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Content Analysis of Articles Published on Spatial Ability in Turkey Until 2022

2022 Yılına Kadar Türkiye'de Uzamsal Yetenek Konusunda Yayınlanan Makalelerin İçerik Analizi

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CONTENT ANALYSIS OF ARTICLES PUBLISHED ON SPATIAL ABILITY IN TURKEY UNTIL 2022

ABSTRACT

It has been found that existing articles on research trends related to spatial ability in Turkey primarily focus on the content of postgraduate theses. However, there is a lack of research examining published articles in this field. The aim of this study is to address this gap and provide valuable insights for future research. This study analyzes total of 43 articles scientific journal articles in the reach on spatial ability that were published in Turkish scientific journals until 2022. This study aims to provide an extensive and thorough synthesis of the existing literature on spatial ability studies, specifically focusing on the research conducted in the search engines of DergiPark and TR Dizin. The research group was selected using criterion sampling. The selected articles were examined based on authorship, publication year, objectives, research methods, sample groups, results, and data analysis methods. Objectives of the studies were categorized into four main headings: improving spatial ability, examining spatial ability in relation to variables, investigating spatial ability with specific sample groups, and studying factors influencing spatial ability. The results obtained from the research are that the spatial ability levels of the sample group are low or medium; they are tabulated according to whether there is a relationship between spatial ability and gender and whether there is an effect on other variables. Apart from these, it has also been revealed that there are articles in which it is concluded that spatial ability can be improved. According to the results of the analysis, suggestions were made for people who will do research in this field.

Keywords: Spatial Ability, Content Analysis, Literature Review.

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2022 YILINA KADAR TÜRKİYE'DE UZAMSAL YETENEK KONUSUNDA YAYINLANAN MAKALELERİN İÇERİK ANALİZİ

ÖZ

Türkiye'de uzamsal yetenek ile ilgili araştırma eğilimlerine ilişkin mevcut makalelerin ağırlıklı olarak lisansüstü tezlerin içeriğine odaklandığı tespit edilmiştir. Ancak bu alanda yayınlanmış makaleleri inceleyen araştırmaların eksikliği bulunmaktadır. Bu çalışmanın amacı bu boşluğu gidermek ve gelecekteki araştırmalar için değerli bilgiler sağlamaktır. Bu çalışma, 2022 yılına kadar Türk bilimsel dergilerinde yayınlanmış, uzamsal yetenek kapsamındaki toplam 43 bilimsel dergi

makalesini analiz etmektedir. Bu çalışma, özellikle DergiPark ve TR Dizin arama motorlarında yapılan araştırmalara odaklanarak, uzamsal yetenek çalışmalarına ilişkin mevcut literatürün kapsamlı bir sentezini sunmayı amaçlamaktadır. Araştırma grubu ölçüt örnekleme yöntemiyle seçilmiştir. Seçilen makaleler yazarlık, yayın yılı, amaçlar, araştırma yöntemleri, örneklem grupları, sonuçlar ve veri analiz yöntemleri temel alınarak incelenmiştir. Çalışmaların amaçları dört ana başlıkta toplanmıştır: Uzamsal yeteneğin geliştirilmesi, Uzamsal yeteneğin değişkenlerle ilişkisinin incelenmesi, Uzamsal yeteneğin spesifik örneklem grupları ile araştırılması ve Uzamsal yeteneği etkileyen faktörlerin incelenmesi. Araştırmadan elde edilen sonuçlar örneklem grubunun uzamsal yetenek düzeylerinin düşük veya orta düzeyde olduğu; uzamsal yetenek ile cinsiyet arasında ilişki olup olmadığına ve diğer değişkenlere etkisi olup olmadığına göre tablolaştırılmıştır. Bunların dışında uzamsal yeteneğin geliştirilebileceği sonucuna varılan makalelerin de olduğu ortaya çıkmıştır. Analiz sonuçlarına göre bu alanda araştırma yapacak kişilere önerilerde bulunulmuştur.

Anahtar Kelimeler: Uzamsal Yetenek, İçerik Analizi, Literatür Taraması.

