



CONTENT ANALYSIS OF META-ANALYSIS STUDIES MADE IN MATHEMATICS EDUCATION IN TURKEY

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Abstract:

The aim of this research is to determine the trends of academic articles and postgraduate theses that employ the meta-analysis method in the field of mathematics education and that were published in Turkey between 2011 and 2020. Using the qualitative research method, this research aims to examine with descriptive content analysis the studies carried out in the field of mathematics education by using the meta-analysis approach. The data of this research consists of academic articles and postgraduate theses prepared using the meta-analysis approach in the field of mathematics education at the national level between 2011 and 2020. The data collection tool of the research is the "Publication classification form", which was prepared by the researcher. The data of the research were analyzed by descriptive content analysis. The reliability of the research was determined by the consensus formula of Miles and Huberman (1994). The studies examined in the research are classified according to years, study type, independent variable, dependent variable, effect sizes, and effect directions. For the findings of the research, frequency and percentage tables of the studies examined were created. In the findings of the research; It was concluded that the studies were carried out mostly in 2019, academic articles and theses were mostly examined together in the studies, the Computer-Aided Mathematics Teaching method was the most frequently investigated subject through the meta-analysis, academic success was investigated as the dependent variable, and the effect sizes of the studies were moderate and their directions were mainly positive. It is recommended to conduct a meta-analysis of recently used distance education methods and of the new constructivist approaches.

Keywords: content analysis, mathematics education, meta-analysis

1. Introduction

Mathematics (Sarpkaya Aktaş, 2019), which generally examines the properties and relationships of numbers, shapes, and multiplicities, and is divided into many sub-

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disciplines such as geometry, algebra, and numbers (Sarpkaya Aktaş, 2019), is a logical system that deals with measurable qualities (Dost, 2019). Mathematics, which includes processing, producing, estimating information, and solving problems using a language of its own, is also the science of patterns and order (MoNE, 2009). Mathematics, which is not a set of abstract concepts and rules, is the whole of the skills that are formed in the process and problem solving based on the modeling of reality (Altun, 2013). Being used to solve problems in daily life, it is a system that develops logical thinking and a language in which symbols are used (Baykul, 2020). As a result, according to some, mathematics is the science of abstraction and modeling, and according to others, it is the common language and instrument of science (Ersoy, 2003).

Since societies that effectively use mathematics, which is an important tool in today's developments in the field of science and technology, flourish and develop more than societies that cannot do this, it is of great importance to raise individuals who can understand, work with mathematics and use it in their daily lives (Sarpkaya Aktaş, 2019). Since the importance and value of mathematics education will increase when the developed and developing societies give importance to mathematics (Baykul, 1999), the aim should be to raise individuals who not only know mathematics and have the ability to perform operations but also are eager to apply it, solve problems through it and use their reasoning skills (Olkun & Toluk, 2003).

The most important aim of education is to raise individuals who are useful to society. The schools aim to train technicians, engineers, scientists, and technocrats that the societies need, while giving the necessary mathematical culture to the students and improving their mathematical thinking ability (Baki, 2020). Developing individuals' creative thoughts, the main purpose of mathematics education, which provides knowledge, skills, and aesthetic feelings in understanding their physical and social environment and the world (Baykul, 1999), is to train individuals who know and use mathematics and have the capacity to keep up with the developing technology with mathematical knowledge (Ersoy, 2003).

Mathematics education provides individuals with a wide range of knowledge and skills to help them understand the physical world and social interactions. It provides individuals with a language and systematic thinking through which they can analyze, explain, predict, and solve problems in a variety of cases. It also facilitates creative thinking and provides aesthetic development. In addition, it accelerates the development of individuals' reasoning skills by creating environments in which various mathematical situations are examined (MEB, 2009). Considering the main objectives of mathematics education, there is a need to raise individuals who actively participate in the education process, produce knowledge and use it in real life, and individuals who can solve problems, think critically, who are entrepreneurial, determined and who have communication skills, and who can contribute to the development of the society they live in (Ünlü, 2020).

Researches in the field of mathematics education, which is the link between mathematics and education research fields, are defined as scientific studies in which the methods and paradigms used by educational research are employed in mathematics

teaching (İlhan, 2011). In other words, mathematics education, which is a field of study that provides the development and application of methods and theories on the learning and teaching of mathematics, reflects the knowledge of academic mathematics to school mathematics, in order to meet the mathematics education, need of the society, by making use of educational psychology, sociology, philosophy, and history, producing new information in the field. (Baki, 2020). Research on mathematics education makes a great contribution to gaining new perspectives on existing educational elements, reorganizing the ongoing wrong methods, and adding new concepts to the field in accordance with the requirements of the age. Each new study in the relevant field also fulfills the task of shedding light on the next one (Er and Biber, 2020). In recent years, there has been a noticeable increase in postgraduate studies in the field of mathematics education in Turkey, and the belief that "*every mathematician is also a mathematics educator*" has disappeared and the field of mathematics education has become a separate and important research area (Baki, Güven, Karataş, Akkan, Çakıroğlu, 2011).

