

## EXAMINATION OF MATHEMATICAL PROBLEM SOLVING STUDIES WITH SECONDARY SCHOOL STUDENTS

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### ABSTRACT

The aim of this study is to make a descriptive content analysis of the articles related to mathematical problem solving from the theses in the National Thesis Centre and the journals of the faculties of education published in Tr-dizin and to determine the general trend. A total of 159 theses were included in the study. The studies were examined within the framework of the "Study Review Form on Mathematical Problem Solving Published in National Thesis Centre and Tr-dizin" prepared within the scope of the research. The related studies were analysed within the categories determined within the framework of sub-problems. Frequency and percentage distributions of the categories were calculated with the help of an Excel programme and the data obtained were presented in detail with the help of tables. According to the results of the study, it was concluded that studies on mathematical problem solving were mostly conducted with 7th grade students, quantitative research methods were selected, quantitative analyses were performed and questionnaires and scales were preferred as data collection tools. It is thought that it will be useful in terms of seeing the strengths and deficiencies of the studies carried out in this field and it can be a guide for future studies in terms of seeing the trend of the studies from a holistic perspective.

**Keywords:** Problem Solving; Mathematical Problem Solving; Descriptive Content Analysis; TR-Dizin; National Thesis Centre

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# ORTAOKUL ÖĞRENCİLERİYLE YAPILAN MATEMATİKSEL PROBLEM ÇÖZME İLE İLGİLİ ÇALIŞMALARININ İNCELENMESİ

## ÖZET

Bu çalışmanın amacı; Ulusal Tez merkezinde tezlerden ve Tr-dizin’de yayınlanan Eğitim fakülteleri dergilerine ait matematiksel problem çözme ile ilgili makalelerin betimsel içerik analizinin yapıp genel eğiliminin belirlenmesidir. Toplan 159 çalışmaya dâhil edilmiştir. Araştırma kapsamında hazırlanan "Ulusal Tez Merkezi ile Tr-dizin’de Yayınlanan Matematiksel Problem Çözme Temalı Çalışma İnceleme Formu" çerçevesinde çalışmalar incelenmiştir. İlgili çalışmalar alt problemler çerçevesinde belirlenen kategoriler kapsamında analiz edilmiştir. Oluşturulan kategorilere ait frekans ve yüzde dağılımları Excel programı yardımıyla hesaplanmış ve ulaşılan veriler ise tablolar yardımı ile detaylı bir şekilde sunulmuştur. Araştırmanın sonuçlarına göre; matematiksel problem çözmeyle ilgili en çok 7. sınıf öğrencileriyle çalışmalar yapıldığı, nicel araştırma yöntemlerinin seçildiği, nicel analizlerin yapıldığı ve veri toplama aracı olarak anket ve ölçeklerin daha çok tercih edildiği sonuçlarına ulaşılmıştır. Bu alanda gerçekleştirilen çalışmaların güçlü ve eksik yönlerini görme açısından yararlı olacağı ve çalışmaların eğiliminin bütüncül bir bakış açısıyla görülebilmesi açısından gelecek çalışmalara rehber olabileceği düşünülmektedir.

**Anahtar Kelimeler:** Problem Çözme; Matematiksel Problem Çözme; Betimsel İçerik Analizi; TR-Dizin; Ulusal Tez Merkezi

## 1. INTRODUCTION

We have encountered many problems in our daily lives and have tried to overcome these problems by making sense of and solving them. Solving the problems encountered has become an important subject in the mathematics course when it is considered as a process of processing information, thinking, making sense and creating a strategy. This has given problem solving an important place in mathematics education research. Altun (2016) used the definition of problem solving as finding what to do when faced with a situation and not knowing what to do. Therefore, when faced with a problem, it enters into a process such as understanding this problem, creating new solutions through previous experiences and travelling a path until reaching the result.

Various objectives have been set in our education system in order to improve the quality of the mathematics course and increase success. Some of these objectives are that students should have the necessary mathematical concepts, have self-confidence and courage in mathematics, gain problem solving skills, have self-efficacy and positive attitude towards mathematics. In order to achieve these aims, we should consider some factors. Because the way to teach mathematics well depends on understanding human nature and discovering how mathematics is comprehended by human beings (Underhill, 1988; Frank, 1990; Carte, 1997). These factors are categorized as cognitive factors, affective factors and external factors (Charles & Lester, 1982).

Mathematics has always been used when making the smallest calculations in daily life or when making great discoveries for humanity. In order for other sciences to develop and progress in their own way, mathematics must be used, guide and be a tool. The development of a mechanics software is

impossible without mathematics. Let's think of a logo or an advertisement that is pleasing to the eye, when we think about why it looks more beautiful to people, we can actually say that designers know the golden ratio and use appropriate measurements when designing, that is, they use mathematics. When we hear a melody that sounds good, when we examine its notes, we see that a certain number rule may appear, and from here we will come across mathematics. Based on these points, mathematics is a guide in many places that come to mind and surrounds us. Learning mathematics and transferring these learnings to life are important due to the necessity of using them in daily life (Kırnap-Dönmez, 2014).

Since problem solving is so much in our lives and is of great importance in mathematics, it has an important place in the studies on problem solving in mathematics. In order to be able to solve problems, it is necessary to have a good command of the subject and to be able to acquire and apply mathematical thinking. According to Polya (1957), problem solving is a process of searching for the solution of obtaining what is clearly thought. These situations have increased the focus of most of the studies in the field of mathematics on problem solving.

