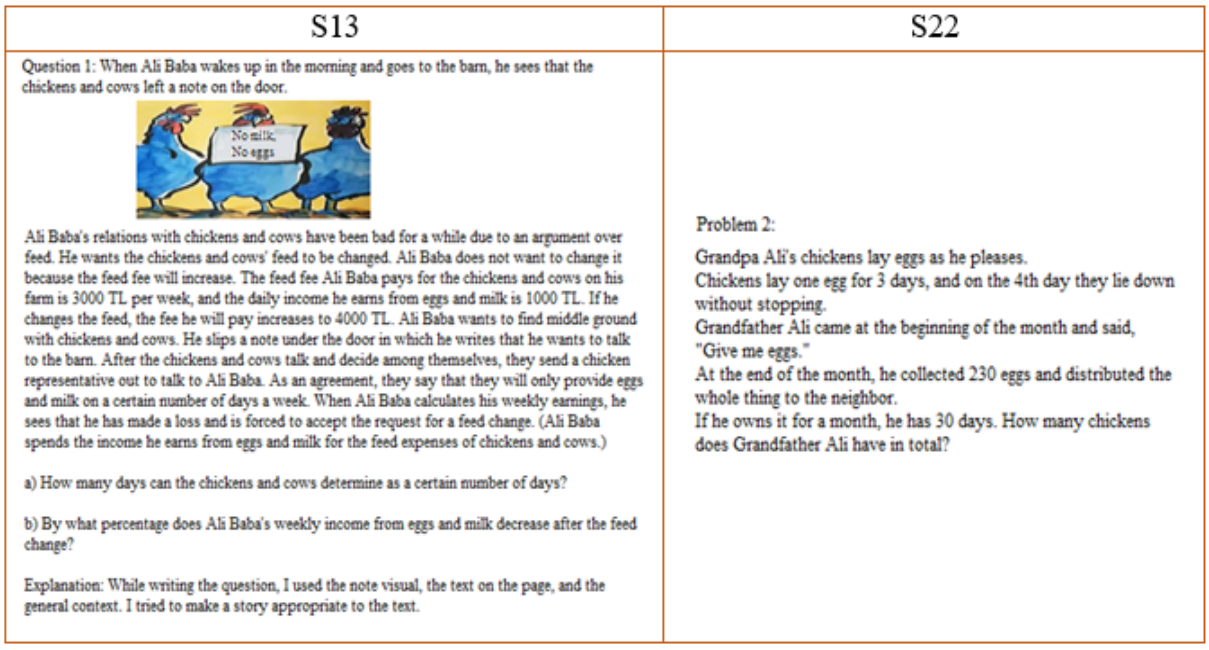


**Figure 7** Different Examples of the Problems Posed by the Prospective Teachers in Terms of Interdisciplinary Connections

When the table above is examined, it is seen that the prospective teacher with code S13 aimed to make a story suitable for the problem and the prospective teacher with code S22 wrote the problem in a literary language as a poem.

When the problems posed by the prospective teachers were examined within the scope of the theme of "Creativity", it was determined that 40 out of 66 problems contained divergent thinking. In the analysis of the problems posed regarding the fluency code, it was seen that there were ten prospective teachers with a fluency score of one, eight prospective teachers with a fluency score of two, and nine of them with a fluency score of three or more. It was also determined that 21 out of the 66 problems posed were flexible. Examples regarding the theme of creativity are given in Figure 8.

| S19 | S21 |
|---|---|
| PROBLEM 4<br>A group of chickens is arranged in a square shape in a large area. Arranging in a square shape means that the number of chickens next to each other is equal to the number of rows. Then, on the rooster's command, the same chickens are arranged in a rectangular shape, and in this case the number of rows increases by 5.<br>If chickens are arranged in a row with 50 chickens, how many rows will be formed in total? | Except for 4 of the 3-legged stools on Ali Baba's farm, the stools are upside down.<br>When the stools are upright, 2 chickens are placed on each stool, while when the stool is upside down, one chicken is placed on each leg of the stool. There are 3 chickens on this farm. Accordingly;<br>  <br>a) If all the chickens find a place for themselves on the stools, how many stools are there in this farm?<br>b) If 3 chickens were placed on a flat stool on the farm, how many stools would remain idle?<br>c) What is the absolute value of the difference between the number of feet of chickens and the number of feet of stools? |

**Figure 8** Different Examples of the Problems Posed by the Prospective Teachers in Terms of Creativity

When the given figure is examined, it is seen that participants coded S19 and S21 included connections with new ideas in the problems they posed.

## Conclusions and Suggestions

This study aims to examine the reflections of mathematics education practices connected with children's literature on the problem-posing situations of prospective mathematics teachers. At the end of the practices, the prospective teachers were asked to pose as many problems as possible using an illustration from a children's literature book. These problems were then analyzed by the researchers within the framework of three main themes: "Content," "Mathematical Connection," and "Creativity."

