



# **A systematic review of experimental researches on the learning fields of numbers and operations in middle schools: The case of Turkey**

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## **A systematic review of experimental researches on the learning fields of numbers and operations in middle schools: The case of Turkey**

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### **ABSTRACT**

The numbers and operations learning field in the mathematics curriculum is very important regarding the number of gains and course hours. In this review, experimental studies related to the sub-learning fields of the number and operations learning field were reviewed according to methodological characteristics and Turkey's demographic. 90 theses and 23 articles published between the years 2006-2021 were reviewed through a systematic literature review. "Fractions" was the most investigated sub-learning field both in theses and articles. Regarding dependent variables, academic achievement and attitude towards mathematics were the most studied variables in both theses and articles. All sub-learning fields of the number and operations learning field, which occupy an important place in the secondary school mathematics curriculum, were reviewed. Different aspects of the most and least studied learning fields were discussed. The results are expected to shed light on the academicians researching the secondary school mathematics curriculum. It is suggested that the researchers should focus on less-studied subjects of the 8<sup>th</sup>-grade curriculum and fill the areas deemed incomplete.

**Keywords:** curriculum, mathematics education, numbers and operations, systematic review

### **INTRODUCTION**

Many factors affect learning. Seven and Engin (2008) explained these factors under five elements: the learner, learning, learned, teaching, and learning environment. Regarding these five elements in terms of their effects on learning, the teacher and the learning environment do not directly affect learning; they affect it by influencing other elements. If we exemplify this for mathematics teaching, a teacher, who aims to reach a gain from the natural numbers sub-learning field, is expected to "help the student get ready for learning," "organize the learning tools for this gain," and "use the appropriate learning strategy." It means that there are clues that make learning easy or difficult. To answer the question "What is the appropriate strategy for teaching mathematics?" it will be helpful first to answer "how to choose an appropriate teaching strategy?". In order to answer this question, researchers suggest that the appropriate learning methods and strategies should be selected by considering the teacher's proficiency and attitude, the quality of the gain, class size, time, teaching environment, and equipment status (Çözümlü, 2008; Güven & Özerbaş, 2018; Ocak, 2007). The selection of methods, techniques, and strategies suitable for teaching mathematics requires more than these elements; it includes some additions involving the nature of mathematics.

Mathematics, by its nature, contains abstract concepts. These abstract concepts need students to concretize, but they should also let them "apply math." Mathematics is expressed as developing and applying a method to solve a problem, seeing if the method is working, and checking the answers' accuracy. In addition, it should include practices aimed at developing problem-solving, reasoning, association, communication, and representation skills (Van de Walle, Karp, & Bay-Williams, 2007). The constructivist approach prioritizes applying math and concretization; it is an approach that may be appropriate for mathematics teaching. It is also the starting point of the mathematics curriculum implemented in our country since the 2004-2005 academic year. Besides, the sociocultural learning approach, which is essential for mathematics teaching and supports the five process standards (problem-solving, communication, association, representation, reasoning, and proof) determined by National Council of Teachers of Mathematics ([NCTM], 2000), is another fundamental approach. Some studies in the international literature (Ferreira, 2018; Hart, 2009; Katwibun, 2004; Leikin & Rota, 2006; Lesnussa, 2018; Maslihah, Waluya, Karomah, & Iqbal, 2021) and national literature (Cumhur, 2016; Güner & Akyüz, 2017; Günhan, 2006) show that an improvement occurs in both academic success and skill achievement in different learning fields of mathematics (numbers and operations, algebra, geometry and measurement, data, probability) with differentiated teaching methods and techniques.

The numbers and operations learning field is one of the learning fields that form the fundamental of mathematics teaching. NCTM (2000) described this learning field as numbers, the ways of representing numbers, the relationships between numbers, number systems, the meanings of operations and how they relate to each other, fluent calculation, and appropriate estimation. Barody (2004) draws attention to the learning of numbers and operations at an early age, the importance of the content and the method used by the teacher in this learning process, and how students should develop their mathematical thinking knowledge. Moreover, he emphasizes that new teaching approaches, methods, or tools have their own (theoretical, empirical, and practical) rationales. Different learning methods and techniques have been used in teaching numbers and operations in the literature. This research aims to reveal the functionality of these methods and techniques and determine which methods are selected, applied, and resulted in in the national literature. A systematic review of academic studies (theses and articles) published in the national literature was performed in this context.

The systematic review is defined by Chalmers, Sequire and Brown (2002) as the collection of all studies on a particular subject, their critical evaluation, and application of the strategies that limit synthesis bias. Systematic reviews are designed to be open, transparent, and repeatable to overcome many of the potential problems associated with the design of traditional reviews. Regarding the systematic reviews (Niebylski, Redburn, Duhaney, & Campbell, 2015; Ramesh et al., 2017; Üstünel, Çeliker, & Güzeller, 2021; Walker, Keane, & Burke, 2010) performed in different disciplines (i.e., nursing, medicine, and tourism), it can be thought of metaphorically as "offers the necessary diagnosis for treatment." In addition to different disciplines, the same metaphor can be used for systematic reviews for mathematics teaching (Bray & Tangney, 2017; Depaepe, Verschaffel, & Kelchtermans, 2013; Hwang & Tu, 2021; Kaya & Ayar, 2020; Shin & Shim, 2021; Stahnke, Schueler, & Roesken-Winter, 2016).

The Numbers and Operations learning field is one of the 5 main learning fields of the secondary school curriculum. It includes 33 (59%) of 56 gains for 5<sup>th</sup> grades, 32 (54%) of 59 gains for 6<sup>th</sup> grades, 14 (29%) of 48 gains for 7<sup>th</sup> grades, and 16 (30%) of the 52 gains for 8<sup>th</sup> grades. These ratios correspond to 44% of all secondary school mathematics gains and 45% of all secondary school mathematics lesson hours. This learning field constitutes almost half of the secondary school mathematics curriculum, but no study structurally reviewed experimental studies. It is thought that a detailed analysis of this learning field will contribute to the literature in terms of both revealing the current situation and shedding light on future experimental studies.

### **The Purpose of the Research**

This study addressed the question of "What is the general situation (tendency) of the studies on the methods and techniques used in the numbers and operations learning field in the national literature?". For this purpose, the research question was set as, "How experimental studies in the numbers and operations learning field of the secondary school mathematics curriculum between 2006-2021 in Turkey change according to distribution by years, the number of authors/advisors, regions, Sample' grades, sub-learning fields, applied method, sample size, duration of the implementation, dependent variables, data collection tools, normality test, tests used in data analysis, administration of the retention test".