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INTRODUCTION AND THEORETICAL FRAMEWORK

Objects are seen in a three-dimensional shape, and the three-dimensional space represents the physical and navigable environment. In this context, the space in which people move is considered three-dimensional, with dimensions of height, width, and depth. Spatial ability allows for the perception of this space (Küçükay & Yenilmez, 2021).

Research on spatial ability has been conducted since the early 1900s. One of the early notable studies in this field was carried out by Thurstone (1938). This study explored the connection between spatial ability and intelligence. As stated in İpekoğlu et al. (2020) there have been studies linking spatial ability to disciplines like geology, chemistry, mathematics, and geometry, with the aim of comprehending and defining spatial ability.

According to Tartre and Fennema (1995), being able to mentally change one's perspective while objects stay in place in three-dimensional space is connected to spatial visualization skills. Sorby (1990) proposes that activities like playing with building toys as a child, drawing and painting during school, playing three-dimensional computer games, and participating in interactive sports can help develop spatial skills. Marunić and Glažar (2014) describe spatial ability as the ability to remember, retrieve, and manipulate visual images.

Carroll (1993) categorized research on spatial ability into three periods. The first period, from 1904 to 1940, viewed spatial ability as a component of intelligence. The second period, spanning from 1940 to 1960, explored the presence or absence of subcomponents within spatial ability. The third period focuses on factors that can impact spatial ability, such as gender and environmental factors. Kurt (2002) has been examined the relationship between spatial ability and academic success. In the ongoing research conducted by Uygan &Turgut (2012), associated with spatial ability and methods to enhance this ability have begun to be investigated.

Examining scientific studies helps uncover facts and truths about a subject. Also reviewing scientific studies contributes to conducting new research based on existing knowledge and advances in the field. Literature reviews compile summaries and significant findings of studies related to a specific topic, making it easier to access and utilize the information.

Literature reviews provide a snapshot of the current state of research on a topic and the accumulated scientific knowledge. They are essential for those considering further research on a subject, offering valuable insights and guidance for researchers. They enable researchers to quickly acquire information about the latest developments in a field, serving as a critical resource when conducting new research or developing studies based on existing knowledge.

Literature reviews help determine the strength of knowledge in a specific field and identify areas that require further investigation. These reviews contribute to the progress of science and offer guidance to researchers.

Within the scope of this research, answers were sought to the following questions:

1. How many authors contribute to each article examined?
2. Distribution of articles in the examined journals over the years?
3. Distribution of articles in the examined journals exhibit in terms of their objectives?
4. Distribution of the research methods used in the articles in the examined journals?
5. Distribution of articles in the examined journals based on their sample groups?
6. Distribution of the results obtained from the articles in the examined journals?
7. What are the data analysis methods used in the articles in the examined journals?

The answers to the research questions will reveal the current trends in studies conducted in the field until 2022. This aims to provide an overview of the current situation and highlight developments for future professionals in this field. Additionally, by analyzing the findings, we can gain insights into the advancements made in recent years and understand the evolving nature of the research. Moreover, this research seeks to identify the direction of research progress and determine areas that require further attention, thereby contributing to the overall growth and development of the field.

It is crucial to determine whether there has been an increase or decrease in interest in studying spatial ability over the years. If the trend shows a decline, it is worth noting this point and directing future studies by highlighting the shortcomings in this area. Additionally, it is important to identify the specific aspects of spatial ability that these studies focus on, as indicated by the main heading. By outlining the subtopics within this subject, it will become evident which areas of research are receiving more attention and which areas have been relatively neglected, based on the significance of the findings anticipated from the respective titles.

METHOD

This study aims to analyze the content of articles published in scientific journals in Turkey that are focused on spatial ability. Content analysis is a method used in processing qualitative research data obtained from sources. It includes the stages of coding the data, explaining and interpreting the findings (Yıldırım & Şimşek, 2006).