The secondary school mathematics curriculum was revised in 2018 in order to raise individuals who enable students to see the connection between concepts, make use of technology, model and solve problems with the help of technology, and perform functions such as communication and reasoning. The emphasis and importance of problem solving was reiterated and it was emphasized that problem solving is one of the basic elements in mathematics teaching (Ministry of National Education [MoNe], 2018).

Since problem solving is the focal point of mathematics education, mathematics research has also focused on this subject. Therefore, it has become one of the main topics of academic research and many studies have been conducted. This situation has made the literature review a bit difficult. In order to facilitate the organisation and follow-up of this research, it has become important to use the content analysis method. The main purpose of the content analysis method is to reach the concepts and relationships that explain the data (Yıldırım & Şimşek, 2008).

Coşkun & Soylu (2021) examined 255 studies on mathematical problem solving published in the field of mathematics education in Turkey between 2000 and 2020 by content analysis method, Kurt & Yeşilyurt (2020) analysed 9 articles by content analysis method to examine the relationship between problem solving and academic achievement. Baş & Katrancı (2021) analysed 103 graduate theses on problem solving under different sub-problems by content analysis method. Rahmatiya & Miatun (2020) aimed to define and analyse mathematical problem solving skills of secondary school students in terms of mathematical resilience.

When the different studies conducted in Turkey and abroad were examined, different studies in many fields were found. It was seen that there were studies examining theses or studies examining articles published in different journals. A study was carried out to bring together the articles related to mathematical problem solving in the journals of faculties of education in TR-Dizin and the studies on problem solving in mathematics for secondary school students published in the National Thesis Centre.

The aim of this study is to determine the general tendency of secondary school students by making a content analysis of the articles related to mathematical problem solving in the journals of faculties of education in Turkey published in TR-Dizin and the theses published in the National Thesis Centre. The sub-problems of the research are;

1. How is the distribution of studies according to sample groups?
2. How is the distribution of the studies according to the size of the sample groups?
3. How is the distribution of studies according to research models?
4. How is the distribution of studies according to data collection tools?
5. How is the distribution of studies according to data analysis methods?
6. How is the distribution of studies according to their aims?
7. How is the distribution of the studies according to the results obtained?

## **2. METHOD**

This section provides information regarding the research model, population and sample, development of the measurement tool, and data collection and analysis.

### **2.1. Research Model**

Qualitative data collection techniques such as observation, interview and document analysis are used in the natural environment in which the phenomena are handled in their own context are called qualitative research (Yıldırım & Şimşek, 2008).

Descriptive content analysis is a method in which qualitative and quantitative studies on a certain subject are examined separately and independently from each other, and then the general trends and results of these studies are determined, synthesized and interpreted in a systematic way by creating themes and main templates (Çalık & Sözbilir, 2014). In this way, researchers who do and want to do research on the relevant subject can see in detail what the general trend is.

### **2.2. Universe and Sample**

The population of the research consists of the articles published by the faculties of education and theses published in the National Thesis Centre and the studies prepared on secondary school students.

The sample group of the study consists of 58 articles on mathematical problem solving published in TR-Dizin between 2004 and the end of 2022 and 101 theses published between 2000 and 2022. As a result, it consists of 159 studies.

### **2.3. Data Collection**

In the process of data collection, the journals belonging to the faculties of education in our country were identified, the articles of these journals published in TR-Dizin were accessed, the articles with the theme of mathematical problem solving were identified among the articles, and then the theses were searched by searching with certain keywords from the National Thesis Centre. The theses were reviewed by paying attention to the fact that they were conducted on secondary school students, that

the problem solving topic was related to mathematics, and that they were not conducted in a social or other field. The data obtained were transferred to the Excel programme and saved for analysis in line with the sub-problems.

#### 2.4. Data Analysis

For the studies obtained, the data were recorded regularly according to the sub-problems. Then, a title was opened in the Excel programme according to each of the sub-problems and the data were brought together. In other words, for the first sub-problem, all thesis studies were examined and the data were combined one by one, and this process was completed by continuing for all sub-headings. Afterwards, frequency distributions were made by looking at how many of each item there were. After the frequencies were determined, the total number of items was examined and percentage calculations were made to determine the tendency in each sub-problem. Content analysis is a technique in which categorisation or coding is performed by systematically arranging certain words of a text (Cohen et al., 2000; Büyüköztürk et al., 2018).

Descriptive content analysis process steps followed throughout the study:

1. Determination of the journals belonging to the Faculties of Education in TR-Dizin
2. Identification of articles in journals containing the keyword "problem solving"
3. Selection of articles on "Mathematical problem solving"
4. Identification of theses by using keywords in the National Thesis Centre
5. Recording the identified theses in order to prevent data loss
6. Examination of articles and theses and creation of bibliographies
7. Analysing and processing the articles and theses identified in the review form one by one
8. Analysing the selected works and creating common and different themes
9. Creating and synthesising the graphs of the findings obtained within the framework of the themes and making inferences.

### 3. FINDINGS

In this section, the data obtained by analysing 159 studies included in the research are presented in tables.

#### 3.1. Findings related to the first sub-problem of the research

**Table 1.** Distribution of Mathematical Problem Solving Themed Studies According to Sample Type

Sample type	Frequency (f)	Percentage (%)
7. class students	53	33,39
6. class students	38	17,64
8. class students	25	15,75
Mixed Classes	22	13,86
5. class students	21	13,23
Total	159	100

When the frequency and percentage values of the distribution of the mathematical problem solving theme according to the study groups are examined, it is seen that the most studied study group is 7th grade students with 53 (33,39%). The least number of studies was 21 (13,23%) 5th grade students.