### **METHOD**

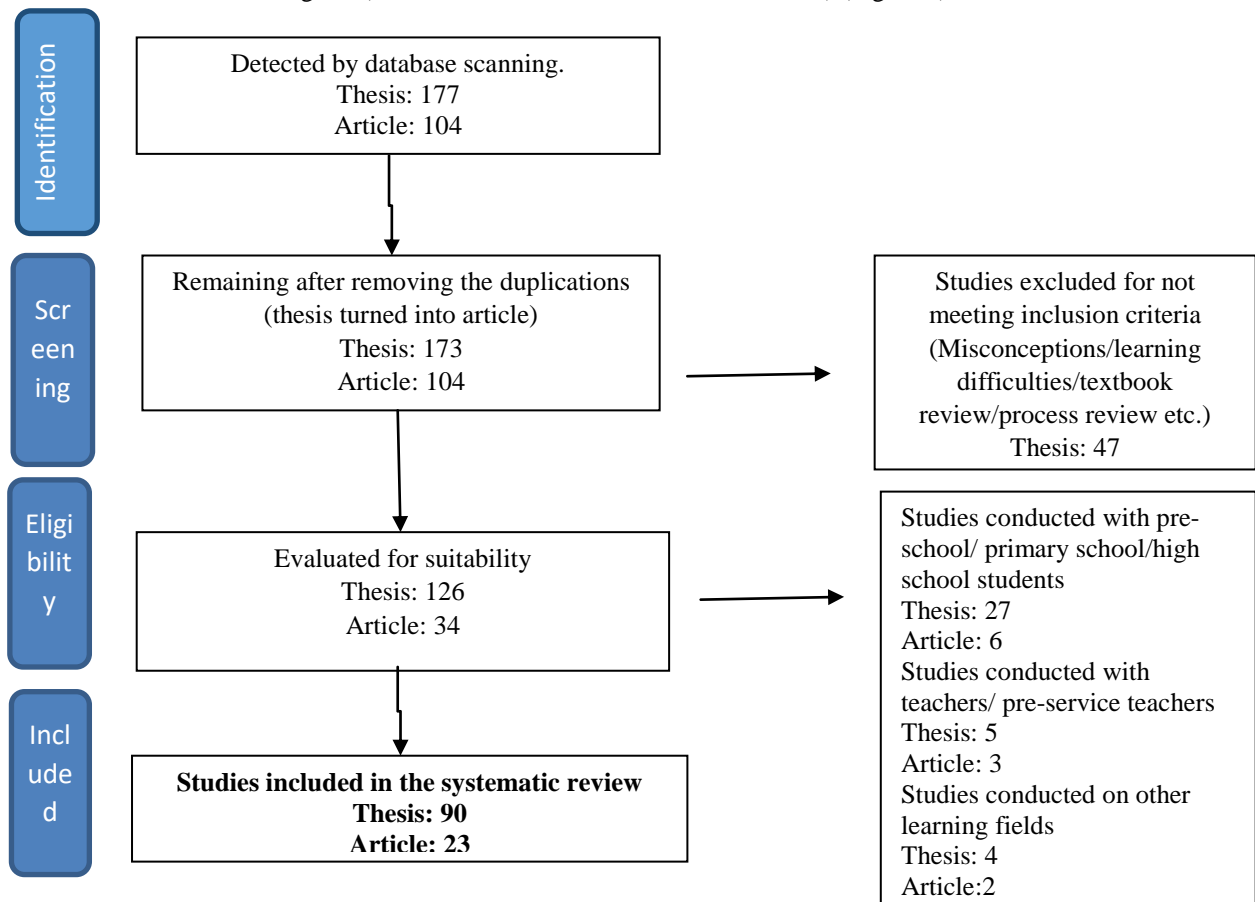
The research analyzed the theses and articles that include experimental studies performed in Turkey in the numbers and operations learning field between 2006 and 2021. 2006 was selected as the starting date because the studies related to the secondary school mathematics curriculum, which radically changed in 2004, started to be published as of 2006. This review includes the studies related to the program implemented in 2004. The reviewed studies were limited to the theses scanned in the National Thesis Center of Higher Education Council (YÖK Tez) and the articles scanned in the Ulakbim Tr Index. The search was completed on November 1<sup>st</sup>, 2021. YÖK Tez is a database of the National Thesis Center of the Council of Higher Education that offers open access electronically to the master and doctoral theses made in universities in Turkey. Tr Index is a database developed by TÜBİTAK (Scientific and Technological Research Institution of Turkey) Ulakbim that provides access to journals published in Turkey according to international standards. A journal should meet specific criteria to be indexed in TR Index (TR Index, 2020). Searched words include "mathematics education" OR "natural numbers" OR "fractions" OR "decimal notation" OR "percentages" OR "multipliers" OR "multiples" OR "sets" OR "integers" OR "rational numbers" OR "ratio" OR "proportion" OR "exponential" OR "root". These words were searched in the study name, index, keywords, and abstract fields by creating appropriate conditions. In the first stage, master's and doctoral theses in YÖK Tez and articles in Tr Index were scanned. The study did not include theses that are not open to access in the YÖK Tez. As a result of multiple searches in databases, 177 theses and 104 articles were reached. The theses published and converted into articles are considered in the review as an article. At this point, 4 theses were removed. The full text of the remaining 173 theses and 104 articles were reviewed. selection and elimination criteria are shown in Table 1.

**Table 1: Selection and Elimination Criteria**

No.	Selection Criteria	Elimination Criteria
1	Theses with open access in YÖK Tez or articles published in TR Index	Theses without open access in YÖK Tez or articles that are not published in TR Index
2	Experimental works	Theses and articles that do not include experimental work, i.e., studies on misconceptions, learning disabilities, textbook review, process review
3	Theses and articles with a sample group of 5-8 <sup>th</sup> grade students	Theses and articles with sample groups of pre-school, primary school, high school students
4	Published between 2006-2021	Theses and articles published before 2006 or after November 2021

As a result of the scanning based on these criteria, 47 theses and 60 articles were excluded from the scope of review because of focusing on misconceptions, learning difficulties, textbook review, process review. Consequently, 126 theses and 34 articles were included in the systematic review.

The data obtained about each reviewed thesis and article in a systematic review should be defined and classified (Goagoses & Koglin, 2020). The article classification forms used in the literature were examined (Aldemir & Tatar, 2014; Sözbilir & Kutu, 2008), and an article classification form was adapted for this study. Each thesis/article was meticulously reviewed by the researchers using this form. The data were coded and saved in an online spreadsheet program (EXCEL) by the researchers in an organized manner. Theses/articles were coded according to their descriptive (titles, publication years, authors) and methodological properties (dependent variables, independent variables, sample size). The researchers independently evaluated the thesis and articles regarding rigor, reliability, and relevance. Disagreements among researchers were resolved through discussion. The factors considered for rigor were the research design's suitability to the purpose of the study, using a well-defined method and sample, and appropriate data collection method. The validity and significance of the findings and results were checked for each study for reliability and relevance. At the end of these processes, it was decided to include 85 master's theses, 5 doctoral theses, and 23 articles. Inclusion and exclusion criteria are detailed in the PRISMA diagram (Moher, Liberati, Tetzlaff, & Altman, 2009) (Figure 1).



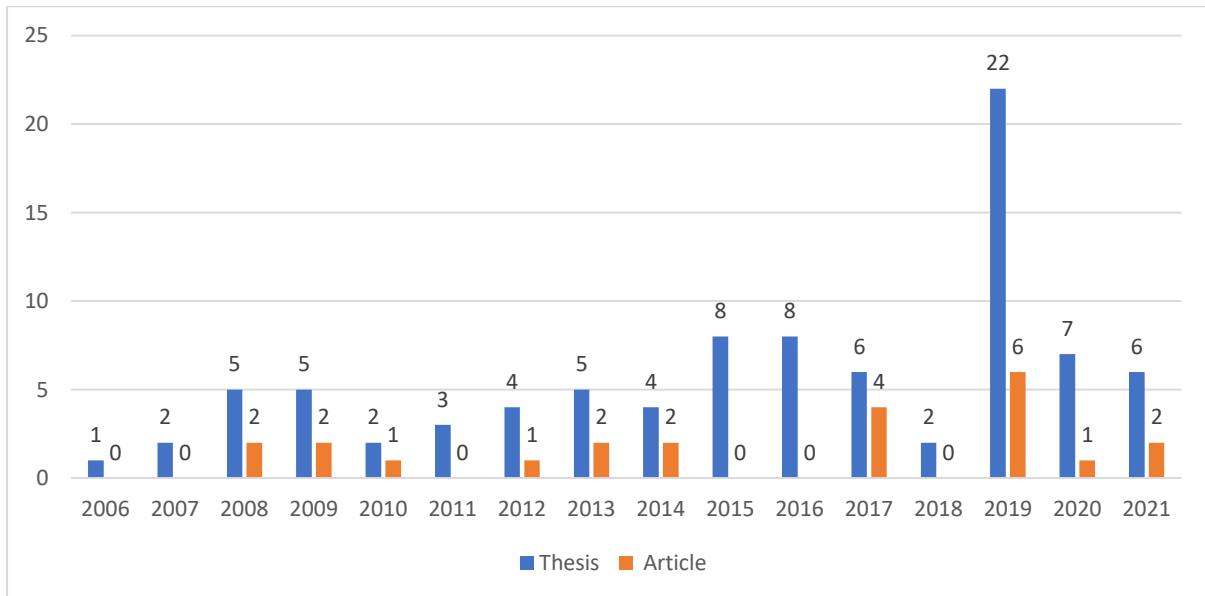
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**Fig.1: Flow Diagram of the Review (Moher et al. 2009)**