In the initial phase of this research, a comprehensive search was conducted in the Google Scholar search engine using the keyword "spatial ability". It was observed that a multitude of diverse terms and phrases were utilized in lieu of the specific term "spatial ability". This study aims to provide an extensive and thorough synthesis of the existing literature on spatial ability studies, specifically focusing on the research conducted in the search engines of DergiPark and TR Dizin. To achieve this, the articles were meticulously examined and analyzed based on the specified keywords in both Turkish and English, ensuring a comprehensive coverage of the subject matter. Notably, the selection criteria for the included studies encompassed articles that contain the term "spatial" and exclude those that primarily focus on "analysis" and "test". The intent is to present a comprehensive overview of the current state of research on spatial ability, shedding light on the various perspectives and approaches adopted in this domain. The search was conducted as follows:

"uzamsal AND (yetenek OR zekâ OR yönelim OR beceri OR düşünme OR

görselleştirme OR görselleme OR canlandırma OR görsellik OR alışkanlık)

NOT (test OR analiz)”

“spatial AND (ability OR intelligence OR orientation OR skill OR tkinking

OR habit) NOT (test OR analysis)”

Content analysis was conducted on the articles listed in Table 1.

Table 1. Articles for Content Analysis

Article ID	***Title of the Article***	***References***
A1	*Contribution of students' mathematical skills and spatial ability of achievement in secondary school physics*	*(Delialioğlu & Aşkar, 1999)*
A2	*A study on Developing Sixth-Grade Students' Spatial Visualization Ability*	*(Yolcu & Kurtuluş, 2010)*
A3	*İlköğretim İkinci Kademe Öğrencilerinin Zihinsel Döndürme Becerilerinin Bazı Değişkenler Açısından İncelenmesi*	*(İrisoğlu & Ertekin, 2012)*
A4	*İlköğretim 7. ve 8. Sınıf Öğrencilerinin Uzamsal Yeteneklerinin İncelenmesi*	*(Turğut & Yilmaz, 2012)*
A5	*Sanal ortam ve somut nesneler kullanılarak gerçekleştirilen modellemeye dayalı etkinliklerin uzamsal düşünme ve zihinsel çevirme becerilerine etkisi*	*(Yurt & Sümbül, 2012)*
A6	*İlköğretim Matematik Öğretmen Adaylarının Uzamsal Görselleştirme Becerilerinin SOLO Modeli ile İncelenmesi*	*(Göktepe & Özdemir, 2013)*
A7	*A Case Study on the Ways How Engagement with Spatial Visualization Problem Solving Activities Helps Pre-Service Mathematics Teachers in Solving Mental Rotation Problems*	*(Kırmaç & Bulut,2013)*
A8	*3D bilgisayar modellerinin akademik başarıya ve uzamsal canlandırmaya etkisi: Atom modelleri*	*(Akıllı & Seven, 2014)*
A9	*The Effect of Teaching Geometry Which is Differentiated Based on the Parallel Curriculum for Gifted/Talented Students on Spatial Ability*	*(Kök & Davaslıgil, 2014)*
A10	*Dinamik Geometri Yazılımı ile Öğretimin İlköğretim 6. Sınıf Öğrencilerinin Uzamsal Yeteneklerine Etkisi*	*(Şimşek & Koru Yücekaya, 2014)*
A11	*8. Sınıf Öğrencilerinin Dönüşüm Geometrisi Başarılarının Uzamsal Becerileri, Geometri Anlama Düzeyleri ve Matematiğe Yönelik Tutumları Arasındaki İlişkinin İncelenmesi*	*(Yıldırım Gül & Karataş, 2015)*
A12	*Uzamsal Beceri ve Uzamsal Kaygı Arasındaki İlişki: Sınıf Öğretmeni Adayları Üzerine Bir Araştırma*	*(Sarı, 2016)*
A13	*Geometrik-Mekanik Oyunlar Temelli Etkinliklerin Ortaokul Öğrencilerinin Uzamsal Düşünebilme Becerilerine Etkisi*	*(Demirkaya & Masal, 2017)*
A14	*Öğretmen Adaylarının Uzamsal Görselleştirme Yetenekleri ve Uzamsal Kaygıları Üzerine Bir Çalışma*	*(Erkek, Işıksal & Çakıroğlu, 2017)*
A15	*Cinsiyet, Uzamsal Beceri, Mantıksal Düşünme Becerisi ve Çözüm Tercihleri Arasındaki İlişkinin İncelenmesi*	*(Hacıömeroğlu & Hacıömeroğlu, 2017)*

