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A Systematic Review Research: *'Mathematics Anxiety'* in Turkey

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Abstract: The aim of this study was to conduct a systematic review research concentrating on studies regarding *'Mathematics anxiety'*. 59 papers were reanalyzed in order to answer the questions derived from the main aim in terms of the rules of systematic review method. These studies were reviewed and analyzed by taking account of their aims, designs, sampling and results. While doing this, the similarities and differences of the reviewed studies were also found. It was seen that most of these studies conducted with middle school students. It was also found that the majority of reviewed studies were designed according to quantitative approaches. The review shows that mathematics anxiety is resulted from students' achievement, self-efficacy and fear along with parents' and teachers' lack of supports in mathematics. The results gathered from reviewed studies suggest that studies designed with approaches like qualitative and mixed-method and studies focused on various topics related with *'Mathematics anxiety'* with different sampling are needed. In conclusion, this systematic review study provides some fruitful information for the area and so for the further studies.

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Causes of Mathematic Anxiety,
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1. INTRODUCTION

> *"I fear in mathematics. Mathematics is really difficult to me. I can't ask anything to my teacher when I can't solve a problem. I am not sure he can help me, yes maybe he can. […] But firstly, I don't want my friends to laugh at me at my mistakes and secondly, I don't want my teacher to embarrass me in front of my friends. […] if I ask him, he may think that I am lazy, but I only can't understand mathematics."*
>
> *Alkan (2009)*

As in quotation above, some of the students feel fear and so anxiety in mathematics. This apprehension diminishes on the one hand students' success in mathematics on the other hand their interests in doing mathematical operations. Anxious students feel that they are incapable of solving problems or finding solutions in mathematics.These feelings might lead students to avoid physically and mentally attending mathematics which then create mathematical handicapped students.

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Since 1950's, anxiety in mathematics has been considered as a problematic situation in educational settings. In those years both Gough (1954) and Dreger & Aiken (1957) defined anxiety as a negative emotional reactions to mathematics. Also, they describe how number anxiety was differed from general anxiety. Thereafter, there have been a wide body of research focusing on anxiety in mathematics. This is not just because of mathematics' being crucial element of the school curriculum but also its being an essential element of life.

Mathematics anxiety described as a negative feeling response to mathematics (Ashcraft, 2000; Gresham, 2010; Maloney & Beilock, 2012 and Richardson & Suinn, 1972). These negative feelings are caused by poor performance and lack of comprehending notions in mathematics. Mathematics anxiety created as a result of these feelings can have an impact on all age groups from primary school students to adults (Alkan, 2013a & 2013b; Ashcraft, 1995; Cemen, 1987; Wu, Willcutt, Escovar & Menon, 2014).

In spite of an increase in technology and new techniques in order to improve learning and teaching in mathematics, it is noticed that students are still anxious in mathematics. Due to this, studies are investigating *'mathematics anxiety'* in Turkey as in other countries. It is seemed that most of the studies conducted in Turkey identified the level of mathematics anxiety (Aydın, 2011; Bekdemir, 2009; Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Dede & Dursun, 2008; Kaçar & Sarıçam, 2015; Karadeniz & Karadağ, 2014; Peker & Şentük, 2012; Taşdemir, 2013; Uysal & Selışık, 2016 and Ünlü, Ertekin & Dilmaç, 2017). Additionally, some of the studies focused on finding out the relation between mathematics anxiety and attitudes and self-efficacy (Adal & Yavuz, 2017; Akın & Kurbanoğlu, 2011; Doruk, Öztürk & Kaplan, 2016 and Kurbanoğlu & Takunyacı, 2012). Apart from these studies, some of the other studies adapted mathematics anxiety scales into Turkish (Akçakın, Cebesoy & İnel, 2015; Akın, Kurbanoğlu & Takunyacı, 2011; Baloğlu, 2010 and Baloğlu & Balgalmış).