In today's world, where the needs of society change rapidly, it is of great importance to conduct research on education in order to train the manpower that can meet these needs (Kayhan and Koca, 2004). It is thought that postgraduate studies have an important place in terms of revealing current problems and producing solutions to these problems. Therefore, master's and doctoral theses written in the field of mathematics education are also considered to be important (Tereci & Bindak, 2019). Examining the studies carried out in the subject area can reveal which subjects have reached saturation or which new researches are needed (Karamustafaoğlu, 2009). In other words, it is important to observe the changing trends of educational research by making periodic examinations on them to shed light on scientists who want to work effectively in the relevant field (Cohen, Manion, & Morrison, 2007).

In the field of mathematics education, apart from studies investigating the relationship between teaching mathematics and cognitive, affective or psycho-motor skills, there are also studies examining academic studies on the trends in mathematics education. In this context, studies are carried out with a view to observe the findings of the researches in the field of mathematics education as a whole (Er & Biber, 2020). Some of the things that have been done in the last 20 years are as follows: Kayhan and Koca (2004) examined the mathematics education research topics between 2000-2002 in their study and aimed to provide a perspective to educators, researchers, and teachers about them. Ulutaş and Ubuz (2008) conducted a research study on the articles published between 2000-2006 in the field of mathematics education and found that the number of studies in this field increased after 2002. Yücedağ (2010) examined the studies conducted in the field of mathematics education between 2000 and 2009 and concluded that there was a concentration on teaching methods in postgraduate theses and on affective field topics in the articles. Baki, Güven, Karataş, Akkan, Çakıroğlu (2011) examined postgraduate theses with document analysis technique in order to determine the trends of mathematics education researching the period between 1998 and 2007. İlhan (2011) examined the theses and postgraduate articles published in the field of mathematics education and determined the intensity of experimental research in the studies. Çiltaş

(2012) carried out a content analysis study for theses made between 2005 and 2010 in the field of mathematics education. Çiltaş, Güler, and Sözbilir (2012) made a content analysis of the researches in the field of mathematics education in Turkey between 1987 and 2009 and stated that there has been an increase in mathematics education research since 2002, quantitative studies are preferred more, and that learning studies are at the forefront as a research subject. They obtained the results like a single data collection tool was used more often in those studies and the use of percentage and frequency tables as data analysis methods came to the fore. Yalçınkaya and Özkan (2012) conducted a content analysis study on alternative methods in mathematics teaching published in the journals of Education Faculties and found that most of the studies were full of experimental research and empirical methods were used. Tabuk (2019) made some suggestions for mathematics educators and researchers by conducting a systematic review on postgraduate theses written on computer-aided mathematics applications in postgraduate theses. Tereci and Bindak (2019) made a comparative analysis of the postgraduate theses written between 2010 and 2017 in the field of mathematics education according to various variables. Er and Biber (2020) aimed to reveal the general situation of experimental research by examining the master's and doctoral theses written in the field of mathematics education. Temporary and Türnüklü (2020) examined the theses prepared on problem posing from a thematic point of view and concluded that problem-posing studies were mostly carried out on the subjects of "Numbers and Operations" and "Fractions". In addition, there are many studies examining the trends of mathematics education research in areas that require certain interests and expertise, such as mathematical modeling, mathematics learning areas, and the use of technology in mathematics education.

2. Content Analysis

Content analysis is the classification and summarization of verbal and written data in terms of a specific problem or purpose, measuring certain variables or concepts of these data, and categorizing them by scanning for a specific meaning (Arık, 1992). Content analysis (Dinçer, 2018), which is a scientific method conducted in order to disseminate information and guide future research, by systematically examining written materials in general, grouping them with certain criteria, consists of three sub categories; meta-analysis, meta-synthesis (thematic content analysis) and descriptive content analysis.

Meta-analysis, which refers to a set of statistical methods performed to quantitatively aggregate the results of more than one primary study to arrive at an overall conclusion or summary, collects quantitative results from multiple studies and makes inferences about the overall effect between studies, regardless of the findings of the original studies. The main purpose of meta-analysis is to present a general evaluation over the effect size values obtained from individual studies (Yıldırım & Şen, 2020). Meta-analysis is a method of combining the results of more than one independent study on a specific subject and statistical analysis of the research findings (Akgöz, Ercan, Kan, 2004). Basically, meta-analysis, which is considered as the analysis of analyzes, is an analysis of

the effectiveness of some studies by addressing the similarities and differences between them (Eser, Yurtçu, Aksu, 2020).