In this study, it was observed that prospective teachers tended to focus on problems that required specific strategies during the problem-posing process, effectively using a total of eight distinct problem-solving strategies. This finding aligns with Ünlü's (2017) research, which highlighted that prospective mathematics teachers can pose problems effectively by employing appropriate problem-solving strategies when needed. The variety of strategies used

by the participants can be attributed to their academic progress, particularly as third-year undergraduate students who have been exposed to problem-solving courses. This suggests that the problem-solving and problem-posing skills of prospective teachers are strengthened through the knowledge and experience gained during their undergraduate education. Knowledge and experience are crucial factors in shaping teachers' instructional practices (Barlow & Cates, 2006), and the courses the participants took during their undergraduate studies were key in shaping their problem-posing knowledge (Lee et al., 2018). Therefore, it can be argued that teacher education programs should place greater emphasis on developing problem-solving skills, as doing so would allow prospective teachers to deepen these abilities and enhance their problem-posing practices. This finding underscores the importance of incorporating a stronger focus on problem-solving and problem-posing within teacher education programs to support the professional growth of future educators.

The findings of this study indicate that the most frequently observed problem-solving strategy employed by prospective teachers in their constructed problems is the "Reasoning Strategy". Reasoning skills hold a crucial place as one of the fundamental components of mathematical literacy processes (Pugalee, 1999). These skills enable students to engage actively in mathematical reasoning and establish mathematical relationships, thereby contributing to a deeper understanding of problem-solving processes (NCTM, 2000). Furthermore, children's literature emerges as a powerful tool in enhancing mathematical literacy and strengthening reading skills (Whitin, 1992). By connecting real-life experiences to mathematical concepts, children's literature facilitates a more concrete and meaningful comprehension of these ideas (Haury, 2001; Van de Walle et al., 2016). In this context, the findings of our study highlight that connecting mathematics with children's literature supports the mathematical literacy skills of prospective mathematics teachers and promotes the use of reasoning strategies in the problems they construct. This result underscores the potential of employing mathematics applications linked to children's literature as an effective pedagogical approach for prospective teachers to transfer mathematical literacy and reasoning skills to their future students.

When the constructed problems were analyzed within the "Learning Area" theme, it was found that prospective teachers predominantly created problems related to the "Numbers and Operations" domain. This finding aligns with the results of Joaquin's (2024) study, which investigated the problem-posing processes of mathematics teachers and prospective teachers. Joaquin reported that while participants were capable of posing problems in various

mathematical topics such as numbers, algebra, geometry, measurement, and data, they tended to follow established routines and predominantly focused on the "Numbers and Operations" domain. The prevalence of problems related to the "Numbers and Operations" domain in the present study can be attributed to the content of the 2018 Mathematics Curriculum, where this domain constitutes 49.5% of the program. It is anticipated that this trend may shift in future studies due to the influence of the updated mathematics curriculum. For instance, an examination of the "Turkish Century Education Model" (2024) reveals that the weight of themes corresponding to the "Numbers and Operations" domain has been reduced to 30.25%, demonstrating a more balanced distribution across other domains.

It has been observed that candidates relate mathematical concepts in various ways within the problems they create. Specifically, in the theme of connections within mathematics, candidates used 16 different concepts, with the most frequently preferred being the concepts of "Fraction" and "Pattern". Similarly, the problems created by candidates to relate mathematics to daily life have also yielded significant findings. Teacher candidates particularly preferred concepts related to everyday life, such as "Shopping" and "Product Quantity". Özgen (2013), in his study examining the connecting skills of prospective mathematics teachers during the problem-solving process, noted that relating mathematics to itself was more commonly used compared to other types of connections. Similarly, Coşkun (2013) found that the most common types of connection used by teachers in the classroom were making connections between concepts and making connections with daily life. These findings align with the results of the present study, which revealed that teacher candidates tend to use mathematics in concrete and familiar contexts, aiming to establish connections that students could more easily understand. On the other hand, one reason for the increased emphasis on connections in the problems could be the characteristics of the problem-creation tasks presented. In the present study, teacher candidates were shown a visual without numerical values. Zhang et al. (2022) identified that participants used more elements and relationships in tasks without numbers, as opposed to tasks involving numerical problem creation. In light of these results, considering that problem-posing activities interact with mathematical connection skills (Mersin & Akkaş, 2023), it is recommended that more problem-posing activities be organized so that prospective teachers can develop their connection skills more effectively. It is believed that such activities will make a substantial contribution to the reinforcement of prospective teachers' mathematical thinking processes,

enhance their comprehension of problem-solving strategies, and foster the development of their ability to establish connections.

Although the problems posed by prospective mathematics teachers have shown positive results in terms of connecting mathematics within itself and with daily life, there are deficiencies in interdisciplinary connections. Only 5 of the 27 pre-service teachers who participated in the study included interdisciplinary connections in the problems they posed. This situation shows that prospective teachers have limited competence in establishing interdisciplinary connections. Özgen (2017) similarly stated that prospective teachers' skills in making connections between mathematics and other disciplines are generally not at a sufficient level. Özgen emphasizes that prospective teachers should participate in interdisciplinary connection practices with more theoretical and practical studies. In this study, it was observed that the activities carried out within the scope of the connection course in mathematics teaching had a limited focus on interdisciplinary connections. However, these findings show that prospective teachers can receive additional training and guidance support to include problems that include interdisciplinary connections. Addressing the issue of interdisciplinary connections more can increase the experiences of prospective teachers in this area. In particular, the inclusion of this process in the activities may encourage candidates to use interdisciplinary connections more frequently and correctly. In addition, it may be clearly stated that teacher candidates are expected to make interdisciplinary connections in the problems they pose, and how they handle this connection may be examined in more detail. In this way, teacher candidates' interdisciplinary thinking skills can be systematically developed and mathematics teaching can be enriched by establishing a stronger connection with other disciplines.