Considering Turkish context, even though several studies were done about *'mathematics anxiety'*, there is a lack of studies concerning systematic review of studies about *'mathematics anxiety'*. It is expected that a systematic review of research about *'mathematics anxiety'* can be helpful for the researchers to see the scope of research done about this topic. It is also expected that the results of this study can provide fruitful information to the area. In addition to this, another expectation is that the results of this study can enable researchers to design their studies with different approaches. Furthermore, it is expected that the results presenting the aim of the previous research can provide new perspectives to the future researchers.

In this study, it was aimed to review previous studies focused on *'mathematics anxiety'* conducted in Turkey systematically. To this aim, following questions were answered:

1) What are the main aims of the studies?
2) What type of methodology is used in the studies about mathematics anxiety?
3) Who are the main participants of the studies reviewed?
4) What are the main outcomes?
5) What are the main similarities and differences of the studies reviewed?
6) What needs to be done in the area reviewed?

The questions formed according to the main aim of this study were answered according to the rules of systematic review research. By this review, the main similarities and differences of the studies about *'mathematics anxiety'* were identified. In addition to this, the research which differed from the broad of previous research related with *'mathematics anxiety'* was determined.

2. METHOD

This study aimed to investigate the previous studies related with *'mathematics anxiety'* considering their aims, designs and results. Therefore, a systematic review research method was used to review previous studies focusing on *'mathematics anxiety'* done in Turkish context. A systematic review is a research method comprising of selection of previous studies related with the decided topic, critically evaluation of these studies and analysis of all relevant studies in terms of systematic rules (Millar, 2004; Littell, Corcoran & Pillai, 2008 and Torgerson, 2003). In this study, it is aimed to select and evaluate research about the topic *'mathematics anxiety'* conducted in Turkey. Consequently, studies investigated topics related with *'mathematics anxiety'* are re-examined by using systematic review process.

According to Millar (2004), while using systematic review research, a researcher should follow such phases. These phases are; a) determination of the aim, b) selection of the studies which are consistent with the aim founded on particular criteria, and c) drawing inferences from the gathered information. In this study, all these phases are paid attention and the process is carried out based on these.

In terms of systematic review rules and based on research questions, primarily 117 studies published between the years 2007 and 2017 were downloaded. These studies were downloaded through such databates as ERIC, EBSCOHost, ULAKBIM and Google Scholar. In order to reach papers through the given databates, the keyword *'matematik kaygısı'* in Turkish and *'mathematics anxiety'* in English is searched.

It should be noted that theses, books, projects and conference papers are not included to the searching process thereby, to the review process. After the completion of downloading papers published in journals, those having only abstracts were excluded. In addition to this, even though a lot of papers were listed after the search, it was seen that some of them were not related with the main topic. Therefore, those not having the words *'mathematics anxiety'* and *'matematik kaygısı'* in the keyword part and not particularly related with the main topic were also excluded.

The papers' being directly related with *'mathematics anxiety'* was the significant criterion in the selection of papers for this study. In other words, papers focusing on such topics as *'mathematics teaching anxiety'*, *'test anxiety in mathematics'* and specifically *'attitudes in mathematics'* were excluded. In addition to this, although some papers both titled with the term *'mathematics anxiety'* and included the term *'mathematics anxiety'* in the keyword part, they were excluded from the review process as they were not focusing mainly on mathematics anxiety and not suitable for the aim of this study. Finally, 59 papers were included in the review process.

The aim and the questions derived were decisive in this study. In this context, this study designed in terms of systematic review method followed the criteria below: *These papers*

- published between 2007 and 2017
- focused mainly on mathematics anxiety
- concerned with mathematics anxiety in educational settings
- published in journals

3. FINDINGS

The selected articles included in review process were analysed in accordance with the questions outlined above. Firstly, the aims, designs and participants of studies were given. Then, the results of studies were presented.

