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An Analysis of Scientific Studies Examining The Relationship Between Chess And Geometry (Descriptıve Analysis)

ARAŞTIRMA MAKALESİ

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Abstract

Chess is a game with a complex set of rules that depends on the rules system being reflected on the board, predicted, and used creatively during the game. Due to its complexity and problem-solving nature, chess is also offered as an elective course in basic education to provide children with cognitive and mental gains. Given this situation, examining studies on chess and mathematics education will provide us with information about the form and structure of chess education. This study seeks to answer the question of what kind of trend exists in the literature regarding the relationship between chess and mathematics. In this context, previous studies on chess and mathematics education were reviewed, and a pool of 19 publications was created, consisting of 9 articles, 9 graduate theses, and 1 conference paper.

Keywords: Chess, Chess education, Mathematics, Descriptive analysis

Öz

Satranç bireysel düzeyde oynanması, kurallar sisteminin tahtaya yansıtılmasına, tahmin edilmesine ve oyun sırasında yaratıcı bir şekilde kullanılmasına bağlı karmaşık kural yapısına sahip bir oyundur. Satrancın karmaşıklığı ve problem çözme üzerine kurulu olmasından dolayı temel eğitimde çocuklara bilişsel ve zihinsel kazanım sağlamak adına seçmeli ders olarak da sunulmaktadır. Durum bu şekilde iken satranç ve matematik eğitimi üzerine yapılan araştırmaların incelenmesi satranç eğitiminin şekli ve yapısı hakkında bizlere bilgi sunacaktır. Çalışmada satranç ve matematik ilişkisini literatürde ne gibi bir eğilime sahiptir sorusuna cevap aranmaya çalışılmıştır. Bu bağlamda satranç ve matematik eğitimi ile ilgili önceden yapılmış araştırmalar taranmış ve 9 makale, 9 lisansüstü tez ve 1 bildiri olmak üzere 19 adet yayın havuzundan oluşturulmuştur.

Anahtar Kelimeler: Satranç, Satranç eğitimi, Matematik, Betimsel analiz

Introduction

Chess is one of the most important fields that exercise and develop the human brain, which has unlimited capacity and processing power. Because chess is directly related to the human brain. It is possible to observe the functioning of the human brain in chess moves and to see the functioning of the brain in the relationships of chess pieces. In chess, which provides an active learning environment, students do most of the work. Students actively use their brains, think about ideas, solve problems, and apply what they learn immediately. Learning chess is fast, fun, supportive, and engaging. In this respect, it is possible to say that chess is an important tool for effective learning. The results of research on chess have shown that individuals who play chess have improvements in their mental capacities such as creativity, critical thinking, decision making, problem solving, that chess has a positive effect on achievement and that chess is a good sport (Manak, 2007: 14). In particular, it can be seen that the most important features that chess gives to the individual can be seen as increasing mathematical ability and memory. It can be said that features such as focusing, the desire to reach the goal, planning, and transferring skills from one area of knowledge to another are directly related to chess. These results can be interpreted to meanthat playing chess is an important learning tool in education. Considering that learning takes place in the brain, it can be said that the educational activities carried out provide the development of the player and thus the brain.

It is quite simple to understand the connection between chess and mathematics; there are an infinite number of calculations involving everything from consciously taking the previous step and predicting the next step at the slightest move, to counting the number of offensive and defensive pieces, to calculating long continuations. Calculating these possibilities and putting them into practice is directly related to logical mathematical intelligence, one of the cognitive abilities that can explain intelligence today. A player's abilities, such as questioning, reasoning, following a logical path, modeling steps, and making connections, are indicators of the effectiveness of this area. Characteristics of Individuals with this Intelligence;

- Performs mental operations easily and quickly.
- They have strong reasoning ability.
- Recognizes, classifies, and explains relationships.
- Establishes connections between information.
- Enjoys dealing with numbers.
- Interested in math games.
- Can think abstractly and conceptually.
- Establishes cause and effect relationships.

It can be said that children with logical-mathematical intelligence develop abstract thinking or cause-effect relationship skills and are interested in strategic games such as chess, compared to their peers. Students aim to achieve success through abstract ways to solve the problems they face (Yaman, 2022).