Meta-synthesis involves dealing with qualitative researches made in a certain field with a qualitative understanding, revealing the similarities and differences comparatively. Meta-synthesis research is a type of study that reinterprets by comparing, through certain principles and criteria, the qualitative findings or interpretations/results of previous studies in a certain field (Çalık and Sözbilir, 2014).

Descriptive content analysis is a type of qualitative data analysis that includes summarizing and interpreting the data obtained by various data collection techniques according to predetermined themes, and its main purpose is to present the obtained findings to the reader in a summarized and interpreted form (Yıldırım & Şimşek, 2003). In descriptive content analysis, which aims to determine trends in a certain direction, previous studies are examined with certain criteria, usually with frequency and percentage distributions (Dinçer, 2018). The main purpose of content analysis is to reach concepts and relationships that can explain the collected data. Through content analysis, data is tried to be defined and facts that may be hidden in the data are tried to be revealed. The basic process in content analysis is to gather similar data within the framework of certain concepts and themes and to interpret them in a way that the reader can understand (Yıldırım & Şimşek, 2016).

The biggest mistake made about meta-analysis and meta-synthesis is to confuse these studies with descriptive content analysis. It has been observed in many studies that researchers examine previous studies on a subject with one or several variables for a certain time period, and they give frequency and percentage distributions and findings, and they express the methods of their studies as meta-synthesis or meta-analysis (Dinçer, 2018).

Meta-analysis requires the expression of research results in terms of the effect size. The concept of "effect size" with Cohen's *d* entered the literature for the first time in 1978. Briefly, different research results on a subject are converted into a common metric and standardized, and the statistical results are summarized together with the research characteristics. The aim is to calculate the general effect size of the method used in the experimental groups and to investigate the effect of the main characteristics of the study on this effect size. Hence, it is important to know the effect size of the method used in the experimental group in a research (Başol, 2009).

The term effect size, which constitutes the essence of a meta-analysis study, is used to inform the readers about how much the independent variable in a study affects the dependent variable positively or negatively. When an application is performed on a group, it certainly has an effect. However, whether this effect is significant or how effective it is varies. The purpose of the meta-analysis is to investigate the level of this effect. The effect size, which is also used as the effect coefficient in the literature, gives information to the readers about how the independent variable in a study affects the dependent variable positively or negatively. Linguistic intervals in the scale (Cohen's *d* or Hedges's *g*) that are mostly used when classifying the impact of the studies are expressed as insignificant, small, medium, large, very large, and huge (Dinçer, 2021).

2.1 Purpose of the Study

Studies examining the trends of researches made in the field of mathematics education will guide researchers, educators, teachers, and students in various scientific discussions and inquiries. Studies conducted in recent years to examine the trends of research in mathematics education provide a framework for what has been done in this field and reveal the need for more comprehensive research (Çiltaş, Güler, Sözbilir, 2012). In this way, researches in the field of mathematics education will be revealed as a whole, new examinations and evaluations will be made as to the number of studies in the field increases, and more detailed studies on narrow-scoped subjects will be conducted (Ulutaş & Ubuz, 2008).

This research aims to determine the trends of academic articles and theses published in Turkey between 2011 and 2020 by using the meta-analysis method in the field of mathematics education. Within the scope of this research, which focuses on the studies carried out in the field of mathematics education using the meta-analysis approach with descriptive content analysis, answers to the following questions were sought.

- 1) What is the distribution of the types of meta-analysis studies by years?
- 2) What is the distribution of meta-analysis studies according to the types of research they examine?
- 3) What is the distribution of meta-analysis studies according to sample sizes?
- 4) What is the distribution of meta-analysis studies by type?
- 5) What is the distribution of meta-analysis studies according to the package programs used?
- 6) What is the distribution of meta-analysis studies according to the use of funnel plots?
- 7) What is the distribution of meta-analysis studies according to the size effect calculation formulas?
- 8) What is the distribution of meta-analysis studies according to an independent variable?
- 9) What is the distribution of meta-analysis studies according to the dependent variable?
- 10) What is the distribution of meta-analysis studies according to the effect sizes they have at the end of the research?
- 11) What is the distribution of meta-analysis studies according to the direction of the effect they have at the end of the research?