### 3.2. Findings related to the second sub-problem of the research

**Table 2.** Distribution of Mathematical Problem Solving Themed Studies According to Sample Size

Sample size	Frequency (f)	Percentage (%)
0-100	95	59,85
101-300	44	27,72
301-1000	20	12,60
Total	159	100

When the frequency and percentage values of the distribution of mathematical problem solving themed studies according to the sample size are analysed, it is seen that 95 (59,85%) studies were mostly conducted on sample groups with a sample size between 0-100. At least 20 (12,60%) studies were conducted with a sample size of 301-1000.

### 3.3. Findings related to the third sub-problem of the research

**Table 3.** Distribution of Mathematical Problem Solving Themed Studies According to Research Approaches

Research approach	Frequency (f)	Percentage (%)
Quantitative	80	50,40
Qualitative	55	34,65
Mixed	24	15,12
Total	159	100

When the frequency and percentage values of the distribution of mathematical problem solving themed studies according to research models are examined, it is seen that 80 (50,40%) studies were conducted with quantitative methods, 55 (34,65%) studies were conducted with qualitative methods and 24 (15,12%) studies were conducted with mixed research model

### 3.4. Findings related to the fourth sub-problem of the research

**Table 4.** Distribution of Mathematical Problem Solving Themed Studies According to Data Collection Tools

Data Collection Tools	Frequency (f)	Percentage (%)
Questionnaire/Scale	87	26,10
Interview	54	16,20
Problem Solving Test	53	15,90
Attitude / Perception / Personality Tests	41	12,30
Forms	39	11,70
Achievement Test	26	7,80
Observation	11	3,30
Problem Formation Test	7	2,10
Activity	7	2,10
Video	5	1,50
Document Review	3	0,90
Other	2	0,60
Total	335*	100

\*The reason why the total frequency is higher than the number of studies analysed is that some studies reached more than one result.

Looking at the table of the distribution of problem solving themed studies according to data collection tools, it is seen that the most commonly used data collection tool is the use of questionnaire/scale in 87 (26,10%) studies. Afterwards, it is seen that interview methods are preferred in 54 (16,20%) studies.

### 3.5. Findings related to the fifth sub-problem of the research

**Table 5.** Distribution of Mathematical Problem Solving Themed Studies According to Data Analysis Methods

Data Analysis Methods	Frequency (f)	Percentage (%)
Predictive Analysis (t-test, correlation, anova, ancova, manova, mancova, factor analysis, regression, non parametric tests)	96	40,32
Qualitative Data Analysis (content analysis, qualitative descriptive analysis, document analysis)	93	39,06
Quantitative Data Analysis	28	11,76
Descriptive Analysis (frequency, percentage tables, mean, standard deviation, graphical representation)	22	9,24
Total	239*	100

\*The reason why the total frequency is higher than the number of studies analysed is that some studies reached more than one result.

When the table of the distribution according to the data analysis methods used in mathematical problem solving themed studies is examined, it is seen that predictive analysis is

used in 96 (40,32%) studies. Then, it is seen that qualitative data analysis was preferred in 93 (39,06%) studies. The least used method was descriptive analysis.

### 3.6. Findings related to the sixth sub-problem of the research

**Tablo 6.** Distribution of Mathematical Problem Solving Themed Studies According to Their Purposes

Code	Subcode	Articles	f	%
Methods in Problem Solving	Different solving methods; Problem solving methods of gifted students; Mathematical thinking	Akçakın (2010), Aktaş (2019), Altıntaş (2009), Altuntaş (2019), Arıkan (2014), Arslan (2013), Ayaz (2009), Balır (2019), Bayazıt (2021), Baysal (2020), Ceylan (2018), Çakır Balta (2008), Çelebi (2013), Gökkurt (2015), Kablan (2019), Kaplan (2017), Kara (2013), Kara Çalışkan (2019), Karataş (2002), Kaş (2010), Kaya (2020), Keklik (2018), Koç Deniz (2019), Koç Koca (2021), Küpçü (2012), Özkubat (2021), Sarıtaş (2015), Sezgin (2019), Sipahi (2021), Süzer Uğur (2018), Şanlıdağ (2020), Tanrıseven (2000), Tat (2015), Terzi (2021), Tuncel (2019), Yıldırım (2018)	36	23,08
Problem Solving Skills	Problem solving in process; Metacognitive skills; Responses of metacognitive skills according to demographic characteristics; Contribution of realistic mathematics education to skills	Akkaş (2014), Akkurt (2020), Alan (2009), Altun (2006), Atasoy (2021), Atay (2017), Ateş (2020), Aydın (2016), Aydın (2017), Aydın (2020), Bal Sezerel (2012), Baş (2013), Ceylan (2008), Demir (2019), Derin (2006), Ericek (2020), Erkan (2013), Genç (2020), Güreffe (2018), Kablan (2016), Karaoğlan (2009), Kılıç (2011), Kirişçi (2019), Kozikoğlu (2020), Özgen (2017), Öztuncay (2005), Sevgi (2020), Sezgin Memnun (2015), Soylu (2007), Şakar (2018), Takır (2020), Taşpınar (2011), Töre (2007), Ulu (2008), Umurbek (2020), Usta (2013), Yeşilova (2013), Yıldız (2008)	36	23,08
Relationships in problem solving	Mathematics subjects; Metacognitive and other subjects; Reading habits and success; Chess knowledge and problem solving	Altındağ Kumaş (2019), Aşık (2009), Atlıhan (2021), Bağdat (2020), Bakırcı (2014), Balcı (2007), Büyükaşık (2017), Çavuşoğlu (2010), Deryal (2021), Gören (2020), Gür (2015), Gürtaş (2021), Hut	25	16,03