Method

Research Design

When the researches on chess, mathematics, and geometry education in recent years were examined, it was seen that the researches were carried out with descriptive survey and document analysis techniques as well as the bibliometric analysis method (Karasar, 2014). In this study, the descriptive analysis method was preferred since the number of studies reached was small. As a matter of fact, descriptive analysis is a quantitative method that determines the relationship between articles, journals, authors, organizations, countries, and keywords in a particular field, regardless of the number and amount (Büyüköztürk et al., 2013). This method also allows us to review the literature over a long period of time and to check effective research in that field by using tools that allow us to visually see this relationship (Yıldırım & Şimşek, 2014).

Population Sample

As stated in the previous sections, the scientific studies to be examined in the research consist of scientific papers, graduate theses and articles from bases such as Google Scholar, Yök-thesis, and Dergipark published in Turkish. These Google Scholar, Yök-Tez, and Dergipark sites were accessed by searching with the keywords used (chess, mathematics, and chess, geometry and chess, etc.). The scientific studies accessed were examined one by one, and only the studies that reveal and examine the relationship between chess, geometry, and mathematics were subjected to examination. Accordingly, a total of 19 scientific studies (Şahin & Yıldırım, 2022; Güner, 2013; Karalı & Taşkesen, 2022; Gül & Serin, 2017; Karamete & Güneş, 2014; Gözübüyük Tamer, 2020; Çubukçu & Kahraman, 2017; Yaman, 2022; Yenilmez & Uygan, 2010; Şahin, 2021; Kaynar, 2014; Manak, 2007; Sağlam Tekneci, 2009; Kuduz, 2022; Büyükaşık, 2017; Aydın, 2017; Uludağ, 2017; Baltayeva, 2021; Sadık, 2018) constituted the population and sample group of our study.

Data Collection Tools

In the study, the "scientific article classification form", which was first designed by Sözbilir et al. (2015) and then edited and developed by Uzun and Öngören (2022), was used to subject the articles to a certain classification. The article classification form includes the article introducer, the subject of the article, the research method, data collection tools, sampling and data analysis stages, the type of the article, the period of acceptance of the article, keywords, and the city where the research was conducted.

The first step in the data collection process of the research was to review the literature on chess, mathematics, geometry, and chess. After the literature review was completed, Google Scholar, Yök-Tez, and Dergipark were used for the purpose of the research by typing words such as chess, mathematics, and geometry in the search engine section. This screening process was conducted on April 05, 2023.

Data Analysis

The research was analyzed using descriptive content analysis, one of the quantitative research methods. The basic element in content analysis is to bring together data that are similar to each other within the scope of determined themes and concepts, and as a result, to create and evaluate them in a way that the reader can understand (Stemler, 2000). In the study, descriptive content analysis was conducted by creating certain themes and coding. In order to ensure the reliability of the research, the selected articles were first analyzed by the researcher, and then the classifications and findings were re-examined by expert and impartial researchers, and inconsistencies in the classifications and findings were eliminated. The data from the content analyzed articles were transferred to the scientific article classification form, and the data obtained here were digitized and transferred to Microsoft Excel 2022 LTC environment. Then, with the help of descriptive statistics, the number of articles by year, article type by year, time of acceptance for publication, author titles, scientific subject areas of the authors, keywords, city where the research was conducted, research method used, data collection tool, sample group and size, validity and findings, reliability and data analysis methods were tabulated as frequency and percentage using the mathematical processing module in the database environment and some data were visualized.

Findings

The scientific researches conducted in a field of science are very important in order to have information about the current situation of the field of science and the level of development of the country where the researches are conducted (Kozak, 2003; Hotamışlı & Erem, 2014).

In this study, data were obtained by following descriptive analysis processes and accordingly, findings were obtained in terms of the distribution of the studies in terms of number and types in terms of years; distribution according to the cities where the research data were collected; distribution of the scientific field of the authors, keywords used in the studies; distribution in terms of methods and data collection tools used in the studies; sample type and size used in the studies; distribution of validity and reliability used in the studies and data analysis methods used in the studies.

Distribution of Studies by Number and Types

According to the data examined within the scope of the research, the distribution of studies according to their number and types is organized in the table below.

Table 1.

Distribution of Studies by Number and Type by Years

Year	Article	Graduate Thesis	Declaration
2007		1	
2009	1	1	
2010	1		
2014	1	1	
2017	2	2	
2018		1	1
2020	1		
2021		2	
2022	2	1	
Total (n: 19)	**9**	**9**	**1**

According to the data in Table 1, the number of studies analyzed is 19. Accordingly, the latest study was completed with a postgraduate thesis in 2007. In the studies conducted until today, the number of articles and postgraduate theses has been the same.