3.1. Main Aims of the Studies

Considering the main aims of the previous studies it can be seen that most of the studies focused on identifying the level of anxiety in mathematics (e.g. Aydın, 2011; Bekdemir, 2009; Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Dede & Dursun, 2008; Kaçar & Sarıçam, 2015; Karadeniz & Karadağ, 2014; Peker & Şentük, 2012; Taşdemir, 2013; Uysal & Selışık, 2016 and Ünlü, Ertekin & Dilmaç, 2017). It can be also seen that some studies about identification of anxiety in mathematics targeted determining various issues related with mathematics anxiety. For instance, such issues as *relationship between attitudes and anxiety in mathematics* (e.g. Hacıömeroğlu, 2017; Karadeniz & Karadağ, 2014, Şimşek, Şahinkaya & Aytekin, 2017 and Yenilmez, Girginer & Uzun, 2007), *relationship between some variables and mathematics anxiety* (e.g. Çatlıoğlu, Gürbüz & Birgin, 2014; Doruk & Kaplan, 2013; Taşdemir, 2013; Oksal, Durmaz & Akın, 2013; Peker & Şentürk, 2012 and Uysal & Selışık, 2016), *relationship between anxiety, attitudes and self-efficacy in mathematics* (e.g. Adal & Yavuz, 2017; Akın & Kurbanoğlu, 2011; Doruk, Öztürk & Kaplan, 2016 and Kurbanoğlu & Takunyacı, 2012) *relationship between anxiety and achievement in mathematics* (e.g. İlhan & Öner Sünkür, 2013, Şad, Kış, Demir & Özer, 2016 and Yılmaz & Bindak, 2016), *relationship between mathematics anxiety and classroom assessment* (e. g. İlhan, 2015), *relationship between metacognitive awareness and mathematics anxiety* (e. g. Gökbulut & Akdağ, 2016 and Kaçar & Sarıçam, 2015) and *relationship between mathematics anxiety and learning strategies* (e.g. Arslan, Güler & Gürbüz, 2017) were investigated.

Table 1 indicated the whole picture of the main aims of the previous studies. As seen in Table 1, while some studies focused on finding out the level of mathematics anxiety and its relation with such variables as mentioned above, some of them showed variety of topics. It was seen that there were studies on *adaptation of mathematics anxiety scales to Turkish* (e.g. Akçakın, Cebesoy & İnel, 2015; Akın, Kurbanoğlu & Takunyacı, 2011; Baloğlu, 2010; Baloğlu & Balgalmış, 2010). There was one study focusing on *reducing mathematics anxiety* at primary school level (e.g. Alkan, 2013a) and one study focusing on the *relation between mathematics anxiety and mothers* (e.g. Alkan, 2013b). On the other side there were two reseach investigated the *relationship between mathematics anxiety and mathematics teaching anxiety* (e.g. Peker & Ertekin, 2011 and Ünlü, Ertekin & Dilmaç, 2017).

Table 1. Main Aims of the Studies

Aims of the Studies	Examples
The level of anxiety in mathematics	Baloğlu, 2008; Dede & Dursun, 2008; Aydın, Delice, Dilmaç & Ertekin, 2009; Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Pamuk & Karakaş, 2011; Aydın, 2011; Taşdemir, 2015
Mathematics anxiety and its causes	Bekdemir, 2007; Alkan, 2010; Alkan, 2011; Özdemir & Sezginsoy Şeker, 2017
Relationship between mathematics anxiety and such demographic variables	Peker & Şentürk, 2012; Doruk & Kaplan, 2013; Taşdemir, 2013; Çatlıoğlu, Gürbüz & Birgin, 2014; Uysal & Selışık, 2016
Relationship between mathematics anxiety and attitudes towards mathematics	Yenilmez, Girginer & Uzun, 2007; Karadeniz & Karadağ, 2014; Hacıömeroğlu, 2017; Şimşek, Şahinkaya & Aytekin, 2017
Relationship between mathematics anxiety, attitudes towards mathematics and self-efficacy	Akın & Kurbanoğlu, 2011; Kurbanoğlu & Takunyacı, 2012; Doruk, Öztürk & Kaplan, 2016; Adal & Yavuz, 2017.
Relationship between mathematics anxiety and metacognitive awareness	Kaçar & Sarıçam, 2015; Sarıçam & Ogurlu, 2015; Gökbulut & Akdağ, 2016

Table 1. Main Aims of the Studies (Cont.)