**FINDINGS**

**a) Distribution by Years**

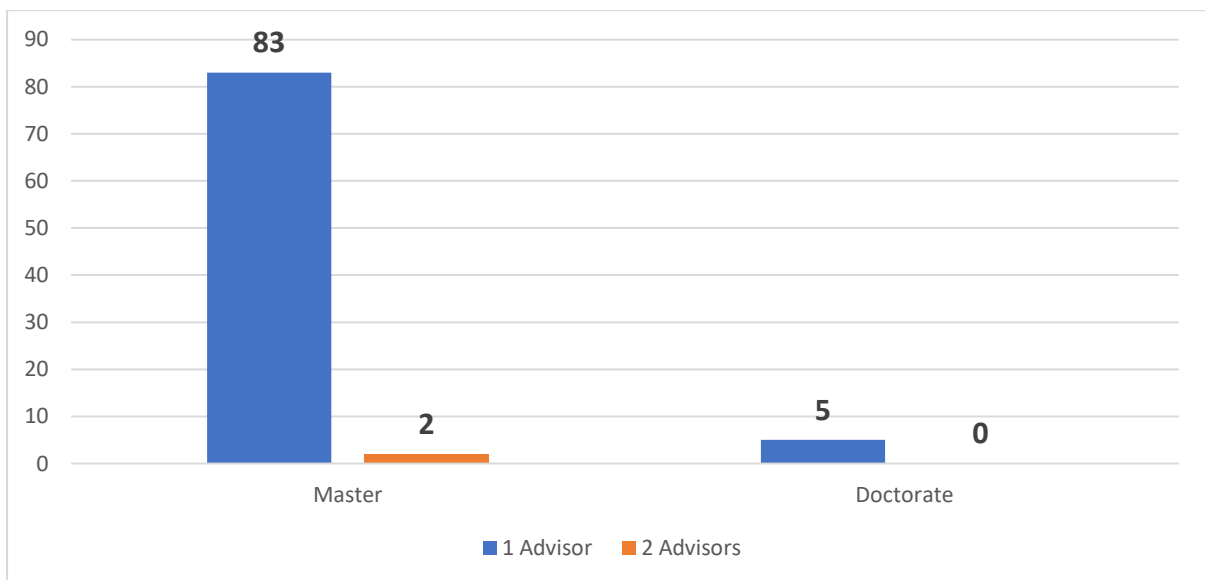
The distribution of the experimental studies conducted between 2006-2021 in the numbers and operations learning field of the secondary school mathematics course in Turkey and included in the systematic literature review by years is given in Figure 2. Accordingly, 90 theses and 23 articles were conducted between the mentioned years. Regarding the distribution by years, most theses were published in 2019 (22), followed by 2015 (8), 2016 (8), 2017 (6), and 2020 (7). Most articles were written in 2019 (6 articles) and 2017 (4 articles).



**Fig.2: Distribution of Studies by Years**

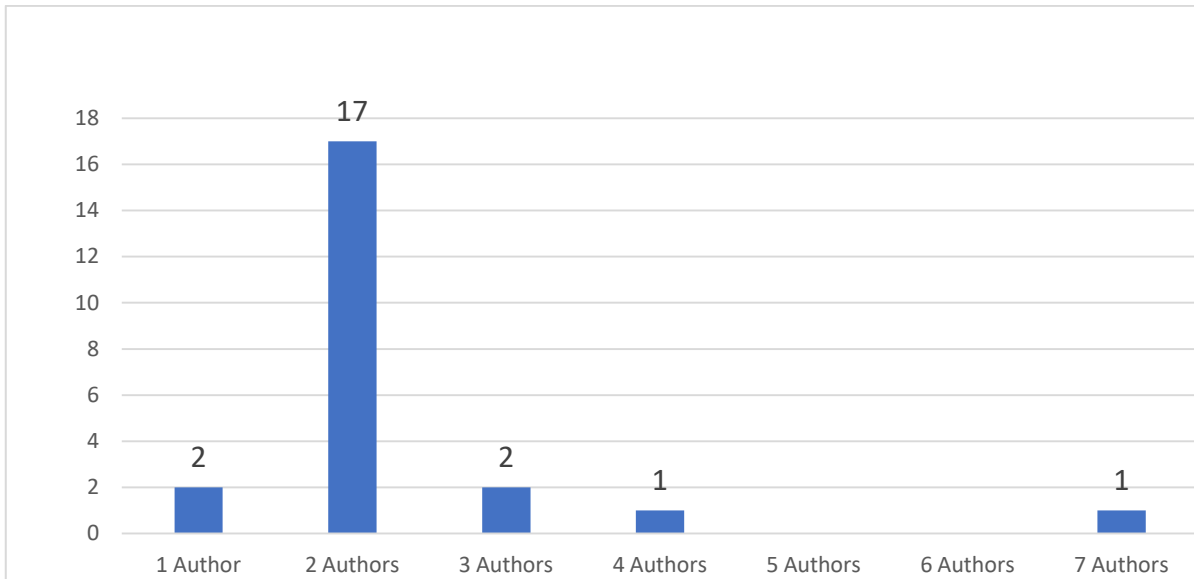
**b) Distribution by Number of Advisors/Authors**

Except for two master's theses, 83 master theses and all of the doctoral theses were performed with a single advisor (Figure 3).



**Fig.3: Distribution of Thesis by Number of Advisors**

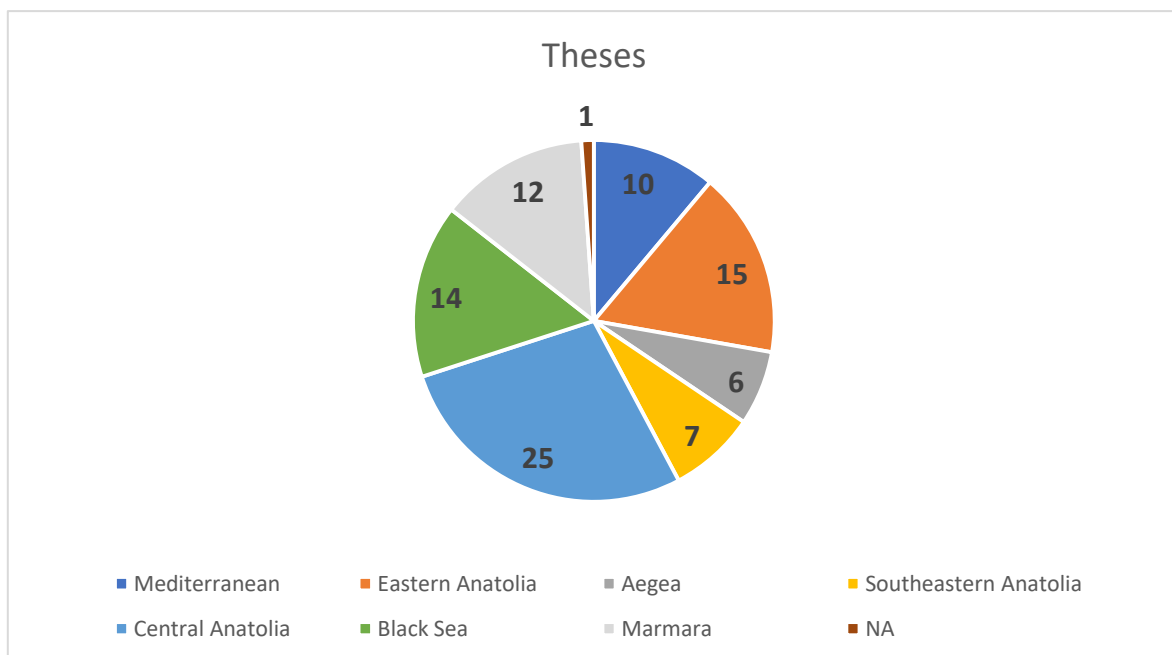
The majority of the articles had 2 authors (17), 2 with a single author, 2 with 3 authors, 1 with 4 authors, and one with 7 authors (Figure 4).