		(2019), Kadirhan (2018), Karakoca (2011), Karakuş Aktan (2019), Karatağ (2017), Karslıgil Ergin (2015), Kavuncu (2019), Kazak (2012), Polat (2012), Sevgi (2021), Yıldız Üstündağ (2021), Yılmaz (2017), Zorbozan (2021)		
Effects on Problem Solving	The effect of mathematical modeling on achievement; The effect of visual representations on solving problems correctly; Misconceptions in verbal problems; The effect of creative problem solving activities; The effect of metacognitive skills of activities in the process	Altuntaş (2019), Arsu (2019), Aycan Kavlak (2019), Aydurmuş (2013), Bakır (2019), Bal İncebacak (2018), Başol (2015), Beydili (2019), Cankoy (2011), Çelik (2012), Çora (2018), Genç (2017), Gündoğdu (2020), İnan Tutkun (2018), Mayan (2019), Özkök (2005), Özkubat (2019), Özyıldırım Gümüş (2020), Pehlivan (2012), Tat (2015), Tuncel (2019), Uysal (2007), Ülger (2004), Yıldırım (2012)	24	15,38
Strategies in Problem Solving	Strategies of gifted students; Strategies in verbal problems; Success and retention in cooperative learning; Strategies used by special students and normal students; Strategies used in solving non-routine problems; Effects of gamified educational robot activities on strategies	Bayazit (2017), Gök (2017), Gündoğdu (2020), Kaplan (2017), Katrancı (2014), Kaya (2020), Koç Koca (2021), Mayan (2019), Özenoğlu (2021), Özkubat (2021), Sipahi (2021), Uysal (2007), Yazlık (2016), Yıldız (2012)	14	8,97
Processes in Problem Solving	Determination of students' learning and misconceptions; Problems with more than one solution containing excessive, incomplete or contradictory information; Differentiation of demonstration tools or special software compared to traditional methods; Effects on students' problem solving process from 5th to 8th grade	Akkan (2012), Bozkurt (2010), Çelik Arslan (2007), Karabacak (2013), Keşan (2018), Özdemir (2018), Taş (2017), Taşpınar (2015), Topcu (2022), Yılmaz (2007)	10	6,41
Problem posing	The effects of mathematics teaching on achievement and attitude	Erdoğan (2019), Fidan (2008), Salman (2012), Şimşek (2012), Turhan (2011), Turhan (2014)	6	3,85

Scales in Problem Solving	Scale development and interrater reliability	Baran Bulut (2018), Büyükkıdık (2012), Çanakçı (2011)	3	1,92
Attitudes and Concepts in Problem Solving	Attitude towards problem solving; Definitions of problem concept	Turhan Türkkkan (2016), Uğurluoğlu (2008),	2	1,28
Total			156	100

When the frequency and percentage values of the distribution of the mathematical problem solving themed studies according to their aims are analysed, it is seen that the most studies are "Methods in Problem Solving" and "Problem Solving Skills" with 36 (23,08%) studies. The least was "Attitudes and Concepts in Problem Solving" with 2 (1,28%) studies.

### 3.7. Findings related to the seventh sub-problem of the research

**Table 7.** Findings Related to the Distribution of Mathematical Problem Solving Themed Studies According to the Results Obtained

Code	Subcode	Articles	f	%
Skills in Problem Solving	There is a positive relationship between students' metacognitive skills; The effect of gender variable; There is a positive relationship between metacognitive skills; Polya's problem solving steps are not sufficient; There is a significant difference in socio-economic level; There is a significant increase in Polya's problem solving methods; There is a significant relationship between mother and father's education levels; There is a significant relationship with multiple representation skills; There is a positive effect in preschool education; Intelligence games improve reflective thinking skills; Problem-based learning is more successful than traditional method; Gifted students exhibited metacognitive skills; Increase as a result of creating effective learning spaces; Positive relationship between number perception and non-routine; Problem posing skill level increases as it increases; There is a negative relationship between learned helplessness;	Adagideli (2017), Akçakın (2010), Akkaş (2014), Alan (2009), Altıntaş (2009), Altun (2006), Aşık (2009), Ateş (2020), Atlıhan (2021), Aycan Kavlak (2019), Aydın (2016), Aydın (2020), Balcı (2007), Ceylan (2018), Çavuşoğlu (2010), Derin (2006), Deryal (2021), Durmaz (2014), Erdoğan (2019), Ericek (2020), Gökkurt (2015), Gündoğdu (2020), Gürtaş (2021), Hut (2019), Işık (2011), Kaplan (2016), Kara (2013), Karakoca (2011), Kaş (2010), Kaya (2020), Koç Deniz (2019), Özgen (2017), Özkubat (2021), Pehlivan (2012), Salman (2012), Sevgi (2020), Sezgin (2019), Sezgin Memnun (2015), Şanlıdağ (2020), Takır (2020),	51	25,63