A16	*Relationship of Pupils' Spatial Perception and Ability with Their Performance in Geography*	*(Likouri et. Al,.2017).*
A17	*Artırılmış Gerçeklik Uygulamalarının İlköğretim Öğrencilerinin Uzamsal Yeteneklerine ve Akademik Başarılarına Etkisi*	*(Tosik Gün & Atasoy,2017)*
A18	*Öğretmen Adaylarının Mantıksal ve Uzamsal Düşünme Becerileri: Bölüm, Cinsiyet ve Akademik Performansın Etkisi*	*(Turgut et. al., 2017)*
A19	*Öğretmen Adaylarının Uzamsal Yeteneklerinin Çeşitli Değişkenler Açısından İncelenmesi*	*(Abay et. al., 2018)*
A20	*Mühendislik Eğitiminde Uzamsal Görselleştirme Becerisinin Akademik Başarıya Etkisinin Araştırılması*	*(Balak & Kısa, 2018)*
A21	*The Relationship Between Mathematical Reasoning and Spatial Ability of Eighth Grade Students*	*(Gürbüz et. al.,2018)*
A22	*7. Sınıf Öğrencilerinin Uzamsal Yönelim Becerilerini Geliştirmeye Yönelik Tasarlanan Öğrenme Ortamının Değerlendirilmesi*	*(Kösa & Kalay, 2018)*
A23	*Apartmanlar Oyununun Ortaokul Matematik Öğretmen Adaylarının Uzamsal Görselleştirme Yeteneklerine Olan Etkisi*	*(Zeybek & Saygı, 2018)*
A24	*Farklılaştırılmış Geometri Öğretiminin Üstün Yetenekli Öğrencilerdeki Yaratıcılık, Uzamsal Yetenek ve Erişiye Etkisi*	*(Batdal Karaduman & Davaslığı, 2019)*
A25	*Ters-Yüz Sınıf Modelinin ve Web 2.0 Yazılımlarının Bilgisayarca Düşünme Becerisi, Etkinlik Tecrübesi ve Uzamsal Düşünme Becerisine Etkisi*	*(Çakır et. al., 2019)*
A26	*Matematik ve Sınıf Öğretmen Adaylarının Uzamsal Yeteneklerinin İncelenmesi*	*(Dündar et. al., 2019)*
A27	*Sekizinci Sınıf Öğrencilerinin Uzamsal Görselleştirme, Zihinsel Döndürme ve Zihinde Canlandırma Becerilerinin Matematik Odaklı Epistemolojik İnançlar ve Bazı Değişkenlerle İlişkisi*	*(Kaya, 2019)*
A28	*Görsel İspat Becerisinin, van Hiele Geometrik Düşünme Düzeyleri ve Uzamsal Yetenek ile İlişkisi*	*(Polat et. al., 2019)*
A29	*Öğretmen Adaylarının Uzamsal Yetenek ve Uzamsal Yetenek Öz-Değerlendirmeleri Arasındaki İlişki*	*(Sütçü,2019)*
A30	*Seventh Grade Students' Spatial Ability and Their Attitudes Towards Geometry*	*(Topraklıoğlu & Öztürk,2019)*
A31	*Investigation of Spatial Ability Self-assessment Levels of High School Students*	*(Bedir & Yılmaz, 2020)*
A32	*Meslek Yüksekokulu Son Sınıf Öğrencilerinin Uzamsal Yeteneklerinin İncelenmesi*	*(Benzer& Yıldız, 2020)*
A33	*Uzaktan Eğitimde Uzamsal Görselleştirme: 3 Boyutlu Tasarım Sürecinin Uzamsal Yeteneğe Etkisi*	*(Çetin, 2020)*
A34	*An Exploration of First Year Pre-service Engineering Graphics and Design Teachers' Spatial Visualisation Ability at a University of Technology*	*(Sıngh-Pıllay & Sotsaka, 2020)*