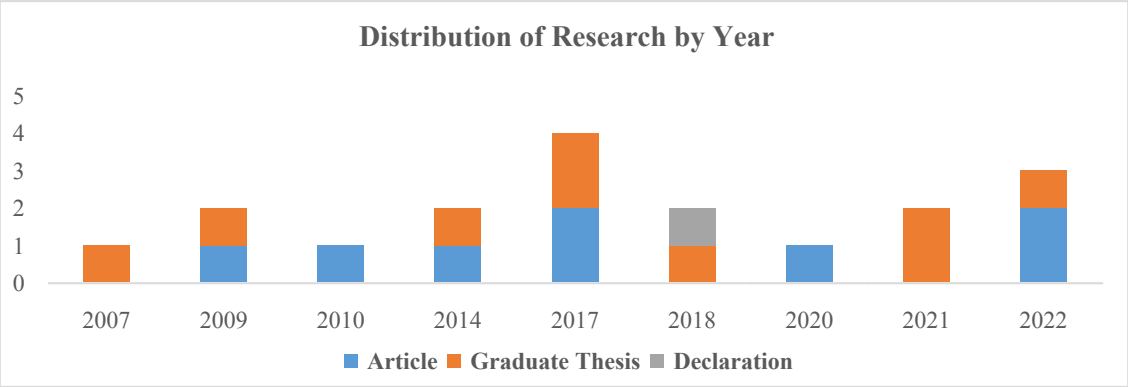


Figure 1.

Number Distribution of Studies by Years

According to the data in Chart 1, 2017 was the year in which the most studies were conducted with two articles and two raduate studies. According to these data, the cities in which the studies were conducted have also gained importance. As a matter of fact, it is essential to collect the data with an equal distribution throughout the country in order to make a healthy evaluation based on the results obtained.

According to the data in Table 2, it is understood that Ankara (N: 5) was the province where most of thr data was collected. The capital city is followed by Eskişehir (N: 4), Istanbul (N: 3), Çanakkale (N: 2), and Bursa (N: 2). The only place where data was collected in Turkish outside the country was the research conducted in the TRNC.

Table 2.

Distribution of Cities where Data was Collected

Cities Where Data is Collected	*n*	*%*
Ankara	5	20
Eskisehir	4	16
Istanbul	3	12
Canakkale	2	8
Bursa	2	8
Batman	1	4
Kutahya	1	4
Sakarya	1	4
Giresun	1	4
Kilis	1	4
Mugla	1	4
Hatay	1	4
Kocaeli	1	4
Duzce	1	4
TRNC	1	4
Total	**25**	**100**

According to the data in Table 3, the distribution of the scientific fields of the authors mentioned in the studies was generally dominated by educational sciences. In the field of educational sciences, the most predominant field of the authors was Preschool Education, with a rate of 28% compared to general fields. This field was followed by Mathematics Education (16%), Computer Education and Instructional Technology Education (12%), Classroom Teacher Education (12%), Guidance and Psychological Counseling Education (8%), and Science Education (4%). The field of educational sciences constitutes 80% of the total distribution. Other disciplines included Sociology (4%), Psychology (4%), Computer (4%) Engineering (4%), Forensic Medicine (4%), and Sports Management (4%).

Table 3.