Aims of the Studies	Examples
Relationship between mathematics anxiety and self-regulation	İşleyen, 2015; Yurt & Kurnaz, 2015
Relationship between mathematics anxiety and achievement in mathematics	Şad, Kış, Demir & Özer, 2016
The impacts of mathematics anxiety on mathematical achievement	Bekdemir, 2009; İlhan & Öner Sünkür, 2013
The effects of achievement and social comparison on mathematics anxiety	Kesici & Erdoğan, 2010; Erdoğan, Kesici & Şahin, 2011
The predictive power of students' perceptions of classroom assessment environment for their mathematics anxiety.	İlhan, 2015
Relationship between the achievement in mathematics and mathematics anxiety and test anxiety	Yılmaz & Bindak, 2016
The predictive power of mathematics anxiety and perceived social support from teacher	Erden & Akgül, 2010
The relation between anxiety and achievement in mathematics and achievement in geography	Bekdemir & Başıbüyük, 2011
The predictive power of mathematics anxiety, positive and negative perfectionism to the mathematics achievement	İlhan & Öner Sünkür, 2012
Relationship between Mathematics Teaching Anxiety and Mathematics Anxiety	Peker & Ertekin, 2011
The impacts of teachers' mathematics anxiety on students mathematics achievement	Aslan, Gürgah Oğul & Taş, 2013
Investigation test and mathematics anxiety according to such variables	Oksal, Durmaz & Akın, 2013
Mothers and their relation with mathematics anxiety	Alkan, 2013b
Relationship between students mathematics anxiety and their learning strategies	Arslan, Güler & Gürbüz, 2017

Table 1. Main Aims of the Studies (Cont.)

Aims of the Studies	Examples
Relationships between Mathematics Anxiety, Mathematics Teaching Anxiety, Self-efficacy Beliefs towards Mathematics and Mathematics Teaching	Ünlü, Ertekin & Dilmaç, 2017
The effects of students' basic psychological needs on motivational regulations towards mathematics and mathematics anxiety	Durmaz & Akkuş, 2016
The ways implemented by teachers to reduce mathematics anxiety	Alkan, 2013a
Relationship between self-concept and mathematics anxiety	Işıksal, Curran, Koç & Askun, 2009
Relationship between mathematics anxiety and mathematical beliefs	Hacıömeroğlu, 2013
Relationship between mathematics anxiety and epistemological beliefs	Delice, Ertekin, Aydın & Dilmaç, 2009
The effect of geogebra software on mathematics anxiety and mathematics teaching anxiety	Zengin, 2017
Relationships between students' perception of self-efficacy, mistake-handling learning awareness, and mathematical anxieties	Aksu, Özkaya, Gedik & Konyalıoğlu, 2016
The effect of a "Geometry Garden" on mathematics anxiety	Kurt & Özel, 2013
Classification of students' mathematics anxiety according to the PISA 2012 results.	Erten Tatlı, Atalan Ergin & Demir, 2016
Adaptation of MARS-SV into Turkish	Baloğlu, 2010
Adaptation of MARS-E into Turkish	Baloğlu & Balgalmış, 2010
Adaptation of R-MARS into Turkish	Akın, Kurbanoğlu & Takunyacı, 2011
Adaptation of MAS-R into Turkish	Akçakın, Cebesoy & İnel, 2015
Validity and Reliability Study of MASS	Özdemir & Gür, 2011

When the reviewed papers are considered, it can be said that most of the studies tried to determine whether mathematics anxiety is related to gender, type of the school, attitudes toward mathematics and self-efficacy. In addition to this, there are few studies investigated the reasons of mathematics anxiety. Another point gathered from the reviewed papers is that there is not any study about developing a scale between 2007 and 2017. On the other hand, there are four studies focused on adaptation of such scales used in other countries.