<p>Success in Problem Solving</p>	<p>Significant increase with activity supported flipped classroom model; Significant increase with realistic mathematics education; Levels increase as grade levels increase; Male students have higher levels than female students; Mother and father's occupation does not affect; There is no difference between students studying in public and private schools; There is a significant difference between parents being together or apart; There is a positive relationship between number sense and representation in decimal notation; There is an increase within the framework of active learning; Teaching through dramatization improves compared to traditional teaching; Purdue model is effective; Worksheets increase skills; Learning with inquiry problem solving approaches is more effective than traditional learning approach; Abacus mental arithmetic training has a positive effect on skills; Feedback increases collaborative performance.</p> <p>Gender difference does not affect; Relationship between metacognitive self-regulation; Relationship between mathematical self-efficacy; Reflective thinking skills have a positive effect; mother and father's education levels do not affect; Reading comprehension and interpretation are effective; Positive relationship between problem solving factors and mathematics achievement; There is a significant difference in problem solving steps; Those who do problem solving steps are more successful; Gifted students are more successful than normal students; Misconceptions are in the positive direction compared to achievement; Operational is less successful in solving concept problems in probability; Mathematics</p>	<p>Tanrıseven (2000), Taş (2017), Taşpınar (2015), Tat (2015), Terzi (2021), Topcu (2022), Uğurluoğlu (2008), Usta (2013), Uysal (2007), Ülger (2004), Yıldız (2008)</p> <p>Akkurt (2020), Altundağ Kumaş (2019), Altuntaş (2019), Arslan (2013), Arşuk (2019), Aşık (2009), Ateş (2020), Ayaz (2009), Aydurmuş (2013), Bakırcı (2014), Balcı (2007), Baş (2013), Başol (2015), Bayazit (2017), Beydili (2019), Ceylan (2008), Çakır Balta (2008), Çelebi (2013), Çelik (2012), Çelik Arslan (2007), Erkan (2013), Gür (2015), Kadirhan (2018), Kaplan (2017), Karakoca (2011), Karakuş Aktan (2019), Karaoğlan (2009), Kaş (2010), Kaya (2020), Kılıç (2011),</p>
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	<p>achievement is high; There is a significant increase when solved by paying attention to the contexts of the problem; There is a significant difference between Pirie-Kieren levels; There is a significant success among those who are trained with the selective problem solving model; There is an increase in levels by integrating daily life situations into mathematics; Public school students are more successful than private school students; High achieving students exhibit more metacognitive behaviors than unsuccessful students; Low achieving students exhibit behaviors in the awareness dimension and other students in the evaluation dimension; Personalized verbal problems increase academic achievement.</p>	<p>Kirişçi (2019), Koç Koca (2021), Koçoğlu (2019), Kozikoğlu (2020), Öztuncay (2005), Polat (2012), Salman (2012), Sevgi (2021), Tat (2015), Tuncel (2019), Uğurluoğlu (2008), Umurbek (2020), Uysal (2007), Yeşilova (2013), Yılmaz (2007), Zorbozan (2021)</p>	
<p>Strategies in Problem Solving</p>	<p>Different solutions used by students; Gifted students use more than one different strategy compared to normal students; The least table was used; Equation construction strategy; It was seen that they had misconceptions; Positive in computer assisted mathematics teaching; They made necessary drawings while solving; Positive effect of quantum learning model; Estimation and control are used the most; Extraordinary problem solving training increases flexibility scores; The highest performance shows at the comprehension stage; Students develop different solution strategies to the questions; There is a significant difference between the strategies used by students, pre-service teachers and teachers in solving questions.</p>	<p>Altun (2006), Aşık (2009), Atay (2017), Aycan Kavlak (2019), Aydın (2016), Bakır (2019), Balcı (2007), Bayazit (2017), Ceylan (2018), Demir (2019), Durmaz (2014), Genç (2020), Gören (2020), Güreffe (2018), Kal (2013), Koç Koca (2021), Özenoğlu (2021), Özkubat (2021), Özyıldırım Gümüş (2020), Sevgi (2020), Sipahi (2021), Taş (2017), Taşpınar (2011), Ulu (2008), Uyar (2019), Yıldız (2012)</p>	<p>26 13,07</p>
<p>Positives in Problem Solving</p>	<p>To be able to make necessary modeling; Students show positive development as the level increases from Grade 5 to Grade 8; Creative problem solving curriculum has a positive contribution; There is a significant relationship between mathematical thinking</p>	<p>Akkan (2012), Aktaş (2019), Altuntaş (2019), Aydın (2020), Bal İncebacak (2018), Bal Sezerel (2012), Baran Bulut (2018), Baysal (2020), Beydili (2019), Çelebi (2013), Çelikkol</p>	<p>24 12,06</p>

skills and achievement; Generalization has an effect on improving problem understanding; Self-evaluation Grade; Creative problem solving curriculum has a positive contribution; There is a significant relationship between mathematical thinking skills and achievement; Generalization has an effect on improving problem understanding; Self-evaluation is higher than teacher evaluation; Peer evaluation is higher than teacher evaluation; Out-of-order problem solving education significantly increases the scores in the high school transition exam; It is more effective when parents are together; Reflective thinking is usually carried out; There is a high level of relationship between metacognitive in students with learning disabilities; Students with high academic achievement use multiple representations more; Education in accordance with the standards is more effective than the traditional method; Selective problem solving technique is a technique with high social validity; Feedback increases collaborative performance; Mathematics teaching based on the theory of didactic situations has positive behaviors; The factor structure of the original version of the creative problem solving inventory and the adapted version of the inventory to Turkish overlapped.

Not being able to interpret mathematical expressions verbally; Inadequate use of Geogebra by teachers; They could not make the necessary modeling; They had difficulty in solving problems; They had problems in understanding, modeling and solving daily life problems; They had the most difficulty in mathematical modeling at the point of understanding the problem; Students with learning difficulties have lower performance

(2016), Çora (2018), Derin (2006), Genç (2020), Gök (2017), İnan Tutkun (2018), Kal (2013), Karakoca (2011), Kavuncu (2019), Özgen (2017), Özkök (2005), Özkubat (2019), Öztuncay (2005), Sarıtaş (2015)

Aktaş (2019), Aycan Kavlak (2019), Aydın (2016), Bayazit (2021), Bozkurt (2010), Çoksöyler (2020), Demir (2019), Genç (2017), Hıdıroğlu (2014), Karatağ (2017), Kazak (2012), Özdemir (2018), Özkubat (2019), Soylu (2007), Töre (2007), Turhan Türkkan (2016)

Negatives in  
Problem  
Solving

16 8,04

than students with low and medium levels; Student success in problems related to the sum of two fractions remains low; Students defined it as difficult, boring, requiring effort and not easily solved.