Distribution of Scientific Fields of Authors

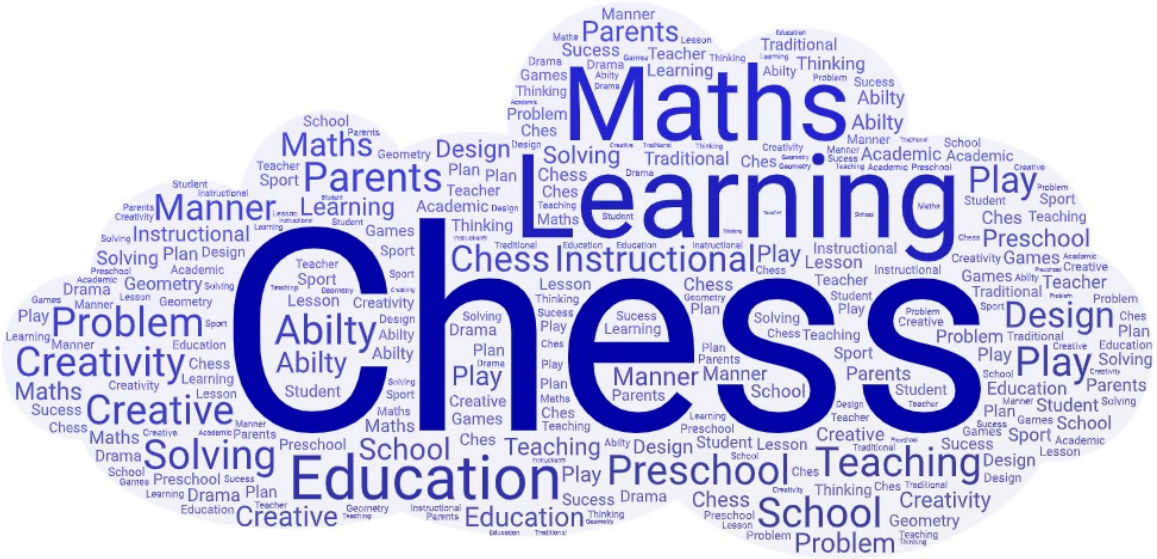
Scientific Fields of the Authors		*n*	*%*
Education Sciences (%80)	Preschool Education	7	28
	Mathematics Education	4	16
	Computer Education and Instructional Technology	3	12
	Classroom Teacher Education	3	12
	Guidance and Psychological Counseling Training	2	8
	Science Education	1	4
Other Disciplines (20%)	Sociology	1	4
	Psychology	1	4
	Computer Engineering	1	4
	Forensic Medicine	1	4
	Sport Management	1	4
Total		**25**	**100**

Key Words Distribution of Research

The keywords in the analyzed studies were turned into a word cloud through the Word Art program. Accordingly, the word "chess" was at the center of the keywords. After this word, in order of frequency, chess education, preschool mathematics, mathematics, game, and problem-solving perception were included (Figure 1).

Figure 2.

Keyword Cloud of Research



Distribution of Studies in Terms of Methods and Data Collection Tools

Knowing the methods and data collection tools used in the analyzed studies provides guidance on how future research should be conducted and what type of research should be conducted. Accordingly, the data collection method used in the analyzed studies was a quantitative method with a rate of 63.2%. Considering the quantitative methods, the rate of experimental research was 26% and the rate of non-experimental research was 36.9%. In terms of qualitative research, the rate of phenomenological research was 21.2%, while ethnographic analysis, theory building, and case studies were distributed as 5.3% each.

Table 4.

Distribution According to Methods Used in Research

Methods			*n*	*%*
Quantitative (63.2%)	Non-Experimental	Scanning	6	31,6
		Correlational	1	5,3
	Experimental	Quasi-Experimental	5	26,3
Qualitative (36.8%)	Interactive	Phenomological	4	21,1
		Ethnographic Analysis	1	5,3
		Theory Building	1	5,3
		Case Study	1	5,3
Total			*19*	*100*

The number of data collection tools used in the analyzed studies varied. Accordingly, the scale was the most used data collection tool, with a rate of 31% due to the fact that the most used method in the research methods section was quantitative research methods. After scales, the most used data collection tool was achievement tests, with a rate of 27.2%. Likert-type data collection tools constituted 20.6% of the data collection tools used. In the studies in which 29 data collection tools were used in total, the most used data collection tool was Likert (17.2%) from achievement tests. The least used data collection tool was observation (3.4%).

Table 5.

Data Collection Tools Used in Research Distribution

Data Collection Tools		*n*	*%*
Survey (6.8%)	Open-ended Question	1	3,4
	Likert	1	3,4
Interview (20.6%)	Structured	1	3,4
	Semi-structured	4	13,8
	Unstructured	1	3,4
Achievement Test (27.2%)	Open-ended Question	1	3,4
	Multiple Choice	2	6,9
	Likert	5	17,2
Scale (31%)	Perception	3	10,3
	Interest	2	6,9
	Attitude	4	13,8
Observation (3.4%)	Participant	1	3,4
Documents (10.3%)	Document	3	10,3
Total		*29*	*100*

Distribution of Samples Used in Research in Terms of Type and Size

It is important to know the sample types and sample sizes used in the analyzed studies in order to know to whom the studies were applied and what kind of results were obtained. In this study, when we look at the data on the sample types and sample sizes used in the studies we examined in this research, there is a general and nearly homogeneous distribution of sample types from preschool education group to university students.