3. Methods

3.1 A Section Research Model

This research is based on descriptive content analysis of data collected through document analysis. Document analysis, which is considered within the scope of qualitative research, is a scientific method that includes the collection, review, questioning, and analysis of various documents as the primary source of research data. Researchers who

aim to obtain understandable, objective, and convincing results from documents prefer the content analysis method for data analysis (Özkan, 2020). Document analysis includes the analysis of written materials containing information about the targeted phenomenon or phenomena (Yıldırım & Şimşek, 1999). Cohen, Manion, and Morrison (2007) argued that content analysis is a technique that consists of organizing scientific data according to a certain criterion, comparing their differences and classifying them according to their characteristics, and drawing theoretical conclusions. Content analysis, which is the process of bringing together the results of scientific researches conducted in the same field separately from each other, combining them in a common denominator, categorizing them according to similar characteristics, and creating a systematic and accessible information source (Ültay, Dönmez Usta & Durmuş, 2017). By pointing out to the gaps and deficiencies, it has a guiding feature for researchers for future studies (Kanlı, Gülçiçek, Göksu, Önder, & Oktay, 2014).

Descriptive content analysis is conducted in four stages. In the first stage, the researcher determines under which themes the data will be organized and presented by creating a framework for data analysis based on the research questions, the conceptual framework of the research, and the dimensions obtained from the literature review. At this stage, where it is important to bring the data together in a meaningful and logical way, the researcher reads, organizes, and digitizes the data based on the framework he has previously created. After this stage, the researcher defines the data he has arranged. At the end of this process, the researcher explains, relates, and makes sense of the findings he has defined and explains the cause-effect relationships between the findings in order to further strengthen his comments and makes comparisons between different cases if needed (Özen & Aslan-Hendekçi, 2016).

3.2 Data Collection

The data of this research consists of academic articles and postgraduate theses prepared using the meta-analysis approach in the field of mathematics education at the national level between 2011 and 2020. The universe of the research consists of all meta-analysis studies conducted in the field of mathematics education.

The criteria taken into account in determining the studies included in the research are as follows:

- 1) The studies were carried out in Turkey,
- 2) The studies carried out between 2011 and 2020,
- 3) The fact that the studies were carried out in the field of mathematics education,
- 4) The effect sizes were calculated using the meta-analysis approach in the studies,
- 5) The study includes the meta-analysis as one of the keywords,
- 6) The work is open to access or the full text is accessible.

In the light of these criteria, a data collection tool suitable for the purpose and content of the research was developed by the researcher, taking into account similar content analysis studies and previously used basic categories. In the data collection tool named the publication classification form, the categories for the sub-problems of the research were handled. For the validity of the form, the form was finalized by taking the

opinions of experts from the fields of mathematics education and measurement and evaluation field.

In the process of reaching the studies made using meta-analysis in mathematics education, first of all, a large-scale literature review was made. In line with the purpose of the research and adhering to the criteria stated above, YÖK National Thesis Center, UlakBim and Scholar Google search and indexing engines were used to reach the data. These research databases were scanned using the keywords "mathematics education" and "meta-analysis", and 26 studies, 15 of which were academic articles and 11 of which were post-graduate theses, were reached and analyzed. The studies included in the research are given in Appendix 1.

3.3 Coding of Research Data

All studies reached at the national level using the publication classification form created in line with the determined criteria were included in the coding process by using the descriptive content analysis coding method. Coding and evaluation of 26 studies were carried out using the table given in Appendix 1. While the studies were carefully examined, first of all, the abstracts and the research problems of the studies were examined in order to decide whether they fully fit the categories specified in the form. In line with the purpose of the research, the results and discussion sections were also carefully examined in order to determine the effect size value in the study. In order to avoid any material errors, the studies were re-evaluated by the researcher once again after a certain period of time, and necessary adjustments were made. Finally, in terms of descriptive analysis, each article was coded as A1, A2, ..., A15 and each post-graduate thesis was coded as T1, T2, ..., T11.

3.4 Validity and Reliability of the Research

For the validity of the studies, first of all, there must be compatibility between the aims and the means. As in other researches, the validity of the content analysis studies can be of appearance, prediction, structure, and criterion. If the research is only for descriptive purposes, face validity may be considered sufficient. In which case, the reliability of the content analysis technique depends especially on the coding process. Identifying the categories and defining them clearly is the most important step. As long as this is done, the reliability and objectivity of the analysis will be increased. In other words, the fact that the interpretations of the categories do not change from researcher to researcher or at two different times ensures reliability, which is a condition of objectivity (Tavşancıl & Aslan, 2001).

The reliability formula ($\text{Reliability} = \frac{\text{Consensus}}{\text{Consensus} + \text{Disagreement}}$) of Miles and Huberman (1994) was used to calculate the reliability of the study. With this formula, the studies are accepted as reliable if the reliability calculations are over 70%, the reliability of this study was calculated as 94%. As a result, no incompatibility was observed between the encodings.