**Fig.4: Distribution of Articles by Number of Authors**

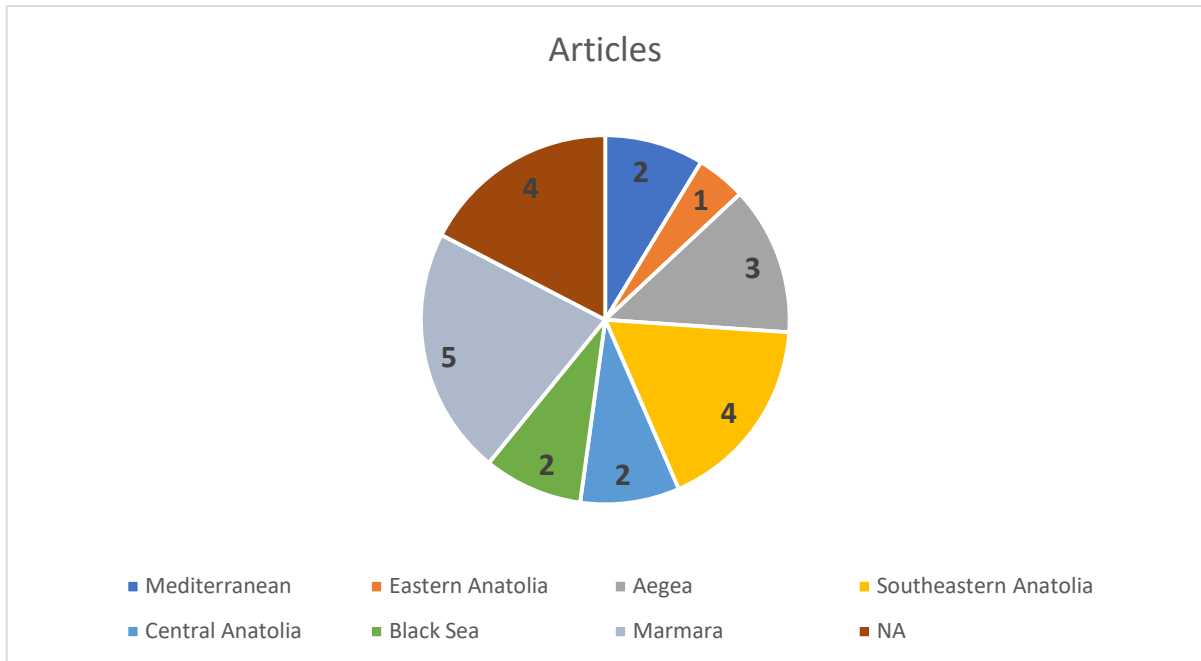
**c) Distribution by Region**

The thesis distribution according to regions is shown in Figure 5. The data of most thesis were collected from the Central Anatolia region (25). It is followed by Eastern Anatolia (15), Black Sea (14), Marmara (12), Mediterranean (10), Aegea (6), and Southeastern Anatolia (7). The data collection region was not reported in 1 thesis.



**Fig.5: Distribution of Thesis by Region**

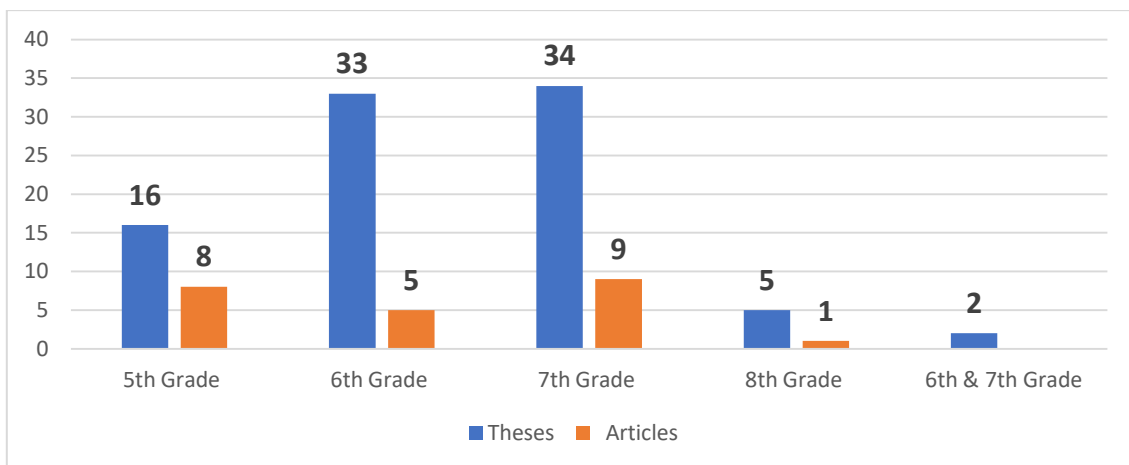
Regarding the distribution of articles according to data collection regions shown in Figure 6, most data were collected from the Marmara region (5), followed by Southeast Anatolia (4), Aegea (3), Black Sea (2), Central Anatolia (2), Mediterranean (2), and Eastern Anatolia (1). The region was not reported in 4 articles.



**Fig.6: Distribution of Articles by Region**

**d) Distribution by Samples' Grade**

The grades of the samples of theses/articles are shown in Figure 7. In the theses, 7<sup>th</sup> graders (34) and 6<sup>th</sup> graders (33) were mostly included in the sample, followed by 5<sup>th</sup> graders (16) and 8<sup>th</sup> graders (5), then 6<sup>th</sup> and 7<sup>th</sup> graders (2). Regarding the articles, the samples covered 7<sup>th</sup> graders (9) the most, followed by 5<sup>th</sup> graders (8), 6<sup>th</sup> graders (5), and 8<sup>th</sup> graders (1).



**Fig.7: Distribution by Samples' Grade**

**e) Distribution by Sub-Learning Fields**

The review of the studies in numbers and operations according to the sub-learning fields showed that in the theses, most of the studies were on fractions (21) and ratio-proportion (18), followed by operations with fractions (9), rational numbers (9). The sub-learning field with the minimum study was ratio (1). Regarding the articles, mostly studied subjects in the sub-learning fields were fractions (10) and then integers (5). In contrast, no study was conducted on operations with fractions, factors and multiples, sets, operations with rational numbers, ratios, and exponential numbers. 2 sub-learning fields were studied in 11 theses and 4 sub-learning fields in 1 thesis. Similarly, 2 sub-learning fields were studied in 4 of the 24 articles (Figure 8).