Table 6.

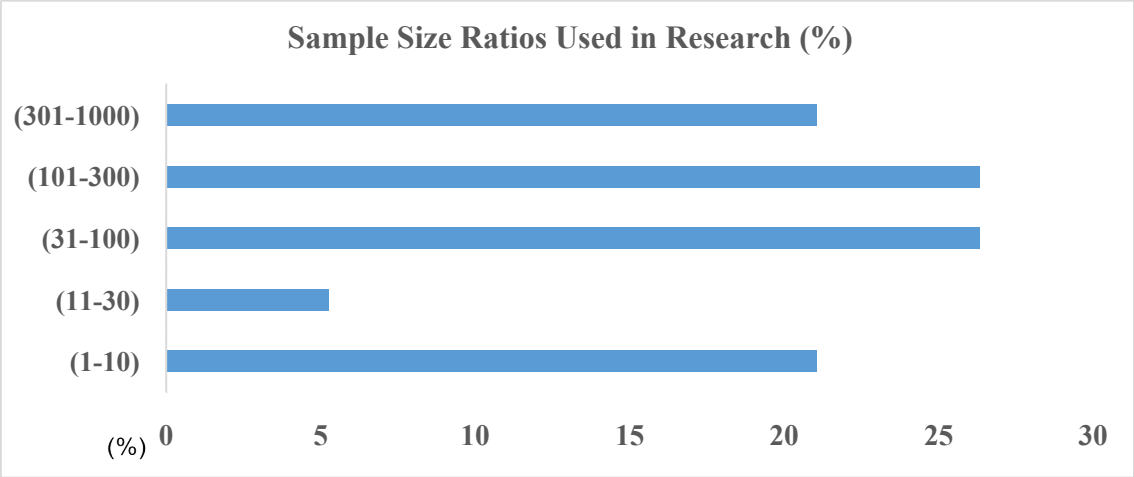
Sample Types and Sample Size Ratios Used in Research

Sample Types	*n*	*%*
Secondary School Students	4	21,1
Teachers	4	21,1
Primary School Students	3	15,8
Preschool Education Students	2	10,5
University Students	2	10,5
Document	2	10,5
High School Students	1	5,3
Adults	1	5,3
Total	*19*	*100*
Sample Size	*n*	*%*
(1-10)	4	21,1
(11-30)	1	5,3
(31-100)	5	26,3
(101-300)	5	26,3
(301-1000)	4	21,1
Total	*19*	*100*

In terms of sample size, the most preferred sample size groups were 31-100 (26.3%) and 101-300 (26.3%). Afterwards, 1-10 (21.1%) and 301-1000 (21.1%) sample size groups were preferred at the same rate. The least preferred sample number group was 11-30 (5.3%) (Table 6; Graph 3).

Figure 3.

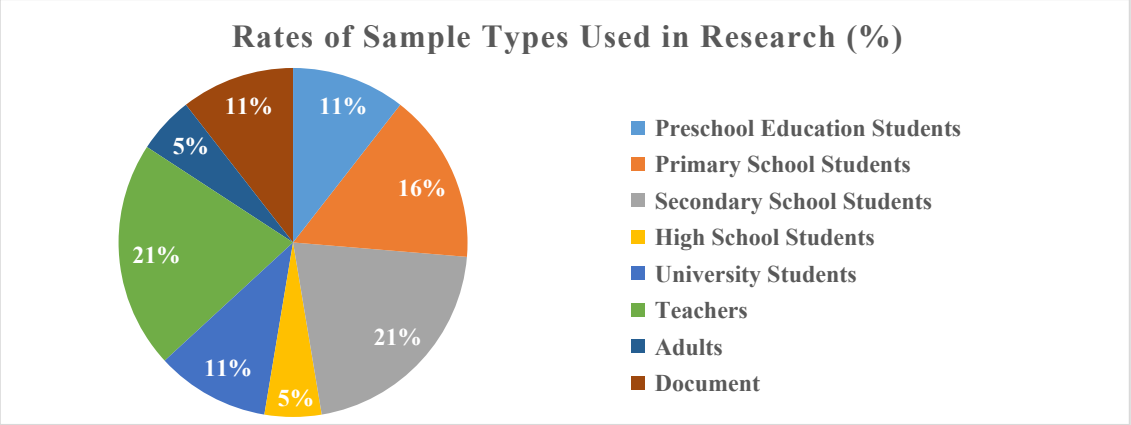
Proportional Distribution Graph of Sample Size Used in Research



The pie chart below shows that the distribution of sampling types is close to homogeneous. Accordingly, the most preferred sampling groups among the sampling types were secondary school students (21.1%) and teachers (21.1%). Then, primary school students (15.8%), preschool education students (10.5%), university students (10.5%), and documents (10.5%), respectively (Graph 4).