3.2. Types of Methodology Used in Studies

The studies reviewed in this study indicated that a majority of these studies used quantitative approach. These quantitative studies designed according to the survey method as illustrated in Figure 1 below. Beside this, it can be seen that very few studies used qualitative and mixed method approaches compare to those quantitatives.

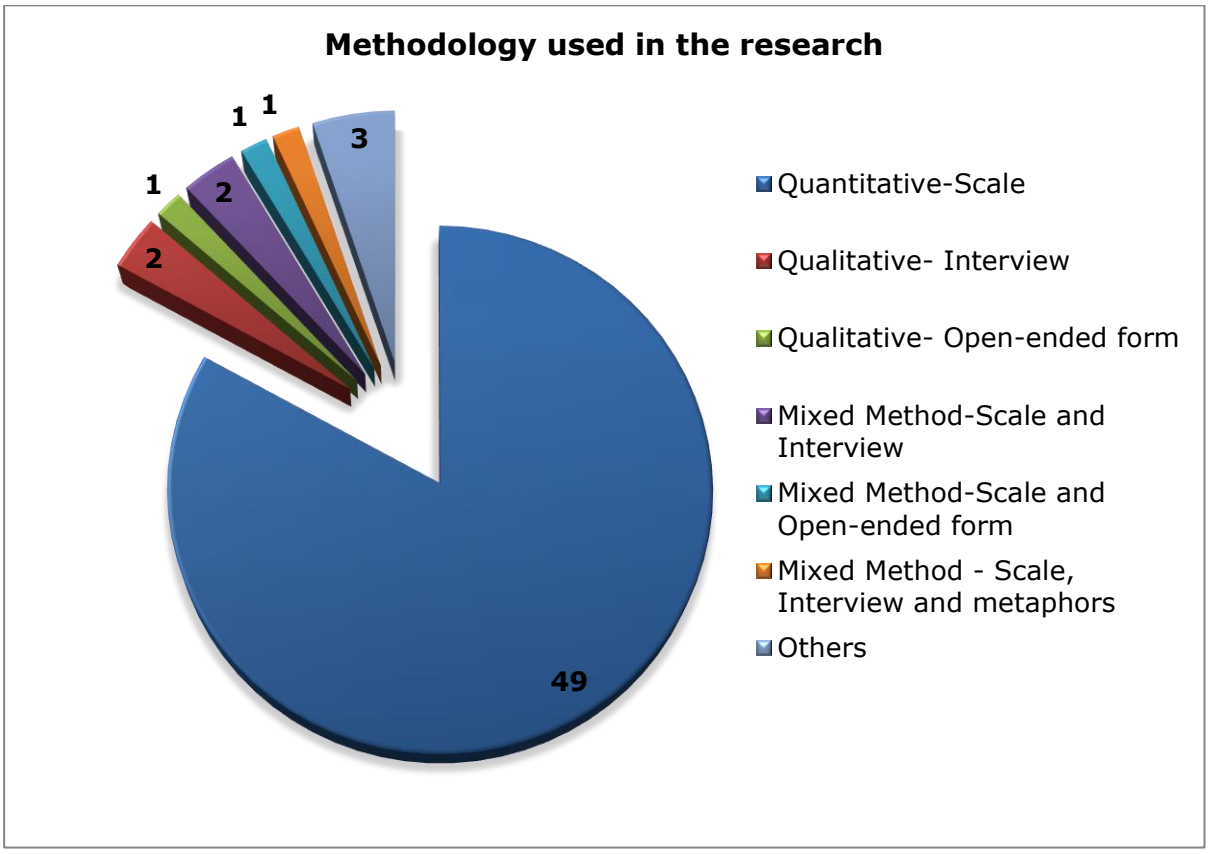

Figure 1. The distribution of the type of methodology in studies

As said earlier and as given in Table 2, it can not be said that studies were used variety of different approaches. In other words, papers were mostly designed according to quantitative methodology. Considering the data collection tools used in these quantitive studies, it is seen that scales are used by most of them. The majority of researchers used mathematics anxiety scale whereas some of them collected the data with attitude or self-efficacy scale beside mathematics anxiety scale.