A35	*Effects of 3D Applications in Organic Chemistry Lessons on Preservice Teachers' Spatial Ability*	*(Yavuz et. al., 2020)*
A36	*The Spatial Thinking Ability Students on the Character of Urban and Rural Environments in Solving Population Problems*	*(Purwanto et. al., 2021)*
A37	*Ortaokul Öğrencilerinin Uzamsal Zekâ Becerilerinin Cinsiyet, Sınıf ve Okul Açısından İncelenmesi*	*(Sevgi et.al., 2021)*
A38	*İlköğretim Matematik Öğretmen Adaylarının Uzamsal Görselleştirme ve Zihnin Uzamsal Alışkanlıkları Arasındaki İlişki*	*(Şen, 2021)*
A39	*Uzaktan Eğitimde Uzamsal Görselleştirme: 3 Boyutlu Tasarım Sürecinin Uzamsal Yeteneğe Etkisi*	*(Yenilmez & Küçükay, 2021)*
A40	*The Effects of Augmented Reality in the Technical Drawing Course on Engineering Students' Spatial Ability and Academic Achievement*	*(Akkuş & Yüksel Arslan, 2022)*
414	*Mimar Adayları İçin Uzamsal Yetenekleri Geliştirmeye Yönelik Eğitici Bir Oyun Önerisi*	*(Dural, 2022)*
A42	*Üç Boyutlu Tasarım Programlarıyla Gerçekleştirilen Etkinliklerin Sınıf Öğretmeni Adaylarının Uzamsal Becerilerinin Gelişimine Etkileri*	*(Özçakır Sümen, 2022)*
A43	*Mobil Uygulamaya Dayalı Öğretimin Öğrencilerin Uzamsal Becerilerine Etkisi*	*(Taş & Yavuz, 2022)*

FINDINGS

Within the scope of the study, a total of 43 articles published in scientific journals in Turkey on spatial ability until 2022 were reviewed, and content analysis of these articles was performed. The initial question is: "How many authors contribute to each article examined?"

Table 2. Author Distribution in Articles

Number of Authors	***Article ID***	***f***	***%***
1	*A12, A27, A29, A33, A38, A41, A42*	*7*	*16,2*
2	*A1, A3, A4, A5, A6, A7, A8, A9, A10, A11, A13, A14, A15, A17, A20, A22, A23, A24, A30, A31, A32, A34, A39, A40, A43*	*26*	*60, 47*
3	*A16, A18, A19, A21, A25, A26, A28, A35, A36, A37*	*10*	*23,26*
TOTAL		***43***	***100***

According to Table 2, it has been found that the majority of articles on spatial ability are written by two authors, and there are no more than three authors in this field.

The second question of the study is defined as " 1. Distribution of articles in the examined journals over the years?". Based on the data presented in Table 3, it

can be observed that the highest number of articles were published in 2019. Based on recent research, it appears that there has been a significant increase in the number of studies conducted on the subject since the year 2017.

Table 3. Articles Distribution by Year

Publication Date	*Article ID*	*f*	*%*
1999	*A1*	*1*	*2,33*
2010	*A2*	*1*	*2,33*
2012	*A3, A4, A5*	*3*	*6,98*
2013	*A6, A7*	*2*	*4,65*
2014	*A8, A9, A10*	*3*	*6,98*
2015	*A11*	*1*	*2,33*
2016	*A12*	*1*	*2,33*
2017	*A13, A14, A15, A16, A17, A18*	*6*	*13,94*
2018	*A19, A20, A21, A22, A23*	*5*	*11,63*
2019	*A24, A25, A26, A27, A28, A29, A30, A31*	*8*	*18,60*
2020	*A32, A33, A34, A35*	*4*	*9,3*
2021	*A36, A37, A38, A39*	*4*	*9,3*
2022	*A40, A41, A42, A43*	*4*	*9,3*
TOTAL		***43***	***100***

The third question of the study is, "Distribution of articles in the examined journals exhibit in terms of their objectives?". As shown in Table 4, the purposes of the articles have been grouped into four main categories. There are 8 articles focused on enhancing spatial ability, 9 articles analyzing spatial ability based on variables like gender, class or school. In 14 articles analyzing spatial aptitude, and 12 articles investigating the impact of activities (virtual environment, augmented reality, 3D design programs, games) on spatial ability.