Figure 4.

Proportional Distribution Graph of Sample Types Used in Research



Data Analysis Method and Validity/Reliability Distributions of the Studies

The data analysis method used in scientific research is a very important issue for both scientific validity and scientific acceptance. In fact, knowing the data analysis methods used in the research conducted in the relevant field in the scientific research examined in the descriptive research we conducted provides researchers with an idea about what kind of path to follow in future research Looking at the data in the table below, the most commonly used data analysis types in the studies examined are proportionally quantitative descriptive analysis types. Among the quantitative descriptive analysis types, the most used descriptive analysis types were frequency (23.1%), and mean/std. Deviation (19.2%), and graph (3.8%), respectively. Among the predictive analysis types, the most commonly used analysis types were t-test (15.4%), ANOVA/ANCOVA (13.5%), non-parametric tests (3.8%), and correlation (1.9%), factor analysis (1.9%) and regression (1.9%), respectively. Among the data analysis types used in the analyzed studies, qualitative analysis had a usage rate of 15.3%. Within the qualitative analysis types, qualitative descriptive analysis (9.6%), content analysis (3.8%) and document analysis (1.9%) were used respectively (Table 7).

Table 7.

Ratios of Data Analysis Types Used in Research

Data Analysis Types			*n*	*%*
Nicel	Descriptive (46.2%)	Frequency	12	23,1
		Mean/Std. Deviation	10	19,2
		Graphic	2	3,8
	Predictive (38.2%)	T-Test	8	15,4
		ANOVA/ANCOVA	7	13,5
		Non-Parametric Tests	2	3,8
		Correlation	1	1,9
		Factor Analysis	1	1,9
		Regression	1	1,9
Qualitative	Qualitative Analysis (15.3%)	Qualitative Descriptive Analysis	5	9,6
		Content Analysis	2	3,8
		Document Analysis	1	1,9
Total			*52*	*100*

Looking at the validity and reliability data used in the analyzed studies, the quantitative validity tools used in the studies were 61.9%, while the qualitative validity tools were 34.4%. In addition, the rate of research that did not specify validity was 3.4%. Among the quantitative validity tools used in the scientific validity phase, factor analysis was the most used, with a rate of 37.9%. Within factor analysis, exploratory factor analysis was the most used validity analysis in all studies, with a rate of 24.1%. Among the quantitative validity tools, correlation analysis has a usage rate of 20.2%. Predictive validity and structural equation modeling were used by 10.3% and 6.9%, respectively. The lowest use of quantitative validity tools was expert interpretation, with a rate of 6.8%. This is due to the fact that scales are mostly used in the studies. When we look at the qualitative validity types in the studies examined, descriptive validity (20.7%), interpretive validity (6.9%), theoretical validity (3.4%), and generalizable validity (3.4%) were listed according to their usage rates (Table 8).

Table 8.

Ratios of Validity Types Used in Research

Validity and Reliability Method			*n*	*%*
Quantitative (61.9%)	Factor Analysis (37.9%)	Exploratory Factor Analysis	7	24,1
		Confirmatory Factor Analysis	4	13,8
	Correlation (20.2%)	Predictive Validity	3	10,3
		Structural Equation Modeling	2	6,9
	Expert Comment (6.8%)	Face Validity Index	1	3,4
		Content Validity Index	1	3,4
Qualitative Validity (%34,4)		Descriptive Validity	6	20,7
		Interpretive Validity	2	6,9
		Theoretical Validity	1	3,4
		Generalizable Validity	1	3,4
Unspecified			1	3,4
Total			*29*	*100*

When we look at the validity and reliability data used in the analyzed studies, the quantitative reliability tools used in the studies were 71.5%, while the qualitative reliability tools were 28.5%. In addition, the rate of research that did not specify reliability was 4.8%. Among the quantitative reliability

tools used in the scientific reliability phase, measurement reliability was the most used with a rate of 52.4%. Within measurement reliability, **Croanbach's alpha** was the most used reliability tool in all studies, with a rate of 33.3%. Among the quantitative reliability tools, internal **consistency** has a usage rate of 9.5%. Among the internal consistency tools, only KR20 has a usage rate of 9.5%.