The result of this review indicates that multiple data collection tools were used in recent studies (e.g. Aslan, Gürgah Oğul & Taş, 2013; Hacıömeroğlu, 2017; Ünlü, Ertekin & Dilmaç, 2017). This means that some researchers tried to find out the relationship between mathematics anxiety and other factors with different perpectives apart from previous studies. It can be said that investigating mathematics anxiety with various scales could be helpful to the area in order to understand the situation.

Although multiple data collection used by quantitative studies in recent years, it could be said that there is a need to use other research methodologies. Since this can enable researchers to discover the phenomenon in detail. As seen in Table 2, interview and open-ended form were the data collection tools in research designed with qualitative approach. In addititon to this, it was emerged that data collection tools in those designed with mixed-method approach were interviews and open-ended form with scales. There are very few studies done according to such methods like meta-analysis, literature review and document analysis. On the other hand, for instance, it is seen that none of these studies used focus group technique in data collection.

Table 2. Type of Methodology used in Research

Research Approach	Data Collection Tools	Examples
Quantitative *(survey)*	* Mathematics Anxiety Scale	* Bekdemir, 2007; Yenilmez, Girginer & Uzun, 2007; Baloğlu, 2008; Dede & Dursun, 2008; Işıksal, Curran, Koç & Askun, 2009; Aydın, Delice, Dilmaç & Ertekin, 2009; Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Baloğlu, 2010; Baloğlu ve Balgalmış, 2010; Pamuk & Karakaş, 2011; Akın, Kurbanoğlu & Takunyacı, 2011; Özdemir & Gür, 2011; Doruk & Kaplan, 2013; Taşdemir, 2013; Akçakın, Cebesoy & İnel, 2015; Taşdemir, 2015
	* Mathematics Anxiety Scale and Epistemological beliefs Scale	* Delice, Ertekin, Aydın & Dilmaç, 2009
	* Mathematics Anxiety Scale, Achievement Motivation Scale and Social Comparison Scale	* Kesici, & Erdoğan, 2010; Erdoğan, Kesici & Şahin, 2011
	* Mathematics Anxiety Scale and Perceived Social Support Scale-R	* Erden & Akgül, 2010
	* Mathematics Anxiety Scale and Mathematics Teaching Anxiety	* Peker & Ertekin, 2011
	* Mathematics Anxiety Scale, Mathematics Teaching Anxiety, Self-efficacy beliefs towards Mathematics Scale and Self-efficacy beliefs towards Mathematics Teaching Scale	* Ünlü, Ertekin & Dilmaç, 2017
	* Mathematics Anxiety Scale and Attitude Scale	* Peker & Şentürk, 2012; Karadeniz & Karadağ, 2014; Çatlıoğlu, Gürbüz & Birgin, 2014; Şimşek, Şahinkaya & Aytekin, 2017

Table 2. Type of Methodology used in Research (Cont.)

Research Approach	Data Collection Tools	Examples
Quantitative *(survey)*	∗ Mathematics Anxiety Scale, Attitude Scale and Self-efficacy Scale	∗ Akın & Kurbanoğlu, 2011; Doruk, Öztürk & Kaplan, 2016
	∗ Mathematics Anxiety Scale, Attitude Scale and Motivation Scale	∗ Kurbanoğlu & Takunyacı, 2012
	∗ Mathematics Anxiety Scale, Attitude Inventory and Students' grades	∗ Hacıömeroğlu, 2017
	∗ Mathematics Anxiety Scale and Positive and Negative Perfectionism Scale	∗ İlhan & Öner Sünkür, 2012
	∗ Mathematics Anxiety Scale and students' grades	∗ İlhan & Sünkür, 2013
	∗ Mathematics Anxiety Scale and Mathematical Beliefs Scale	∗ Hacıömeroğlu, 2013
	∗ Mathematics Anxiety Scale and Test Anxiety Scale	∗ Oksal, Durmaz & Akın, 2013
	∗ Mathematics Anxiety Scale, Test Anxiety Scale and students' grades	∗ Yılmaz & Bindak, 2016
	∗ Mathematics Anxiety Scale, Beliefs survey, Number and Operation Task and Geometric Shapes Sorting Task	∗ Aslan, Gürgah Oğul & Taş, 2013
	∗ Mathematics Anxiety Scale and Self-Regulation Skill Scale	∗ İşleyen, 2015
	∗ Mathematics Anxiety Scale, Basic Psychological Needs Scale and Academic Self-Regulation Scale	∗ Durmaz & Akkuş, 2016
	∗ Mathematics Anxiety Scale and Classroom Assesment Environment Scale	∗ İlhan, 2015
	∗ Mathematics Anxiety Scale and Meta-Cognition Questionnaire	∗ Kacar & Sarıçam, 2015; Gökbulut & Akdağ, 2016
	∗ Mathematics Anxiety Scale and Metacognitive Awareness Inventory	∗ Sarıçam & Ogurlu, 2015