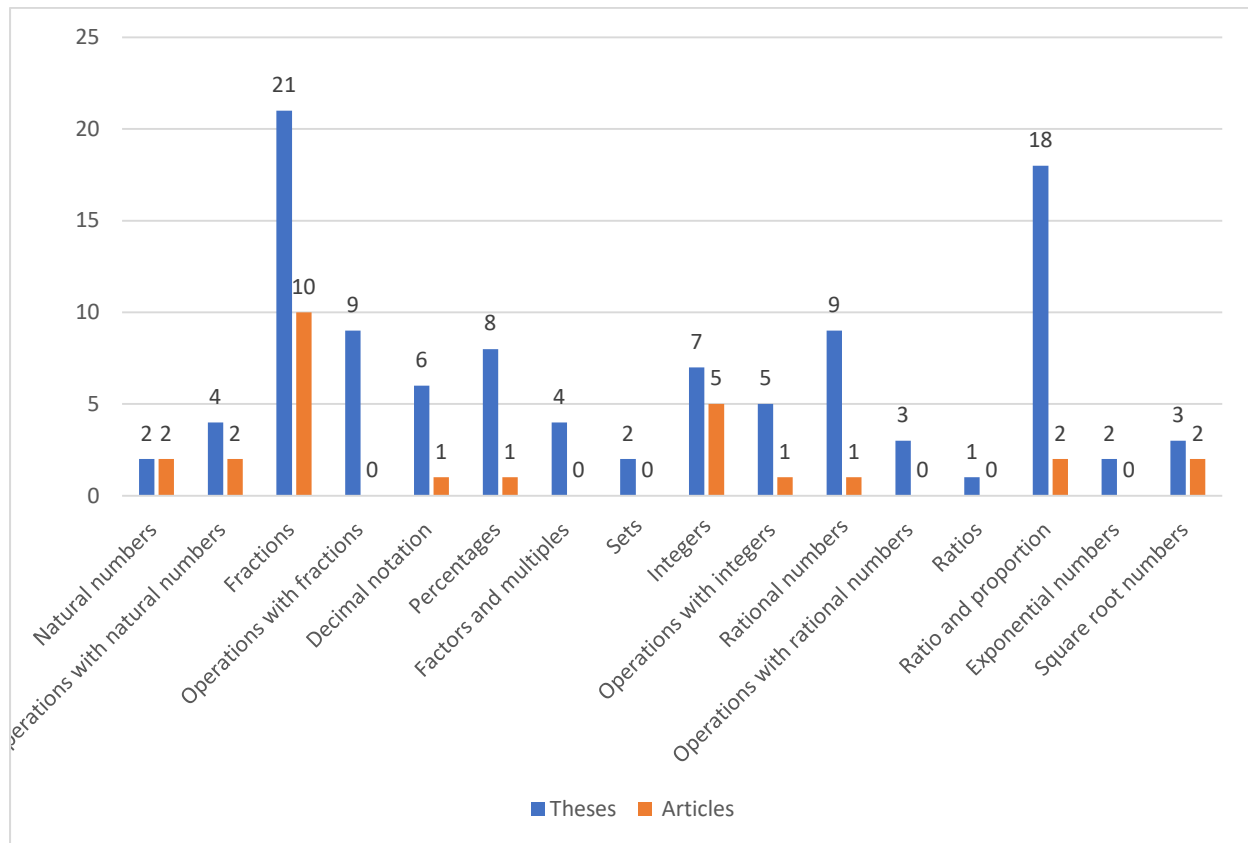


Fig.8: Distribution by Sub-Learning Fields

**f) Distribution by Approaches, Theories, Models, Strategies, Methods, and Techniques Used**

The approaches, theories, models, strategies, methods, and techniques used in experimental studies on numbers and operations learning field in theses and articles were reviewed. Accordingly, the most used method was Realistic Mathematics Education (12), followed by teaching with games (6) and the theory of multiple intelligences (5). Regarding the techniques, the material usage technique was used quite frequently (28). Regarding the materials used, concept maps (5) and teaching with cartoons (3) were used the most (Table 2).

**Table 2. Distribution of the Approaches, Theories, Models, Strategies, Methods, and Techniques Used**

	Approaches, theories, models, strategies, methods, and techniques used	MT	Doctorate	Article	Overall
Approach	Constructionist	1			1
	Constructivist	1			1
Theory	Multiple intelligences	2		3	5
Model	4Mat	1		1	2
	5E	3			3
	7E	2			2
	ARCH Motivation			1	1
	Interest-based learning	1			1
	Personalized teaching	1			1
	Full learning			1	1
	Flipped Classroom	2	1		3
Strategy	By invention			1	3
	With metaphors	1			1
	With model building activities	1			1
	Inquiry learning		1		1
Method	Peer teaching	1	1		1
	Active learning method	2			2
	The educational game supported teaching	1			1
	Realistic mathematics teaching	9		3	12



	Cluster-assisted individualized teaching	1			1
	Material and activity supported teaching	1			1
	Teaching with mathematical modeling	3			3
	Teaching with games	6			6
	Teaching with a problem-posing approach	1		1	2
	Teaching with problem-based STEM activities	1			1
	Problem-based teaching	1		2	3
	Project-based teaching	1			1
	Teaching with creative drama	2			2
	Teaching supported by logic activities		1		1
	Brain-based teaching	2			1
	Teaching with worksheets	1			1
Technique	Teaching with augmented reality			1	1
	Teaching by splitting and joining	1			1
	Computer-assisted teaching	4			4
	Teaching with multimedia	1			1
	EBA-supported teaching	1		1	2
	Teaching with educational computer games			1	1
	E-book supported mathematics teaching	1			1
	An electronic learning system based on learning from mistakes			1	1
	Teaching with calculator	1			1
	Station technique	1			1
	Teaching with the Plickers App			1	1
	Teaching with the use of virtual manipulatives	1			1
Social media supported blended learning	1			1	
Mathematics teaching supported by STEM applications	2	1		3	
Material Used	Activity-based teaching	1			1
	Teaching with activity-based teaching materials	1			1
	Teaching with visual material	1			1
	Teaching with visualization	1			1
	Teaching through stories	1			1
	Teaching with cartoons	3		2	5
	Teaching with a concept map	5			5
	Teaching with concept cartoons	1			1
	Conceptual change text	1			1
	Material supported mathematics teaching	2			2
	Teaching with music	1		1	2
	Teaching Supported by Origami Activities	1			1
	Teaching with authentic activities	1			1
	Teaching with the activities included in the curriculum	1			1
	Teaching with storytelling	1			1
Enriched learning environment			2	2	
Total	85	5	23	113	

#### g) Distribution by Sample Size

Studies were reviewed according to sample sizes. These were mostly conducted with 41-60 people (33), 61-80 people (23), and 21-40 people (24). In the articles, 41-60 people (11) and 61-80 people (6) were the most frequently used sample sizes (Figure 9).

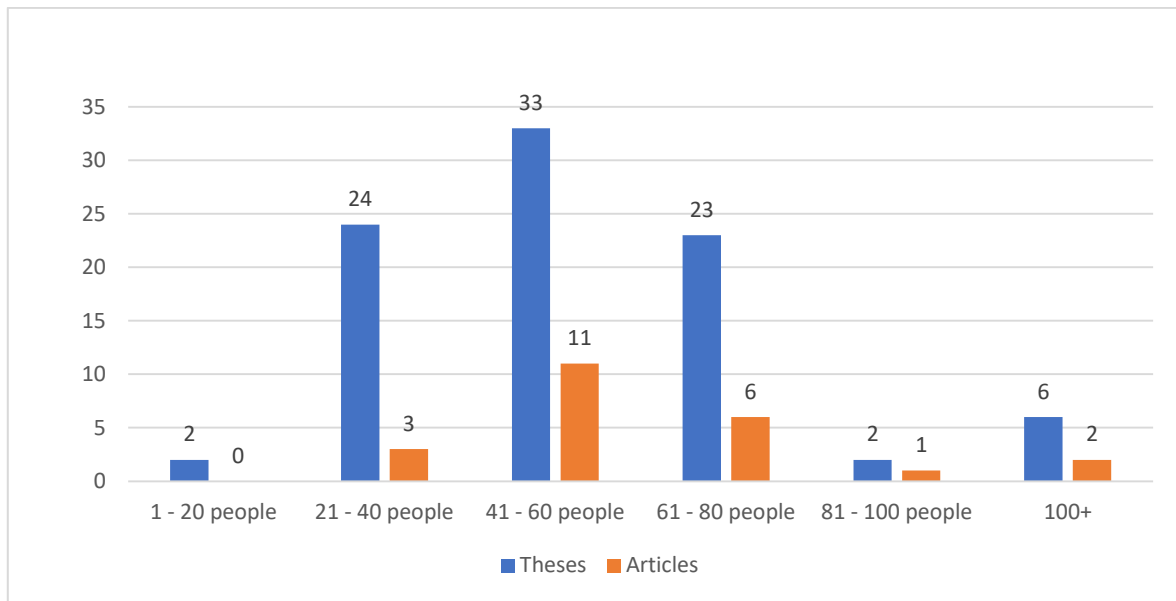


Fig.9: Distribution by Sample Size

**h) Distribution by Implementation Duration**

The experimental studies' implementation duration varied between 4-40 hours. The duration of the implementation in theses was mostly 11-20 hours (33), followed by 21-30 hours (22), 31-40 hours (11), whereas the duration was not reported in 9 studies. Regarding the articles, 21-30 hours (6) was the most frequent duration, followed by 11-20 hours (6) and 1-10 hours (6); the duration was not reported in one study (Figure 10).