3.5 Data Analysis

Research data were recorded in accordance with the publication classification form, which was prepared to analyze the descriptive content of meta-analysis studies in the field of mathematics education. In the analysis of the data obtained, descriptive statistical methods consisting of classifying the data, making frequency distributions, defining these distributions with measures such as means, quartiles, and percentiles, standard deviation, were used, presenting the findings to the reader with tables and graphs. Frequency analysis reveals the frequency of appearance of units quantitatively (by percentage and proportion). If the aim is to count how often message items are seen in the analyzed material, countable units are determined and analysis indicators are expressed in frequency type. This type of analysis allows understanding the intensity and importance of a particular item. At the end of the frequency analysis, the items can be placed in order of importance and a classification based on frequency can be made (Tavşancıl & Aslan, 2001). In the analysis of the data of this study, frequency and percentage values were obtained with the help of the Excel program. The results obtained were presented using tables and graphs, and these tables and graphs were analyzed in detail.

4. Results and Discussion

In this section, the findings obtained from the research are given.

4.1 Findings for the first sub-problem

15 academic articles and 11 postgraduate theses were discussed in this study which examines the distribution of academic studies carried out by using the meta-analysis approach in the last 10 years at the national level in the field of mathematics education. The first sub-problem of the research is "What is the distribution of the types of meta-analysis studies according to years?" in mathematics education between 2011 and 2020. The findings of the question are as in Table 1.

Table 1: The distribution of the types of meta-analysis studies in Mathematics Education according to years

Years	Article		MA Thesis		PhD		Total	
	f	%	f	%	f	%	f	%
2011	0	0,00	1	3,85	0	0,00	1	3,85
2012	0	0	0	0	0	0	0	0
2013	0	0,00	3	11,54	0	0,00	3	11,54
2014	1	3,85	0	0,00	0	0,00	1	3,85
2015	3	11,54	0	0,00	0	0,00	3	11,54
2016	2	7,69	1	3,85	0	0,00	3	11,54
2017	1	3,85	1	3,85	1	3,85	3	11,54
2018	2	7,69	1	3,85	0	0,00	3	11,54
2019	3	11,54	2	7,69	0	0,00	5	19,23
2020	3	11,54	1	3,85	0	0,00	4	15,38
Total	15	57,69	10	38,46	1	3,85	26	100,00

According to Table 1, in the distribution of meta-analysis studies conducted in the field of mathematics education by years, it has been observed that:

- A total of 15 academic articles were published, three (11.54%) in 2015, 2019, and 2020, and one (3.85%) in other years, while no study was conducted in this area in 2011, 2012, and 2013.
- 3 of the 10 master's thesis studies were completed in 2013 (11.54%), 2 studies were carried out in 2019 (7.69%), one study was carried out in other years, and no study was conducted in this area in 2014 and 2015.
- A PhD Dissertation in which meta-analysis approach was used in the field of mathematics education was observed to have been made in 2017.

4.2 Findings for the second sub-problem

At the end of this research, it was seen that while some of the academic articles and postgraduate theses carried out using the meta-analysis approach in the field of mathematics education examined only the postgraduate theses, while the others dealt with both academic articles and postgraduate theses.

Findings relating to the second sub-problem of the research, "What is the distribution of meta-analysis studies according to the type of study they examine?" in mathematics education between 2011 and 2020 are given in Table 2.

Table 2: The distribution of meta-analysis studies in mathematics education according to the type of study they examine

Type of study	Article		Post-graduate thesis	
	f	%	f	%
Academic Article	3	20	3	27,3
Academic Article and Thesis	12	80	8	72,7
Total	15	100	11	100

According to Table 2:

- It was observed that meta-analysis study of only the articles made in the field of mathematics education was done in 3 of the 15 academic articles (20%), and in 12 of them, meta-analyses were made by examining both articles and postgraduate theses (80%).
- It was seen that the meta-analysis method used on only the articles was in 3 of the 11 postgraduate theses examined (27.3%), while the meta-analysis of both the articles and the postgraduate theses was made in 8 of them (72.7%).

4.3 Findings for the third sub-problem

The samples of academic articles and graduate thesis studies conducted using the meta-analysis approach in mathematics education in the last 10 years vary according to the studies in which the independent variable is applied. The number of meta-analyses varies according to the number of studies investigating the effects of methods, techniques and features preferred in academic studies.

Table 3 gives the findings related to the third sub-problem of this research; "What is the distribution of meta-analysis studies according to sample sizes in mathematics education between 2011 and 2020?"

Table 3: The distribution of meta-analysis studies in mathematics education according to sample sizes

	Article		Post-graduate thesis	
	f	%	f	%
1-15	5	33	0	0
16-30	5	33	4	30,8
31-45	3	20	3	23,1
46-60	1	7	1	7,7
61-75	0	0	2	15,3
76-90	0	0	1	7,7
91-105	0	0	1	7,7
106-120	1	7	1	7,7
Total	15	100	13*	100

*Since the samples in which the dependent variable was examined in some studies were different in number, the number of studies examined appears to be higher.