Attitude in Problem Solving	Gender difference does not affect; There is a significant difference in the problem, socio-economic level; Develop a scale; Positive relationship with chess knowledge; Mathematics achievement is high.	Arslan (2013), Aşık (2009), Balcı (2007), Büyükaşık (2017), Çanakçı (2011), Çavuşoğlu (2010), Çelik Arslan (2007), Karakoca (2011), Kaş (2010), Öztuncay (2005), Salman (2012), Tuncel (2019), Uğurluoğlu (2008), Yılmaz (2017), Zorbozan (2021)	15	7,54
Problem Formulation	Students' positive attitudes and achievement in mathematics teaching have improved; it increases mathematics achievement; success in problem solving activities is higher; it increases as the grade level increases.	Arıkan (2014), Atılhan (2021), Bağdat (2020), Erdoğan (2019), Gündoğdu (2020), Karslığıl Ergin (2015), Katrancı (2014), Mayan (2019), Salman (2012), Şakar (2018), Şimşek (2012), Turhan (2011), Yıldız Üstündağ (2021)	13	6,53
Routine Problems	Solved more easily than non-routine problems; Positive increase in problems solved with creative drama; They were more successful with the assimilating learning style than with the modifying learning style.	Gündoğdu (2020), Kara Çalışkan (2019), Keklik (2018), Süzer Uğur (2018), Süzer Uğur (2018),	5	2,51
Non Routine Problems	There is a positive relationship between number perception and problem solving skills; The success of students with the accommodating learning style is higher than that of students with the modifying style; Students use creative reasoning skills.	Işık (2011), Kara Çalışkan (2019), Süzer Uğur (2018)	3	1,51
Total			199*	100

\*The reason why the total frequency is higher than the number of studies analysed is that some studies reached more than one result.

When the frequency and percentage values of the distribution of the mathematical problem solving themed studies according to the results are analysed, "Skills in Problem Solving" with 51 (25,63%) studies and "Success in Problem Solving" with 46 (23,12%) studies are seen the most. The least is "Non-Routine Problems" with 3 (1,51%) studies.

#### **4. DISCUSSION, CONCLUSION AND SUGGESTIONS**

In this study, it was aimed to descriptively examine the theses on mathematical problem solving for secondary school students and the articles on mathematical problem solving published in TR-Dizin between 2000 and 2022 in Turkey. Within the scope of this purpose, the studies were analyzed by content analysis according to sample size, sample type, research approach, data collection methods, data analysis methods, aims, and results. By analyzing the findings of the study, the following conclusions were reached and some suggestions were made according to the results.

When the study was examined, it was seen that the studies were applied to seventh grade students at most, followed by applications to sixth grades. Özturan-Sağırılı & Baş (2020) stated that studies were carried out mostly in the sixth and seventh grades among secondary school students, that is, the intermediate grades were emphasised. When we look at the sample sizes, it is seen that most of the applications were made to the group of 0-100 people. Özdemir-Fincan (2021), in his study, found studies with a sample size between 0-100 at most. Albayrak & Çiltaş (2017) stated in their research that the most used sample size in the theses they examined was in the range of 31-100.

When the distribution of theses and articles according to research models is examined, it is seen that the most preferred research model is quantitative method. Due to the quantitative structure of problem solving and the fact that it contains quantitative variables, the desire to measure and calculate these variables can be shown as a reason for the selection of quantitative methods. In this study and in the literature, the reason why quantitative method is more common in this way can be explained by the reasons of collecting and interpreting data more easily and quickly with quantitative research. When the findings obtained within the scope of this research were analysed, it was seen that the mixed approach was used less in terms of research method. This result coincides with the results of Özdemir-Fincan (2021), Baş & Katrancı (2021), Aykaç, Köğce & Aslandağ (2020), Toptaş & Kılıçkaya (2017), Şenyurt & Özer Özkan (2017), Yaşar & Papatğa (2015), Ozan & Köse (2014) and Ulutaş & Ubuz (2008).

When the distribution of the studies according to data collection tools is analysed, it is seen that the most commonly used data collection tools are questionnaires/scales. The fact that the costs of scales and questionnaires are more economical, that more people can be reached with scales and questionnaires, and that they are more advantageous in terms of labour and time compared to other data collection tools has led to more studies based on scales and questionnaires (Baş, 2005). Again, problem solving tests, open-ended question forms and achievement tests, which are data collection tools within the scope of quantitative approach, have been the most preferred data collection tools in total. Ergül,

Alp & Doğan (2022), Yeşil & Kablan (2019) and Ozan & Köse (2014) also reached results supporting this situation in their studies. Considering the distribution according to data analysis methods, it was concluded that predictive and descriptive quantitative data analyses were preferred more than qualitative data analysis methods. In addition, it was observed that predictive statistics was preferred more than descriptive statistics among quantitative data analysis methods. Coşkun & Soylu (2021) and Ertane-Baş (2019) reached similar results in their studies.