Table 4. Objectives Distribution of the Articles

Objective of the study	*Article ID*	*f*	*%*
Enhancement of spatial ability	*A2, A9, A15, A22, A23, A24, A42, A39*	*8*	*18,61*
Analyzing based on variables (gender, class, school)	*A3, A4, A12, A18, A19, A20, A27, A37, A38*	*9*	*20,93*
Analysis of spatial aptitude	*A1, A6, A7, A11, A14, A16, A21, A26, A29, A30, A31, A32, A34, A36*	*14*	*32,56*
Investigating the impact of activities (virtual environment, augmented reality, 3D design programs, games) on spatial ability	*A5, A8, A10, A13, A17, A25, A28, A33, A35, A40, A41, A43*	*12*	*27,90*
TOTAL		***43***	***100***

The fourth question of the study is: "Distribution of the research methods used in the articles in the examined journals?". It can be seen that 4 articles utilized qualitative methods, 29 articles employed quantitative methods, and 10 articles utilized mixed methods.

Table 5. Distribution of the Research Methods of the Articles

Research Methods	***Article ID***	***f***	***%***
Mixed Methods	*A6, A7, A10, A17, A25, A33, A34, A36, A39, A42*	*10*	*23,26*
Qualitative Methods	*A2, A18, A28, A41*	*4*	*9,30*
Quantitative Methods	*A1, A3, A4, A5, A8, A9, A11, A12, A13, A14, A15, A16, A19, A20, A21, A22, A23, A24, A26, A27, A29, A30, A31, A32, A35, A37, A38, A40, A43*	*29*	*67,44*
TOTAL		***43***	***100***

The fifth question of the study is identified as "Distribution of articles in the examined journals based on their sample groups?". When examining Table 6, it can be observed that the majority of the sample groups analyzed in the articles are at the secondary education level (41,85%), and studies conducted with university students are more common compared to other sample groups (27,91%). Additionally, it is worth noting that there is a limited and inadequate number of samples at the primary and high school levels.

Table 6. Distribution of Sample Groups in the Studies

Sample Groups	***Article ID***	***f***	***%***
Elementary School	*A17*	*1*	*2,33*
Secondary School	*A2, A3, A4, A5, A9, A10, A11, A13, A16, A21, A22, A23, A24, A25, A27, A30, A37, A43*	*18*	*41,85*
High School	*A1, A31, A36*	*3*	*6,98*
University	*A8, A18, A19, A20, A26, A29, A32, A33, A38, A39, A42, A41*	*12*	*27,91*
Teacher Candidates	*A7, A6, A12, A14, A15, A28, A34, A35, A39*	*9*	*20,93*
TOTAL		***43***	***100***

The sixth question of the study was identified as "Distribution of the results obtained from the articles in the examined journals?". The results obtained from the articles are presented in Table 7. When creating this table, it was not subjected to frequency and percentage analysis, as each article could have yielded multiple results. The results were categorized, and articles with similar findings were identified. Among the 43 articles examined, 11 concluded that there was no correlation between the spatial abilities of the sample group and their genders. Additionally, 6 articles found a correlation between spatial ability and gender. 18 articles concluded that spatial ability can be improved.

Table 7. Results Distribution from the Studies

Results	***Article ID***
The spatial ability level of the sample group is low.	*A4, A7, A6, A16, A18, A20, A127, A31*
The spatial ability level of the sample group is moderate.	*A19, A29*

Article ID	***Descriptive Statistics***	***Pre-Test-Post-Test***	***t-test***	***Correlation***	***Regression***	***ANOVA***	***Mann-Whitney U test***	***Wilcoxon Signed Rank test***	***Kruskal Wallis H test***
A1					+				
A2		+							
A3	+		+						
A4	+		+	+					
A5		+	+						
A6		+							
A7		+							
A8		+							
A9		+					+	+	
A10		+							
A11				+			+		
A12			+	+					
A13		+	+						
A14			+			+			
A15			+	+					
A16	+								+
A17		+	+						
A18	+					+			
A19			+	+		+			
A20	+			+					
A21	+			+					
A22		+	+						
A23	+	+	+						
A24		+					+	+	
A25	+	+	+			+			
A26	+					+			
A27	+			+	+				
A28	+			+					
A29	+			+					
A30	+		+	+					
A31							+		
A32	+		+			+			
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A34	+								
A35		+	+						
A36	+						+	+	
A37	+		+						
A38	+		+	+		+			
A39	+	+							
A40		+				+			
A41	+								
A42	+	+						+	
A43		+	+						