According to Table 3:

- Of the 15 academic articles examined, 5 (33%) were meta-analyses in the 1-15 range and 5 (33%) were in the 16-30 range. The meta-analysis of the studies in the range of 46-60 was carried out in only 1 study (7%). Likewise, the meta-analysis in the range of 106-120 was carried out in 1 study (7%).
- While meta-analysis of the studies in the range of 16-30 is 4 (30.8%) out of the 11 postgraduate theses examined, no post-graduate theses were observed to have a sample size of 1-15.

4.4 Findings for the fourth sub-problem

The fourth sub-problem of this research is "What is the distribution of meta-analysis studies by types?" in mathematics education between 2011 and 2020. Findings relating to the question are as in Table 4.

Table 4: The distribution of meta-analysis studies by types in mathematics education

Types	Article		Post-graduate thesis	
	f	%	f	%
Effectiveness of Differences	12	80	11	100
Effectiveness of Relationships	3	20	0	0
Total	15	100	11	100

According to Table 4:

- The effectiveness of differences as a type of meta-analysis was investigated in 12 (80%) of the 15 academic articles examined, while the effectiveness of relationships as a type of meta-analysis was investigated in 3 (20%) of them.

- In all of the 11 postgraduate theses examined, the researchers investigated the effectiveness of the differences.

4.5 Findings for the fifth sub-problem

Researchers preferred to use various package programs while carrying out their meta-analysis studies. The fifth sub-problem of this research is "What is the distribution of meta-analysis studies according to the package programs used?" in mathematics education between 2011 and 2020. The findings relating to the question are as in Table 5.

Table 5: The distribution of meta-analysis studies on mathematics education according to the package programs used in them

Programs	Article		Post-graduate thesis	
	f	%	f	%
CMA	10	71,4	5	45,4
MetaWin 2.0	2	14,3	2	18,2
CMA & MetaWin	2	14,3	2	18,2
R Statistics	0	0	1	9,1
Stata	0	0	1	9,1
Total	14*	100	11	100

*Whether a package program was used or not wasn't specified in one of the studies.

According to Table 5:

- CMA was preferred as the package program used in the meta-analysis in 10 (71.4%) of the 15 academic articles examined, MetaWin program was used in 2 (14.3%) and 2 (14.3%) of these studies used both of the programs.
- While CMA package program was used in 5 (45.4%) of 11 graduate theses examined, R Statistics and Stata package programs were used in one graduate thesis, separately (9.1%).

4.6 Findings for the sixth sub-problem

Visual tools such as funnel graph and normal q-q graph are used to prove that there is no bias effect. A funnel scatterplot, in which the points are clustered when the sample size is small and the points diverge as the sample size increases, is a visual descriptive tool that is frequently used in the evaluation of meta-analysis studies against the biased publication effect (Başol, Doğuyurt, & Demir, 2016).

The sixth sub-problem of this research is "What is the distribution of meta-analysis studies according to the use of funnel graph?" in mathematics education between 2011 and 2020. Findings pertaining to it are as in Table 6.

Table 6: The distribution of meta-analysis studies in mathematics education according to the use of funnel graph

	Article		Post-graduate thesis	
	f	%	f	%
Used	11	73,3	7	63,6
Not used	4	26,7	4	36,4
Total	15	100	11	100

According to Table 6:

- While 11 (73.3%) of the 15 academic articles included funnel graphs, 4 (26.7%) studies did not include them.
- While 7 (63.6%) of 11 graduate theses included funnel graphics, 4 (36.4%) studies did not include them.

4.7 Findings for the seventh sub-problem

The seventh sub-problem of this research is "What is the distribution of meta-analysis studies according to the effect size calculation formulas used in them in mathematics education between 2011 and 2020? The findings related to the question are as in Table 7.

Table 7: The distribution of meta-analysis studies in mathematics education according to the effect size calculation formulas used in them

Effect size	Article		Post-graduate thesis	
	f	%	f	%
Hedges' g	8	53,3	9	81,8
Cohen's d	5	33,3	2	18,2
Fisher's z	2	13,4	0	0
Total	15	100	11	100

According to Table 7:

- Hedges' g effect formula was used as the effect size formula in 8 (53.3%) of the 15 academic articles examined, while Fisher's effect value formula was used in 2 (13.2%) of them.
- Hedges' g effect value formula was used in 9 (81.8%) of 11 graduate theses examined, while Cohen's d effect size formula was used in 2 (18.2%) of them.