Table 2. Type of Methodology used in Research (Cont.)

Research Approach	Data Collection Tools	Examples
Quantitative *(survey)*	∗ Mathematics Anxiety Scale and Self-efficacy Scale	∗ Yurt & Kurnaz, 2015
	∗ Mathematics Anxiety Scale, Mistaken Handling Learning Scale and Self- Efficacy Scale	∗ Aksu, Özkaya, Gedik & Konyalıoğlu, 2016; Adal & Yavuz, 2017
	∗ Mathematics Anxiety Scale and Learning Strategies Scale	∗ Arslan, Güler & Gürbüz, 2017
	∗ Questionnaire	∗ Aydın, 2011; Uysal & Selışık, 2016
	∗ Students' grades	∗ Kurt & Özel, 2013
Qualitative	∗ Interview	∗ Alkan, 2011; Alkan, 2013b
	∗ Open-ended form	∗ Alkan, 2013a
Mixed Method	∗ Mathematics Anxiety Scale, Achievement Test and Interviews	∗ Bekdemir, 2009; Bekdemir and Başıbüyük, 2011
	∗ Mathematics Anxiety and Mathematics Teaching Anxiety Scales and Open-ended form	∗ Zengin, 2017
	∗ Mathematics Anxiety Scale, metaphors and interviews	∗ Özdemir & Sezginsoy Şeker, 2017
Others	∗ Literature Review	∗ Alkan, 2010
	∗ Meta-analysis	∗ Şad, Demir & Özer, 2016
	∗ Document analysis	∗ Erten Tatlı, Atalan Ergin & Demir, 2016

3.3. Main Participants of Research

The main participant of the research related with *'mathematics anxiety'* is students as they are facing with this situation. Additionally, students' teachers are other significant elements of studies related with this topic. Therefore, it is seen that the majority of the research conducted with students. Only two of the studies are done with teachers. The list of participants and related research are given in Table 3.

Considering the participants, it can be said that most of the studies conducted with middle school students among those done with the group of students. This points that there could be an idea accepted in those studies that middle school students were more anxious than students at other levels. Beside this, the results show that pre-service teachers and undergraduates are the second big group of participants in the sampling. Studies on pre-service teachers' and undergraduates' anxieties in mathematics that were reviewed indicate that anxiety in these levels could be problematic for their education.

It is seen in Table 3, there are also research selected high school students as participants. Even though these are less than other groups of participants, the results show that there is a need to study with these students in order to find out the causes of mathematics anxiety. On the other hand, there is a few research conducted with primary school students (e.g. Alkan, 2011;

2013b; Hacıömeroğlu, 2017 and Peker & Şentürk, 2012) Moreover, there is only one research including kindergarten students in the sampling (e. g. Aslan et al., 2013). Apart from all these groups of participants, it is seen that there are three studies done based on the documents (e.g. Alkan, 2010; Erten Tatlı et al., 2016 and Şad et al., 2016)

The reviews about the participants of the research suggest that studying with middle-schools students, pre-service teachers and undergraduates could add extra information to the area. However, it is seen that there is a need to study with primary school students in that students face with mathematics firstly at this level. In addition to this, it could be good to understand *'mathematic anxiety'* from the lenses of different combinations of participants, for instance students and teachers or students and parents, etc.