There is a correlation between the spatial abilities of the sample group and their genders.	*A11, A12, A14, A15, A29, A34*
There is no correlation between the spatial abilities of the sample group and their genders.	*A3, A4, A16, A19, A20, A30, A32, A36, A37, A38, A42*
The spatial abilities of the sample group have an influence on the variables.	*A1, A11, A14, A15, A19, A21, A26, A27, A28, A30, A32, A37, A38*
There is a moderate impact of spatial abilities of the sample group on the variables.	*A3*
The spatial abilities of the sample group do not have an impact on the variables.	*A16, A18, A31, A36*
Spatial ability can be improved.	*A2, A5, A8, A9, A10, A13, A17, A22, A23, A24, A25, A33, A35, A39, A40, A41, A42, A43*

The last question of the study is "What are the data analysis methods used in the articles in the examined journals?". The analysis methods in the examined articles have been categorized as descriptive statistics, pre-test-post-test, t-test, correlation, regression, ANOVA, Mann-Whitney U test, and Wilcoxon Signed-Rank test. The articles that used these analysis methods have been indicated with a plus sign.

Table 8. Data Analysis Approaches Utilized in the Articles

When reviewing Table 8, we can see that the most commonly employed method of data analysis in the articles is descriptive statistics, which is used in 22 articles. Conversely, regression, Wilcoxon Signed-Rank Test and Kruskal Wallis-H Test are among the less frequently utilized methods.

RESULTS

Until 2022, a total of 43 articles on spatial ability in Turkey were identified and analyzed. The articles were categorized based on the number of authors, with 60,47% having two authors, 16,2% having a single author, and the remaining 23,26% having three authors. The year with the highest number of studies on spatial ability was 2019. It has been observed that the academic progress made on this subject has been an improvement over the period extending to the present day. It is understood that these current scientific publications are increasing and that this field is increasing comprehensively when examined academically.

The analyzed articles addressed various aspects of spatial ability, including:

- 8 articles focused on the development of spatial ability.
- 9 articles analyzing spatial ability based on variables like gender, class or school.
- 14 articles focused on the examination of spatial ability
- 12 articles investigating the impact of activities (virtual environment, augmented reality, 3D design programs, games) on spatial ability.

In terms of research methods, 67,44% of the articles used quantitative methods, 9,30% used qualitative methods, and 23,26% utilized mixed methods. When it comes to the samples used in the studies, only one article focused on primary school students, while another article focused on high school-level students. The majority of studies were conducted with secondary education-level students.

Upon reviewing the results, it was found that in 9 out of 43 articles, there was no significant relationship between the sample group's spatial abilities and their genders. However, 6 articles reported a relationship between spatial ability and gender. Additionally, 18 articles suggested that spatial ability can be improved.

Descriptive statistics were the most commonly used data analysis method in the articles, while regression, Wilcoxon Signed-Rank Test and Kruskal Wallis-H Tests were used less frequently.

According to the research results, the following suggestions can be made for those conducting research in the field of spatial ability:

- The research sample groups primarily consist of secondary school students. It is recommended to focus on developing spatial abilities before school, perhaps even in the family environment. Conducting research with younger students would also contribute to the literature.
- Many studies have been conducted on the development of spatial ability, as revealed by the literature review. It has been observed that students' spatial abilities can be enhanced through activities that involve pre-tests and post-tests. These activities can utilize concrete materials, computer-aided games and narratives, as well as virtual and augmented reality technologies. Studies that provide suggestions for improving spatial ability should be emphasized.
- To enhance the research results, it is advisable to diversify data analysis methods and employ advanced statistical and analytical techniques.

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