4.8 Findings for the eighth sub-problem

Meta-analyses of the researches are conducted using various methods, techniques, and features within the scope of the constructivist approach in the field of mathematics education. The method, technique, and features mentioned here are related to the use of the independent variables in the studies examined. In this study, the distribution of the meta-analysis approach according to methods, techniques, and features is also considered as a research question.

The eighth sub-problem of the research is "What is the distribution of meta-analysis studies conducted on mathematics education between 2011 and 2020 according to the independent variable?" Findings relating to the question are as in Table 8.

When Table 8 is examined, it is seen that meta-analyses (15,38%) of the studies using the BDME method are the most encountered ones. It was observed that this method was followed by the meta-analysis of Geogebra studies, which is the Dynamic Geometry software, and the meta-analysis of the Cooperative Teaching method (11.54%). There were also 2 studies on RME, 2 studies examining the effects of the attitude feature, and studies in which meta-analysis of studies under a general denomination as student-centered methods were also conducted (7.69%). Meta-analyses of many other known and

frequently used methods of the constructivist approach (Active Teaching, Contemporary Learning Approaches, Concept Mapping, Multiple Intelligences, Problem Posing, Problem Solving, Material Use, Alternative Teaching Methods, Technology supported) were also observed (3.85%).

Table 8: The distribution of meta-analysis studies conducted in mathematics education according to the independent variable

	f	%
Active Learning	1	3,85
CAML (Computer Assisted Math. Learning)	4	15,38
Contemporary Learning Approaches	1	3,85
Dynamic Geometry Software (Geogebra)	3	11,54
Collaborative Learning	3	11,54
RME (Realistic Math. Education)	2	7,69
Concept Map	1	3,85
Attitude	2	7,69
Anxiety	1	3,85
Multiple Intelligence	1	3,85
Problem Posing	1	3,85
Material Usage	1	3,85
Alternative Learning Methods	1	3,85
Student Centered	2	7,69
Problem Solving	1	3,85
Technology Assisted	1	3,85
Total	26	100,00

4.9 Findings for the ninth sub-problem

In this study, the types of the effects of meta-analysis studies, which examine the effects of methods, techniques, and features used in mathematics education mentioned in the 8th sub-problem, are also considered as a research problem. In the studies in which the meta-analysis approach is used in the field of mathematics education, the total number of studies examined in this sub-problem has increased virtually to 35, since the effects of methods, techniques, and features on many situations are investigated combinatively.

The ninth sub-problem of the research is "What is the distribution of meta-analysis studies conducted in mathematics education between 2011 and 2020 according to the dependent variable?" Findings pertaining to the question are given in Table 9.

Table 9: The distribution of meta-analysis studies conducted in mathematics education according to the dependent variable

	f	%
Academic Success	24	69
Attitude	9	26
Permanence (Memorability)	1	3
Anxiety	1	3
Total	35*	100

*There was an increase in the total frequency value because more than one dependent variable was examined in some studies.

When Table 9 is examined, it was seen that meta-analysis studies on mathematics education seeking the effects of methods, techniques and features on achievement were the most investigated ones (69%). Nine (26%) meta-analysis studies seeking the effects of methods, techniques and features on attitude were investigated. A meta-analysis of the effects of methods, techniques and features on permanence, and anxiety was found in a study for each (3%).

4.10 Findings for the tenth sub-problem

In order to combine the statistical data of the studies included in the meta-analysis and thus to make a general comment, the effect sizes of each study should be calculated. In meta-analysis, effect sizes are the basis for statistically summarizing research results. The tenth sub-problem of the research is "What is the distribution of meta-analysis studies according to the effect sizes obtained at the end of the studies?" in mathematics education between 2011 and 2020. Findings relating to the question are given in Table 10.

Table 10: The distribution of meta-analysis studies in mathematics education according to the effect sizes obtained at the end of the studies

	f	%
Large	13	37
Medium	18	51
Small	3	9
Not specified	1	3
Total	35*	100

*Since more than one dependent variable was examined in some of the studies, there was an increase in the total frequency value of the effect sizes.

According to Table 10, the effect sizes of the meta-analyses of the studies conducted on the field of mathematics education were obtained as medium size in 18 studies (51%). While 13 studies (37%) with large effect sizes were found, 3 studies (9%) had small effect sizes and in 1 meta-analysis study (3%) the effect size was not specified.

4.11 Findings for the eleventh sub-problem

The eleventh sub-problem of the research is "What is the distribution of the studies in which the meta-analysis approach is used in mathematics education between 2011 and 2020, according to the direction of effect obtained at the end of the research?" Findings relating to the question are given in Table 11.

Table 11: The distribution of the studies in which the meta-analysis approach is used in mathematics education according to the direction of effect obtained at the end of the research

	f	%
Positive	23	66
Not specified	11	31
Negative	1	3
Total	35*	100

*Since more than one dependent variable was examined in some of the studies, there was an increase in the total frequency value of the effect directions.