Table 9.

Ratios of Reliability Types Used in Research

Validity and Reliability Method		*n*	*%*
Quantitative (71.4%) — Measurement Reliability (52.4%)	Croanbach Alpha	7	33,3
	Correlation	2	9,5
	T-test	1	4,8
	Special Variance Analysis	1	4,8
Quantitative (71.4%) — Internal **Consistency** (9.5%)	KR 20	2	9,5
Quantitative (71.4%) — Scale Stability (4.8%)	Pearson Moment Correlation	1	4,8
Qualitative Reliability (28.5%)	External Reliability (Code Consistency)	4	19,0
	Presence at the Research Site	2	9,5
Unspecified		1	4,8
Total		*21*	*100*

Among the quantitative reliability tools, the lowest utilization rate was 4.8% for Pearson's Moment Correlation, which examines scale stability. When we look at the qualitative reliability types in the analyzed studies, external reliability (19%) and being present at the research site (9.5%) were ranked according to their usage rates (Table 9).

Conclusıon

Understanding the connection between chess and mathematics is quite simple; there is an infinite number of calculations involved, everything from consciously taking the previous step and predicting the next step at the slightest move, to counting the number of attacking and defensive pieces, to calculating long continuations. Calculating these possibilities and putting them into practice is directly related to logical mathematical intelligence, one of the cognitive abilities that can explain intelligence today. The game of chess is heavily based on probability and strategy. Generally, calculating probabilities and choosing the right strategy are prioritized during the game. The constant visualization of the positions that may occur in the game, the calculation of 10 or more moves by many master players, and the realization of which side will gain advantage from the position to be created completely abstracts chess and bases winning solely on skill. Since mathematics involves abstractions and calculations, it is similar to chess in this respect. As a matter of fact, scientific studies on this subject also confirm this relationship.

In this study, it was aimed to examine the general trends of scientific studies examining the relationship between chess, mathematics, and geometry and to create a resource for future studies.

Accordingly, this study sought to answer the question of what kind of tendency the relationship between chess and mathematics has in the literature. As a matter of fact, as stated by Kozak (2003), Hotamışlı and Erem (2014), the research conducted in a field of science is very important in order to have information about the current situation of the field of science and the level of development of the country where the researches are conducted.

In this study, data were obtained by following descriptive analysis processes and accordingly, findings were obtained in terms of the distribution of the studies in terms of number and types in terms of years; distribution according to the cities where the research data were collected; distribution according to the scientific field of the authors, keywords used in the studies; distribution in terms of methods and data collection tools used in the studies; sample type and size used in the studies; validity and reliability distributions used in the studies and data analysis methods used in the studies.

Conclusion and Discussion

According to the results obtained from the research findings, the number of studies examined is 19. The number of articles and postgraduate theses has been the same in the studies conducted until today. In 2017, it was understood that most studies were conducted with two articles and twopostgraduate studies. According to these results obtained within the scope of the research, it is also important in which cities the studies were conducted. As a matter of fact, it is essential to collect data with equal distribution throughout the country in order to make a healthy evaluation based on the results obtained (Sadık, 2002). Accordingly, it was understood that Ankara was the province where most of data was collected. Ankara was followed by Eskişehir, İstanbul, Çanakkale, and Bursa. The only place where data was collected in Turkish outside the country was the research conducted in the TRNC.

The scientific field distribution of the authors of the studies examined in descriptive analysis and bibliometric analysis studies provides an idea about whether the subject under study has a multidisciplinary structure (Kaynak, 2018). According to the findings of the scientific field distribution of the authors mentioned in the studies, it was concluded that the authors have different branches in the field of educational sciences. In the field of educational sciences, the field in which the authors are most predominant is Preschool Education, according to general fields. This field was followed by Mathematics Education, Computer Education, Instructional Technology Education, Classroom Teaching Education, Guidance and Psychological Counseling Education and Science Education.