When the distribution of theses and articles according to their aims was analysed, it was seen that the main topic was to determine problem solving and its components under the aims such as "Examining its relationship with problem solving using different methods", "Determining problem solving skills in the problem solving process" and "Determining problem solving strategies and metacognitive skills used in the problem solving process". Ergül et al. (2022) analysed the postgraduate studies on mathematical problem solving and its components and concluded that studies on problem solving and its components were more common.

When the distribution of the results of the studies is analysed, it is seen that "Gender difference does not affect the attitude towards problem solving and success", while it is said that gender difference does not affect problem solving skills, in some studies it is found that girls are more successful. It was also seen that there is a positive relationship between problem solving skills and strategy selection and teacher competence. Teachers' pedagogical content knowledge and professional experiences are important factors in the problem solving process for teachers to gain the strategies necessary for the problem solving process and to be an effective guide in the problem solving process. Eroğlu & Taşlı (2015) investigated how teachers interpret student errors in the problem solving process and which strategies they recommend through clinical interviews. In the results of the study, it was observed that experienced and inexperienced teachers were inadequate in interpreting students' errors and suggested similar strategies as strategies. Gürbüz & Güder (2016) concluded in their study that teachers were not sufficient in using different strategies while solving problems. Özpınar & Arslan (2017) concluded that since teachers' effective and correct use of mathematical language is an important factor in teaching problem solving skills to students, teachers should be developed and trained in this regard. Hartman (2010) also stated that teachers' pedagogical content knowledge is shaped in classroom practices.

Based on the findings and the results obtained, the following recommendations are presented;

- Studies on eighth grade and fifth grade students were conducted less than other groups. It can be suggested to contribute more to the literature by increasing the studies on these groups.
- While quantitative studies were carried out in large numbers, others remained fewer in number. It can be suggested that mixed and qualitative studies should be emphasized in order to make more in-depth analyses and to consider the points where quantitative studies may be incomplete.
- It was observed that the data collection tools were mainly test-based, which is due to the predominance of quantitative research. Since the use of more and different data collection



tools while collecting data will prevent the data obtained from being overlooked, it can be suggested that many data tools should be utilised by using mixed research methods. Thus, it can be said that data analysis methods will be used more diversely.

- In order to determine the developments in the field of problem solving, articles and theses published at certain intervals can be analysed. In this way, it is important to identify and analyse the trends of new studies in order to examine and follow the development and change of the problem solving process.
- In future studies on mathematical problem solving, different dimensions can be examined within the scope of content analysis for published studies.

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## GENİŞLETİLMİŞ TÜRKÇE ÖZET

### ORTAOKUL ÖĞRENCİLERİYLE YAPILAN MATEMATİKSEL PROBLEM ÇÖZME İLE İLGİLİ ÇALIŞMALARININ İNCELENMESİ

#### GİRİŞ

Günlük hayatımızda birçok problemle karşılaşmış ve karşılaştığı bu problemleri ise anlamlandırma ve çözüme yoluyla üstesinden gelmeye çalışmıştır. Karşılaşılan problemleri çözüme; bilgiyi işleme, düşünme, anlamlandırma ve bir strateji oluşturma süreci olarak düşünüldüğünde matematik dersinde önemli bir konu haline gelmiştir. Bu ise problem çözmenin matematik eğitimi araştırmalarında önemli bir yer edinmesini sağlamıştır. Altun (2016) problem çözüme için bir durum ile karşı karşıya kalınıp ne yapılacağına bilinmediği anlarda ne yapması gerektiğini bulmaktır tanımını kullanmıştır. Bu yüzden bir problem ile karşılaştığında bu problemi anlamak, önceki deneyimleri aracılığıyla yeni çözüm yolları oluşturmak ve sonuca ulaşana kadar bir yol kat etmek gibi bir süreç içerisine girer.

Ortaokul matematik dersi öğretim programı; öğrencilerin kavramlar arasındaki bağı görmelerini sağlayan, teknolojilerden yararlanıp, teknoloji yardımıyla modelleme yapıp problem çözebilen ve iletişim kurma, akıl yürütme gibi işlevleri yerine getirebilen bireyleri yetiştirebilmek için 2018 yılında revize edilmiştir. Problem çözüme vurgusu ve önemi yinelenerek matematik öğretiminde Problem çözmenin temel elamanlardan olduğu vurgulanmıştır (Millî Eğitim Bakanlığı [MEB], 2018).

Yurt içinde ve yurt dışında yapılmış olan farklı çalışmalar incelendiğinde birçok alanda yapılmış farklı çalışmalara rastlanılmıştır. Tez inceleyen çalışmalar veya farklı dergilerde yayınlanmış makaleleri inceleyen çalışmalar olduğu görülmüştür. TR-Dizin’de Eğitim Fakülteleri Dergilerinde Yer Alan Matematiksel Problem Çözme ile İlgili Makalelerin ve Ulusal Tez Merkezi’nde yayınlanmış olan ortaokul öğrencilerine yapılmış matematikte problem çözme temalı çalışmaların bir arada olduğu çalışmanın literatüre kazandırılması için çalışma yapılmıştır.

Bu çalışmanın amacı ortaokul öğrencilerin TR-Dizin’de yayımlanan Türkiye’deki eğitim fakülteleri dergilerine ait matematiksel problem çözme ile ilgili makalelerin ve Ulusal Tez Merkezi’nde yayımlanmış olan tezlerin içerik analizinin yapıp genel eğiliminin belirlenmesidir. Araştırmanın alt problemleri ise;

1. Çalışmaların örneklem gruplarına göre dağılımı nasıldır?
2. Çalışmaların örneklem grupları büyüklüğüne göre dağılımı nasıldır?
3. Çalışmaların araştırma modellerine göre dağılımı nasıldır?
4. Çalışmaların veri toplama araçlarına göre dağılımı nasıldır?
5. Çalışmaların veri analiz yöntemlerine göre dağılımı nasıldır?
6. Çalışmaların amaçlarına göre dağılımı nasıldır?
7. Çalışmaların ulaşılan sonuçlara göre dağılımı nasıldır?