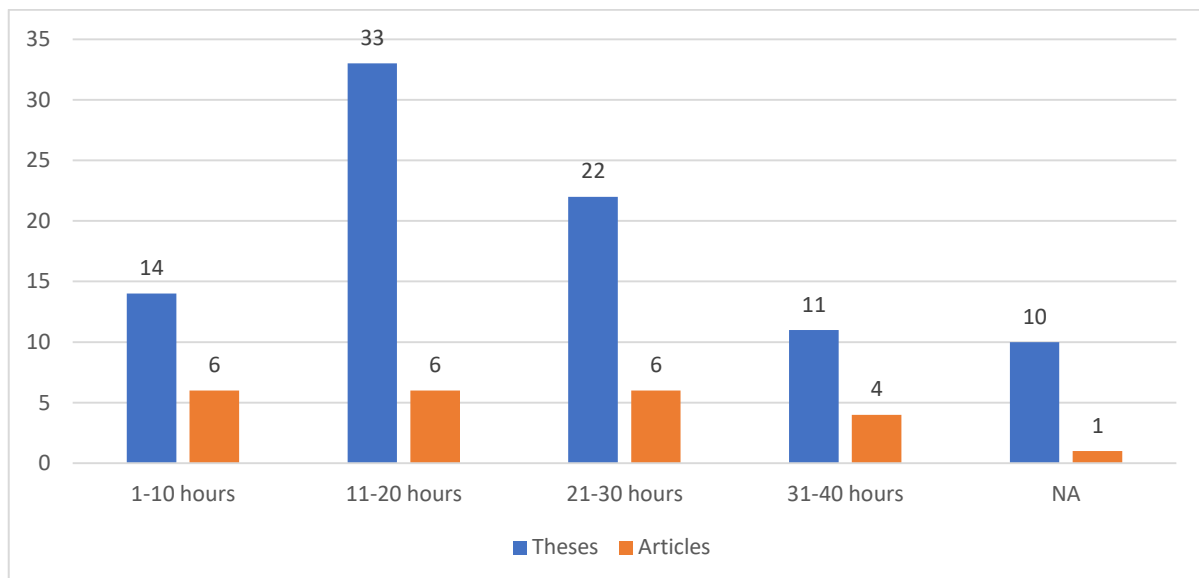
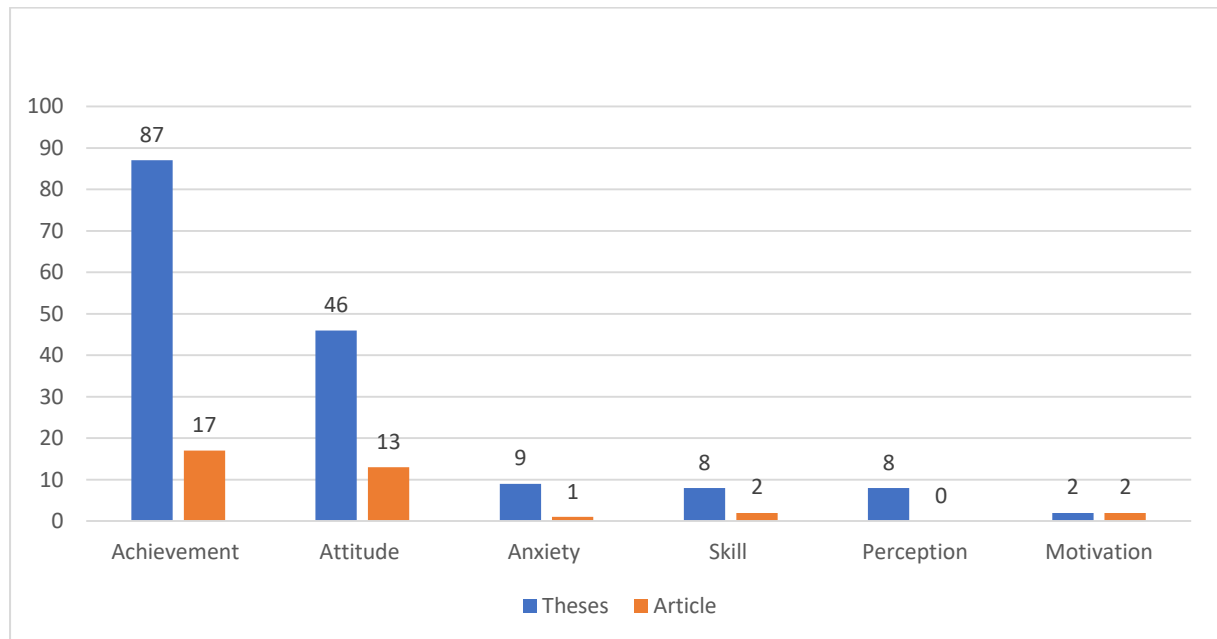


Fig.10: Distribution by Implementation Duration

**i) Distribution by Dependent Variables**

Dependent variables in experimental studies in the numbers and operations learning field were reviewed in detail. Accordingly, there was 1 dependent variable in 46 studies (43 achievement, 2 attitudes, 1 motivation), 2 dependent variables in 49 studies (achievement - attitude, achievement - anxiety, achievement - skill, achievement - motivation, achievement - perception), and 3 in 12 studies (achievement - attitude - anxiety, achievement - attitude - skill). Moreover, 6 studies covered 4, and 1 study covered 5 dependent variables. The most examined dependent variables in the theses were achievement (90), followed by attitude (48), skill (9), and perception (9), whereas they were achievement (18) and attitude (13) in the articles. In the figure, academic achievement is briefly shown as "achievement." Attitudes towards mathematics, problem-solving, STEM, mathematics activities, educational computer games, and internet use were briefly referred to as "attitude." Mathematics anxiety is shown as "anxiety." Logical thinking skills, scientific process skills, critical thinking

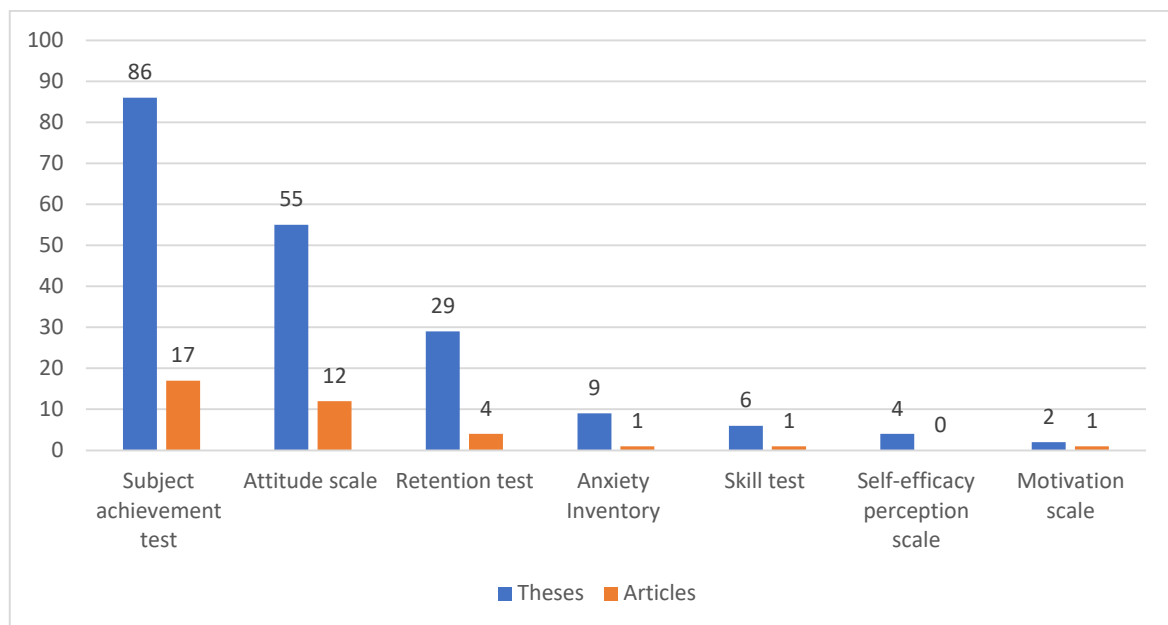
skills, metacognitive skills, computational thinking skills, problem - posing skills were referred to as "skills." Metacognitive behavior perception, self-efficacy perception, textbook perception were briefly shown as "perception" and mathematics motivation as "motivation" (Figure 11).