Another significant finding from the research is that divergent thinking was more prominently evident in the problems posed by prospective teachers. This suggests that the problem-posing tasks implemented within the scope of the study encouraged prospective teachers to engage in creative and innovative thinking. However, this finding contrasts with the results of a study by Korkmaz and Hür (2006), where it was observed that prospective teachers rarely included creative problems in their work. Similarly, Işık and Kar (2012) also noted a lack of creative thinking and connectional skills in the problems posed by prospective teachers. In this regard, the context's distinct impact on creativity should also be considered. Singer and Voica (2015) emphasized the importance of context in fostering creative thinking, while Haury (2001) suggested that the integration of mathematics and literature aims to create

a meaningful context for students. The connection between children's literature and mathematics has proven to be an effective method for supporting prospective teachers' creative thinking processes and enhancing their divergent thinking skills. This study also highlights the positive contribution of linking children's literature with mathematics to prospective teachers' problem-posing abilities. In light of these findings, it is recommended that interdisciplinary tasks, such as those connecting children's literature with mathematics, be incorporated into teacher education programs and that such tasks be further encouraged to help develop prospective teachers' creative thinking skills.

As a result, this study reveals that the integration of children's literature and mathematics has a significant effect on the use of reasoning skills of prospective teachers, diversification of mathematical connection skills and development of divergent thinking skills. In this context, enriching mathematics teaching with interdisciplinary connections will strengthen teachers' pedagogical approaches and add depth to students' learning processes. Incorporating children's literature into classroom environments by connecting it with mathematical content may have the potential to develop students' reasoning skills.

## Compliance with Ethical Standards

*Disclosure of potential conflicts of interest*

The authors declare that this study and no processes involved in conducting the study have the potential for conflicts of interest.

*Funding*

No funding from any institution was received for this study.

*CRediT author statement*

The article was collaboratively written by two authors, with each contributing equally to its content.

*Research involving Human Participants and/or Animals*

This study was carried out taking into account ethical rules. The participants were informed about the study and asked to sign a consent form based on a voluntary basis. The study was approved with the decision number 80 taken at the meeting numbered 11 and dated 23.12.2022, by the Board of Directors of the Institute of Educational Sciences at Bursa Uludağ University, from which ethical approval was obtained. The data of the study were collected in the second semester of the 2022-2023 academic year.

## Çocuk Edebiyatı ve Matematik İlişkilendirmesi: Matematik Öğretmen Adaylarının Problem Kurma Durumlarından Yansımalar

**Özet:**

Matematik öğretiminde disiplinler arası ilişkilendirmeden yararlanmak öğretimin niteliğini arttırmakta, öğrenmeyi daha etkili ve kalıcı hale getirmektedir. Bu çalışmada çocuk edebiyatı ile matematik ilişkilendirmesi ele alınmış, bu ilişkilendirme problem kurma üzerinden incelenmiştir. İlgili araştırma nitel araştırma yöntemlerinden durum çalışması deseni ile yürütülmüştür. Bu doğrultuda matematik öğretmen adaylarına çocuk edebiyatı ve matematik ilişkilendirmesine yönelik aralıklı olacak şekilde 6 haftalık uygulamalar gerçekleştirilmiştir. Bu uygulamalar sonucunda matematik öğretmen adaylarından bir çocuk edebiyatı eserinde yer alan görselden yararlanarak kurabildikleri kadar problem kurmaları istenmiştir. 27 matematik öğretmen adayı tarafından kurulan 66 matematiksel problem "İçerik", "Matematiksel İlişkilendirme" ve "Yaratıcılık" temalarını içeren "Problem Kurmayı Değerlendirme Kriterleri" ile betimsel olarak değerlendirilmiş, temalara yönelik frekanslar tablo halinde sunulmuştur. Çalışma sonucunda çocuk edebiyatı ile matematik ilişkilendirmesinin öğretmen adaylarının matematiksel ilişkilendirme becerilerini ve yaratıcılıklarını olumlu anlamda etkilediği sonuçlarına ulaşılmıştır. Aynı zamanda öğretmen adaylarının kurdukları problemlerde problem çözme stratejilerinin kullanımının sayıca fazla olduğu ve en fazla tercih edilen problem çözme stratejisinin matematiksel muhakeme yapma olduğu görülmüştür.

*Anahtar kelimeler*: Çocuk edebiyatı, ilişkilendirme, matematik eğitimi, öğretmen adayları, problem kurma, yaratıcılık.

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