## **YÖNTEM**

Bu bölümde araştırmanın modeline, evren ve örnekleme, ölçme aracının geliştirilmesine, verilerin toplanması ve çözümlenmesine ilişkin bilgilere yer verilmiştir.

### **Araştırmanın Modeli**

Nitel veri toplama teknikleri olan gözlem, görüşme ve doküman analizinin kullanıldığı olguların doğal ortamda kendi bağlamında ele alındığı araştırmalara nitel araştırma denir (Yıldırım & Şimşek, 2008).

### **Evren ve Örneklem**

Araştırmanın evrenini, TR-Dizin ortamında ulaşılan eğitim fakültelerine ait yayımlanmış olan makaleler ve Ulusal Tez Merkezi'nde yayınlanmış tezlerden ortaokul öğrencileri üzerinde hazırlanmış çalışmalardan oluşmaktadır.

### **Verilerin Toplaması**

Verilerin toplanması sürecinde, ülkemizdeki eğitim fakültelerine ait dergilerin belirlenmesi, bu dergilerin TR-Dizin' de yayımlanan makalelerine ulaşılması, ulaşılan makaleler içinden matematiksel problem çözme temalı makalelerin belirlenmesi daha sonra Ulusal Tez Merkezinden belli anahtar kelimeleri ile taranarak araştırılmış ve tezlere ulaşılmıştır. Ortaokul öğrencileri üzerinde yapılmış olmasına, problem çözme konusunun matematikle alakalı olmasına ve sosyal ya da başka bir alanda yapılmış olmamasına dikkat edilerek tekrar gözden geçirilmiştir. Elde edilen veriler Excel programına aktarılmış ve alt problemler doğrultusunda analiz için kaydedilmiştir.

### **Verilerin analizi**

Elde edilen çalışmalar için alt problemlere göre veriler düzenli bir şekilde kayıt altına alınmıştır. Daha sonra alt problemlerin her birine göre Excel programında bir başlık açılıp veriler bir araya getirilmiştir.

## **TARTIŞMA VE SONUÇ**

Çalışmayı incelendiğinde en fazla yedinci sınıf öğrencilerine çalışmaların uygulandığı, sonrasında altıncı sınıflara uygulamalar yapıldığı görülmüştür. Özturan-Sağırılı & Baş (2020) ortaokul öğrencilerinden en fazla altıncı ve yedinci sınıf öğrencilerinde çalışmaların yapıldığını yani ara sınıflara ağırlık verildiğini söylemişlerdir. Örneklem büyüklüklerine baktığımızda ise en çok 0-100 arası kişi grubuna uygulama yapıldığı görülmektedir.

Tezlerin ve makalelerinin araştırma modellerine göre dağılımına bakıldığında, en çok tercih edilen araştırma modelinin nicel yöntem olduğu görülmüştür. Problem çözmenin nicel yapısından ve nicel değişkenleri barındırmasından dolayı bu değişkenlerin ölçülmek ve hesaplanmak istenmesi nicel yöntemlerin seçilmesine neden olarak gösterilebilir. Yapılan bu çalışmada ve alan yazında bu şekilde nicel yöntemin daha fazla olmasının bir sebebi olarak nicel araştırma ile daha kolay ve hızlı verileri toplama ve yorumlayabilme nedenleri ile açıklanabilir. Bu

araştırma kapsamında ulaşılan bulgular incelendiğinde araştırma yöntemi bakımından karma yaklaşımın daha az kullanıldığı görülmüştür.

Çalışmaların veri toplama araçlarına göre dağılımına bakıldığında, en çok kullanılan veri toplama araçlarının anketler/ölçekler olduğu görülmüştür. Yine nicel yaklaşım kapsamındaki veri toplama araçları olan problem çözme testleri, açık uçlu soru formları ve başarı testleri toplamda en çok tercih edilen veri toplama araçları olmuştur.

Tezler ve makale çalışmalarının amaçlarına göre dağılımına bakıldığında, “Farklı yöntemler kullanılarak problem çözmeyle ilişkisinin incelenmesi”, “Problem çözme sürecindeki problem çözme becerilerini belirlemek” ve “Problem çözme sürecinde kullanılan problem çözme stratejilerini ve üst bilişsel becerilerini belirlemek” gibi amaçlar altında temel konunun problem çözme ve unsurlarını belirlemek olduğu görülmüştür.

Çalışmaların sonuçlarına göre dağılımına bakıldığında, “Cinsiyet farklılığı problem çözmeye olan tutumu ve başarıyı etkilememektedir” cinsiyet farklılığının problem çözme becerisini etkilemediği söylenirken, bazı çalışmalarda kızların daha başarılı olduğu sonucu bulunmuştur. Baz sonuçlardanda “Problem çözme becerisi ve strateji seçimi ile öğretmen yeterliliği arasında olumlu yönde ilişki vardır” sonucuna ulaşıldığıda görülmüştür. Öğretmenlerin problem çözme süreci için gerekli olan stratejileri kazandırmaları ve problem çözme sürecinde etkili bir rehber olmaları için pedagojik alan bilgisi ve mesleki deneyimleri problem çözme sürecinde önemli bir etkidir.