**Fig.11:Distribution by Dependent Variables**

**j) Distribution by Data Collection Tools**

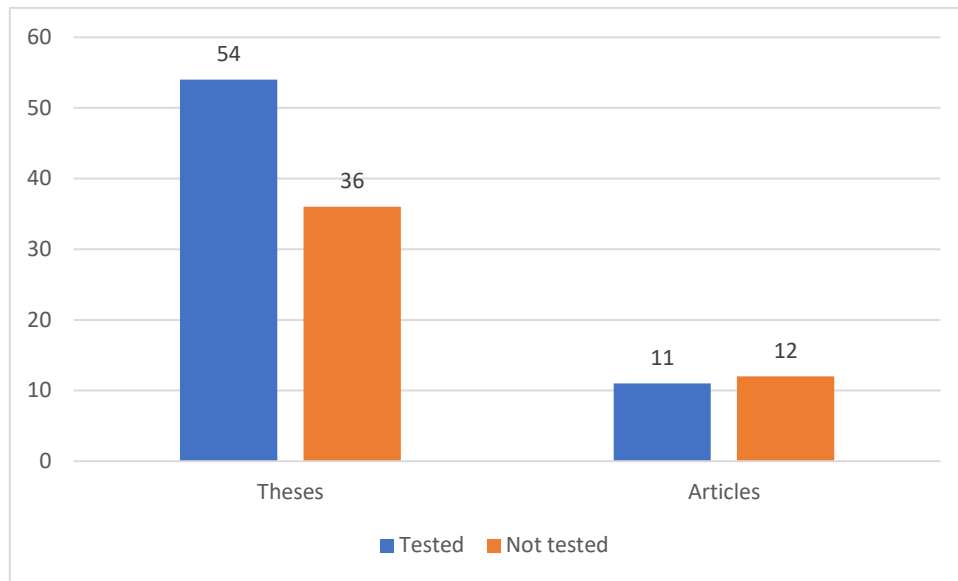
The review of the data collection tools used in experimental studies showed that mostly the "Subject achievement test" (86) were used in theses, followed by the "Attitude scale" (55), "Retention test" (29), and "Anxiety Inventory" (9). "Subject Achievement Test" (17), "Attitude Scale" (12), and "Retention test" (4) were used in articles (Figure 12).



**Fig.12:Distribution by data collection tools**

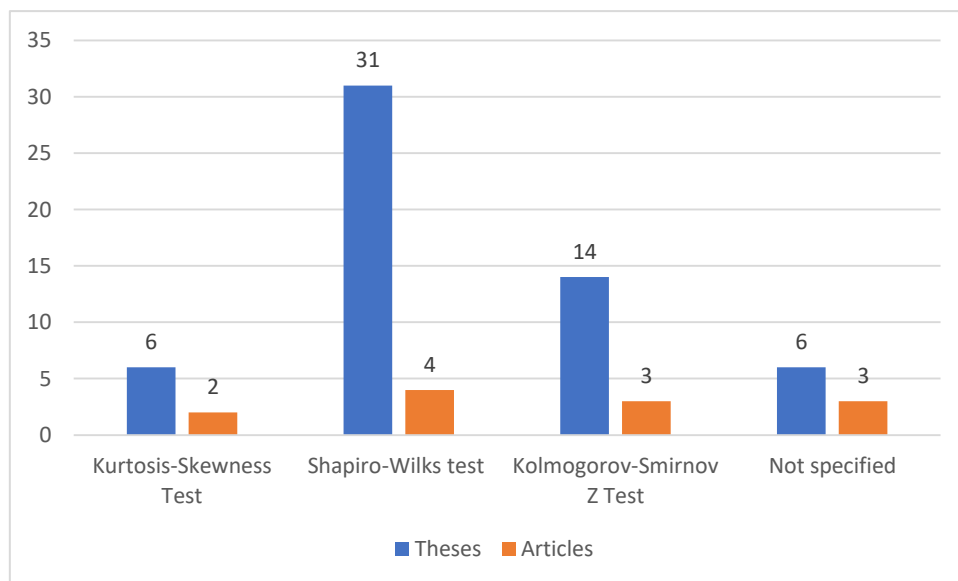
**k) Distribution by Normality Test**

The normality of the data was checked in 54 of the theses and 11 of the articles (Figure 13).



**Fig.13: Distribution by Normality Test**

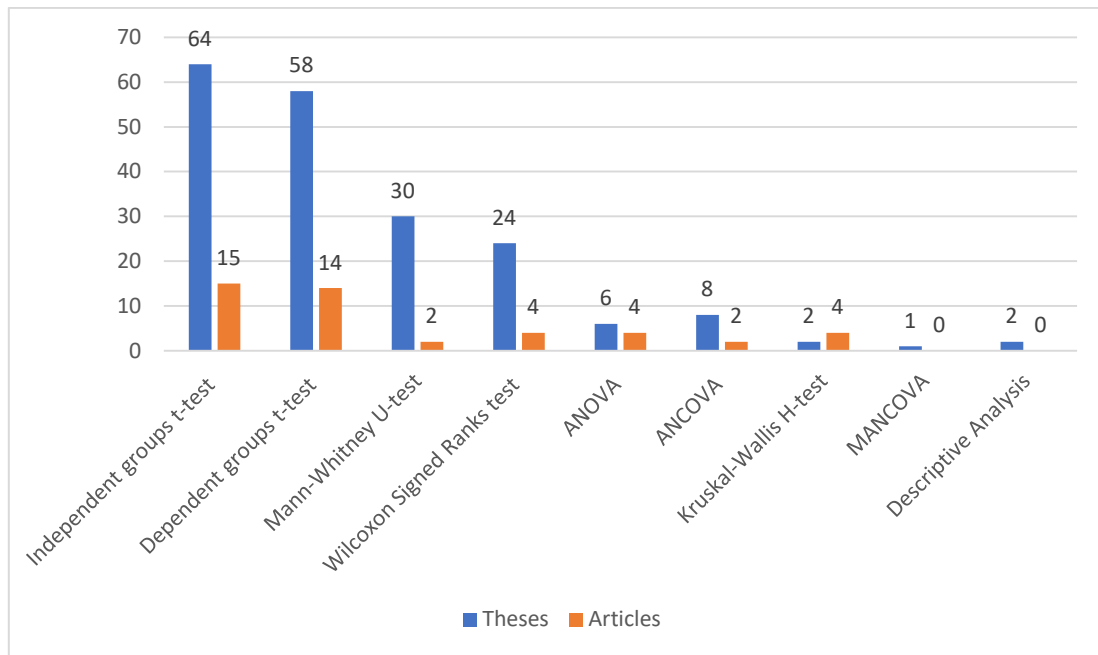
Regarding the types of normality tests, the Shapiro-Wilks test (31) was the most common in theses, followed by Kolmogorov-Smirnov Z Test (14) and Kurtosis-Skewness Test (6); the name of the normality test performed was not specified in 6 theses. The Shapiro-Wilks test was used 4 times, the Kolmogorov-Smirnov Z-Test 3 times, and the Kurtosis-Skewness Test twice in the articles; the name of the normality test was not specified in 3 articles. In some studies, two tests were performed together (Figure 14).