According to Table 11, a positive effect was found in 23 of the meta-analysis studies conducted in the field of mathematics education (66%). While the direction of effect was not specified in one of the studies (31%), it was observed that a negative effect was obtained in one study (3%).

5. Recommendations

In this study, the content analysis of meta-analysis studies conducted in the field of mathematics education in the last 10 years has been carried out with a view to shed light on researchers who want to work in this field. The deficiencies in the field can be clearly seen through the method, techniques, and features of the meta-analysis. The effects of these methods can be investigated by making meta-analyses of experimental studies carried out using many new constructivist approaches. Also, the Meta-analyses of distance education studies, which are preferred due to the pandemic, can also be carried out. Recently, again with the effect of the pandemic, many researchers have conducted content analysis studies. In terms of being a guide in the field and revealing the deficiencies, studies that reveal the trends in content analysis studies covering this period can as well be carried out. This research can be repeated by applying it to other fields of education, too. In addition, in the studies examined, those written only in Turkish were selected by taking into account the YÖK (High Education Board) thesis center database. It is recommended that meta-analysis studies conducted in foreign languages can also be examined in order to expand the findings on the field.

6. Conclusion

In this Content analysis of meta-analysis studies conducted on the field of mathematics education from 2011 to 2020 was carried out within the scope of this research. In content analysis, the frequencies and ratios (percentages) of similar ideas and concepts are found and a meaningful conclusion is tried to be made. In content analysis, similar data are brought together within the framework of certain concepts and themes, and these are arranged and interpreted in a way that the reader can understand (Tekindal, 2021). Meta-analysis, on the other hand, is to reveal the effect of the independent variable on the dependent variable by using the effect size coefficient and the quantitative data obtained from the studies completed in a certain period. In other words, it is to reveal an individual or general effect size by analyzing the findings of dependent and independent variables in similar studies (Dinçer, 2017). In this context, answers to various questions were sought.

When the distribution of meta-analysis studies in the field of mathematics education in the last 10 years is examined, it is concluded that mostly academic articles have been prepared. While the master's studies have an average distribution by years, the only doctoral study in which the meta-analysis method was used was carried out by Gürsoy (2017). In the last 10 years, the highest number of meta-analysis studies was observed to be made in 2019.

In most of the academic articles and postgraduate theses examined within the scope of the research, the articles and theses were examined together and subjected to the meta-analysis method. In the few articles and postgraduate thesis, only the meta-analysis of the postgraduate thesis studies was made. The number of mathematics education studies that were brought together in order to apply the meta-analysis approach was also considered as a research question. In total, it was concluded that meta-analysis of 16-30 studies was carried out at most.

In the meta-analysis of the studies conducted in the field of mathematics education, it was seen that the studies aimed at investigating the effectiveness of the differences were in the majority. It has been found that researchers preferred mostly the CMA package program in mathematics education studies in which the meta-analysis approach is used. Afterwards, it was seen that the MetaWin package program followed it and both programs were used together as the third option. It was found that the funnel plot, which is one of the graphics used to reveal the publication bias effect, is mostly preferred by the researchers in reporting the meta-analysis results in their mathematics education studies, and a small number of researchers did not include this graphic in their studies.

When the method, technique or features of the meta-analysis approach in the field of mathematics education were investigated, that is, when the independent variables of the studies examined, it was seen that the studies carried out with the Computer Aided Mathematics Teaching (CAML) method were the most in number and in these studies of meta-analysis of postgraduate thesis or academic articles, the effects of CAML method on affective characteristics such as achievement or attitude, were examined. This method is followed by Geogebra studies, which is Dynamic Geometry Software, and by studies examining Collaborative Learning, one of the constructivist approach methods. While meta-analyses were conducted on the studies that employed most of the constructivist approaches, there were also meta-analysis studies examining the effects of affective characteristics on academic achievement.

When the studies examining the effects of the methods, techniques or features used as independent variables in mathematics teaching on the dependent variables were investigated, it was concluded that the academic achievement was the most to be investigated. Then, it was the attitude to be examined as a dependent variable. In some studies (Topan, 2013; Ay-Emanet, 2019) it was observed that the effects on several dependent variables were examined.

When the effect sizes used to show how effective the method used in individual studies in the field of mathematics education were examined, it was concluded that the effects of the independent variables on the dependent variables were at a large level. As the last finding of the study, it was concluded that the effect of the independent variable on the dependent variable was mostly positive in the meta-analysis studies examined. Only in one meta-analysis study conducted by Şad et al. (2016), it was seen that the effect of anxiety on academic achievement was found negative.

Conflict of Interest Statement

The author declares no conflicts of interests.

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