Keywords constitute the main theme of any research. Therefore, it is essential to know what the keywords of the research are in order to ensure the integrity of the subject being examined. However, keywords are nowadays transferred to the word clouds environment and have provided an important visual gain in order to emphasize the dominant words. As a matter of fact, the word cloud visually emphasizes the most frequently occurring words in any inscription and shows the keywords (Caner &

Efe, 2022). The keywords of the studies examined through the Word Art program were converted into a word cloud. Accordingly, the word "Chess" was at the center of the keywords. After this word, in order of frequency, chess education, preschool mathematics, mathematics, game, and problemsolving perception.

Knowing the methods and data collection tools used in the analyzed studies provides guidance on how future research should be in terms of method and technique and what kind of research should be conducted (Şan, 2020). According to the research findings, the data collection methods used in the analyzed studies were mainly quantitative methods. It was understood that the rate of non-experimental research from quantitative methods was higher than the rate of experimental research. In studies conducted with qualitative research, it was concluded that the phenomenological research design was mostly used.

When the findings of the data collection tools used in the studies were examined, it was understood that the number of data collection tools varied. Accordingly, it was understood that the scale tool was frequently used due to the fact that the most commonly used method in the research methods section was quantitative research methods. After the scales, the most frequently used data collection tool was achievement tests. The least-used data collection tool in the studies was the observation tool.

It is important to know the sample types and sample sizes used in the analyzed studies in order to know to whom the studies were applied and what kind of results were obtained (Akbaş & Tavşancıl, 2015). When the findings of the sample types and sample sizes used in the studies are examined, it is seen that a general and homogeneously distributed sample type was selected from preschool education group to university students. When the sample size findings were examined, it was concluded that the most preferred sample size groups were the sample size groups of 31-100 and 101-300 people. The least preferred sample size group was the 11-30 group. When the findings on sample types were analyzed, it was found that the most preferred sample types were secondary school students and teachers, respectively.

The data analysis method used in scientific research is very important for both scientific validity and scientific acceptance (Tekindal & Uğuz Arsu, 2020). As a matter of fact, knowing the data analysis methods used in the research conducted in the relevant field in the scientific studies examined in the descriptive research we conducted also provides researchers with an idea about what kind of path will be followed in future research. When the research findings are examined, the type of data analysis frequently used in the analyzed studies is quantitative descriptive analysis. Among the quantitative descriptive analysis types, the most frequently used descriptive analysis types were frequency, mean/std. deviation and graph, respectively. Among the predictive analysis types, the most commonly used analysis types were t-test, ANOVA/ANCOVA, non-parametric tests, correlation, factor analysis, and regression, respectively. Among the data analysis types used in the analyzed studies, qualitative analysis

has a low usage. Accordingly, qualitative descriptive analysis, content analysis and document analysis were used in qualitative analysis types respectively. According to the validity and reliability findings used in the analyzed studies, it was concluded that the most used validity tool was quantitative validity tools. Among the quantitative validity tools used in the scientific validity phase, the most commonly used one factor analysis . Within factor analysis, exploratory factor analysis was found to be the most commonly used validity analysis in all studies. The lowest use of quantitative validity tools is the expert interpretation tool. The fact that scales were mostly used in the studies was effective in this situation. According to the research findings, qualitative validity types were listed as descriptive validity, interpretive validity, theoretical validity, and generalizable validity according to their usage rates. When the findings of the reliability tools used in the analyzed studies are examined, quantitative reliability tools used in the studies constituted the majority. It was understood that measurement reliability was the most commonly used of the quantitative reliability tools in the scientific reliability phase. Within measurement reliability, Croanbach's alpha was the most used reliability tool in all studies. The lowest use of quantitative reliability tools was Pearson's correlation, which examines scale stability. When the qualitative reliability types were examined in the analyzed studies, they were listed as external reliability and present in the research field according to their usage rates.

Suggestions

Considering the results of the research, the following suggestions can be developed;

1- Giving importance and encouragement to the chess elective course in schools may be important in order to sensitize students to the findings obtained in the analyzed studies.
2- In order to contribute to diversity, new studies that address the relationship between chess and mathematics in various dimensions can be included.
3- Studies examining the relationship between chess and mathematics can be examined practically and students can be encouraged to conduct research in the form of action research and useful in order to know which gains students will achieve.
4- Research examining the relationship between chess and mathematics should be conducted in cities across the country where research has not been conducted before, and the differences between cities and regions should be known.
5- Bibliometric studies should emphasize on researches that pool the publications of international journals and highly indexed journals examining the relationship between chess and mathematics, and the gap in the bibliography should be filled by knowing the tendency on this issue.

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