**Fig.14: Distribution of Normality Tests**

#### **1) Distribution by Tests Used in Data Analysis**

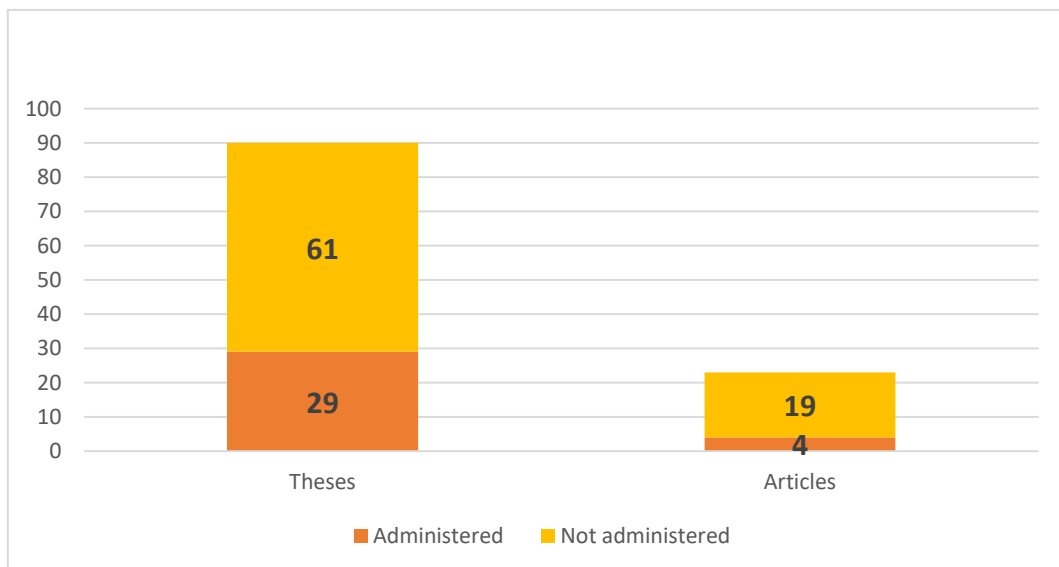
Among experimental studies, descriptive statistics was used in 2 theses, and the others used predictive statistics. In theses, independent groups t-test (64) and dependent groups t-test (58) were mostly used, followed by Mann-Whitney U-test (30) and Wilcoxon Signed Ranks test (24). Regarding the articles, independent groups t-test (15) and dependent groups t-test (15) were mostly used, followed by Wilcoxon Signed Ranks test (4), ANOVA (4), and Kruskal-Wallis H-test (4) (Figure 15).



**Fig.15: Distribution by Tests Used in Data Analysis**

**m) Distribution by the Administration of the Retention Test**

The experimental studies were reviewed regarding whether the retention test was performed or not. As a result, the Retention test was performed in 32% of theses and 17% of articles (Figure 16).



**Fig.16: Distribution by the Administration of the Retention Test**

**RESULTS AND DISCUSSION**

This review analyzed the experimental studies in the numbers and operations learning field of Turkey's secondary school mathematics curriculum. The studies published on YÖK Tez or Ulakbim TR Directory portals were included in the review. The theses published as articles were considered as articles in the study. The published theses and articles were reviewed according to years, the number of authors/advisors, regions where the data were collected, grades, sub-learning fields, sample sizes, sampling methods, dependent variables, independent variables, duration of the implementation, method, normality tests, data analysis methods and the administration of a retention test.

Regarding the distribution of the studies by year from 2006 to 2021, most theses and articles were published in 2019. One of the reasons for this increase may be that most of the oral exams for associate professors at the university were abolished in February 2018 and that doctoral faculty members were entitled to receive associate professorship titles with their published works. The interruption of formal education due to the Covid 19

pandemic in Turkey and the world may have caused a decrease in experimental studies in the last two years. The majority of the articles had two authors, which is similar to the results of other studies (Battal & Çalışkan, 2019; Kutluca & Demirkol, 2016; Ozan & Köse, 2014; Tatar, Kağızmanlı, & Akkaya, 2013), which had found that there are more articles with two authors. Experimental studies were reviewed according to the regions where they were conducted. Accordingly, the theses were mostly conducted in Central Anatolia, Eastern Anatolia, and the Black Sea regions. This result is similar to the results of previous studies (Aldemir & Tatar, 2014; Battal & Çalışkan, 2019; Ulutaş & Ubuz, 2008). It can be explained as the quota for graduate students is higher in Central Anatolia, and the students come from nearby cities. The studies in the articles were mostly carried out in the Marmara and Southeastern Anatolia, followed by the Aegean region; region information was not given in four articles. Experimental studies were not concentrated on a particular region in the articles. Regarding the participants' grades, the theses were mostly conducted with 7<sup>th</sup> graders, followed by 6<sup>th</sup>, 5<sup>th</sup>, and 8<sup>th</sup>-grade students. On the other hand, the articles were mostly conducted with 7<sup>th</sup> graders, followed by 5<sup>th</sup> and 6<sup>th</sup> graders; the least included group was 8<sup>th</sup> graders. The high school entrance exam at the end of the 8<sup>th</sup> grade may be one of the reasons why the least studied sample group was 8<sup>th</sup> graders. The review according to sub-learning fields showed that the theses were mostly focused on fractions, ratio-proportion, operations with fractions, and rational numbers sub-learning fields; the least focused field is the ratio. In the articles, the studies were mostly performed on fractions and integers. Moreover, operations with fractions, factors and multiples, sets, operations with rational numbers, ratios, and exponential numbers sub-learning fields were never studied. The fractions and operations with fractions sub-learning fields are among the most challenging subjects, and many teaching methods can be used in these fields, which may be the reasons for the high number of studies on these subjects. On the other hand, a significant part of exponential numbers are instructed in the 8<sup>th</sup> grade; the low number of studies conducted with 8<sup>th</sup> graders due to the exam they take at the end of the year is one reason why there are few studies about exponential numbers.

When the most used teaching methods and techniques were examined, it was seen that the theory of multiple intelligences, realistic mathematics education, teaching with games, and computer-assisted teaching were observed. It was seen that the most used materials were cartoons and concept maps. These results support the view that computer and material assisted teaching methods are increasing gradually with the development of technology (Fernández-Martín et al., 2020; Newman, & Gough, 2020). Studies were also analyzed according to sample sizes. The theses were mostly performed with 41-60 people, then by 21-40 people, and 61-80 people. The articles, like the theses, were mostly performed with 41-60 people, then 61-80 people and 21-40 people. The sample sizes are distributed in this way is because most of the experimental studies in the theses were conducted with two classes. These rates are in line with the findings of Powell, Mason, Bos, Hirt, Ketterlin-Geller, and Lembke (2021). Regarding the implementation time of the experimental studies, most of the theses endured 11-20 hours, then 21-30 hours, and 1-10 hours. The articles mostly took 1-10 hours, then 11-20 hours, and 21-30 hours. These results are similar to the results of previous studies (Powel et al., 2021, Tatar et al., 2013). The review of the experimental studies analyzed according to dependent variables showed that academic achievement and attitude towards mathematics were the most studied variables. Achievement, attitude, and anxiety were the most included variable in the theses, whereas achievement and attitude were the most examined variables in the articles. This result shows that the subjects with the fastest possible outcome are academic achievement (cognitive), attitude towards mathematics, and mathematics anxiety (affective), which can be measured easily with pre-made scales. Regarding the data collection tools used in the reviewed studies, mostly subject achievement tests, then attitude scale and retention test were used in the theses, in parallel with the dependent variables. Similarly, subject achievement tests, followed by attitude scale and retention test, were frequently used in the articles. This situation shows parallelism with the findings of Battal and Caliskan (2021) and İncikabı, Serin, Korkmaz, & İncikabı, (2017). Regarding the presence of the tests checking the normality of the data, the normality test was performed in approximately half of the studies (theses & articles). For this purpose, the Shapiro-Wilks test was performed the most, followed by the Kolmogorov-Smirnov Z test and Kurtosis-Skewness test. The review of tests used in data analysis showed that mostly independent groups t-test was performed in theses, followed by dependent groups t-test, Mann-Whitney U test, and Wilcoxon Signed Ranks Test. The test mostly performed in the articles was the independent groups' t-test, followed by dependent groups t-test, Wilcoxon Signed Ranks test, Kruskal Wallis H test, and ANOVA. The results are similar to the results of Tatar et al. (2013) and Altan, Genç, and Dağlıoğlu, (2021). The retention test rate was performed in one-third in theses and one-fifth in articles.

## SUGGESTIONS

In the research, the experimental studies conducted in Turkey in the numbers and operations learning field of secondary school mathematics curriculum were reviewed according to some characteristics. The sub-learning areas, the frequency of studying on them, and the frequency of using particular learning methods were revealed. It is aimed that the study will shed light on future research. In particular, the scarcity of experimental studies on some subjects of the 8<sup>th</sup>- grade was noticeable. Similar studies should be carried out on other learning areas. The

study can be expanded to the international literature to view the studies on a global scale from a general perspective.

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