Table 3. The main participants of research

Main Participants	**Examples**
Pre-service Teachers	Bekdemir, 2007; Işıksal, Curran, Koç & Askun, 2009; Delice, Ertekin, Aydın & Dilmaç, 2009; Peker & Ertekin, 2011; Akın, Kurbanoğlu & Takunyacı, 2011; Doruk & Kaplan, 2013; Hacıömeroğlu, 2013; Çatlıoğlu, Gürbüz & Birgin, 2014; Akçakın, Cebesoy & İnel, 2015; Kaçar, Sarıçam; 2015; Zengin, 2017
Undergraduates	Yenilmez, Girginer & Uzun, 2007; Baloğlu, 2008; Bekdemir, 2009; Aydın, Delice, Dilmaç & Ertekin, 2009; Baloğlu, 2010; Pamuk & Karakaş, 2011; Bekdemir & Başıbüyük, 2011; Akın & Kurbanoğlu, 2011; Taşdemir, 2013; Gökbulut & Akdağ, 2016; Ünlü, Ertekin & Dilmaç, 2017; Özdemir & Sezginsoy Şeker, 2017
High School Students	Erdoğan, Kesici & Şahin, 2011; Kurbanoğlu & Takunyacı, 2012; İlhan, 2015; Durmaz & Akkuş, 2016; Uysal & Selışık, 2016;
Middle School Students	Dede & Dursun, 2008; Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Erden & Akgül, 2010; Kesici & Erdoğan, 2010; Aydın, 2011; Özdemir & Gür, 2011; İlhan & Öner Sünkür, 2012; İlhan & Öner Sünkür, 2013; Oksal, Durmaz & Akın, 2013; Kurt & Özel, 2013; Karadeniz & Karadağ, 2014; İşleyen, 2015; Sarıçam & Oğurlu, 2015; Taşdemir, 2015; Yurt & Kurnaz, 2015; Aksu, Özkaya, Gedik & Konyalıoğlu, 2016; Doruk, Öztürk, Kaplan, 2016; Yılmaz & Bindak, 2016; Arslan, Güler & Gürbüz, 2017; Adal & Yavuz, 2017
Primary School Students	Alkan, 2011; Peker & Şentürk, 2012; Hacıömeroğlu, 2017
Primary and Middle School Students	Baloğlu & Balgalmış, 2010; Şimşek, Şahinkaya & Aytekin, 2017
Primary School Teachers	Alkan, 2013a
Primary School Students and their mothers	Alkan, 2013b
Kindergarten students and their teachers	Aslan, Gürgah Oğul & Taş, 2013
Documents	Alkan, 2010; Şad, Kış, Demir & Özer, 2016; Erten Tatlı, Atalan Ergin & Demir, 2016

3.4. Main outcomes of research

A general overview of the reviewed studies' outcomes is given in Table 4. The main outcomes of the studies are classified according to the participants selected in the reviewed studies as seen in the Table 4. While presenting the data, examples of the studies are provided for each result. In addition to this, these outcomes of reviewed studies about mathematics anxiety are categorised under three major themes as *'reasons of mathematics anxiety'*, *'adaptation of scales into Turkish'* and *'reduction in mathematics anxiety'*. In Figure 2 the distribution of these studies based on themes are presented. The numbers of studies presented under three themes in Figure 2 are correspondingly given in Table 4. In other words, each outcome is linked with these themes in Table 4.

As mentioned earlier, the most of the research under the review were designed in terms of quantitative research approach and mostly conducted with students at different levels. Additionally, studies used qualitative and mixed method approaches mostly collected the data based on students' views. Therefore, the results of these studies founded on students' perceptions or perspectives on mathematics anxiety and its relationship with such factors.

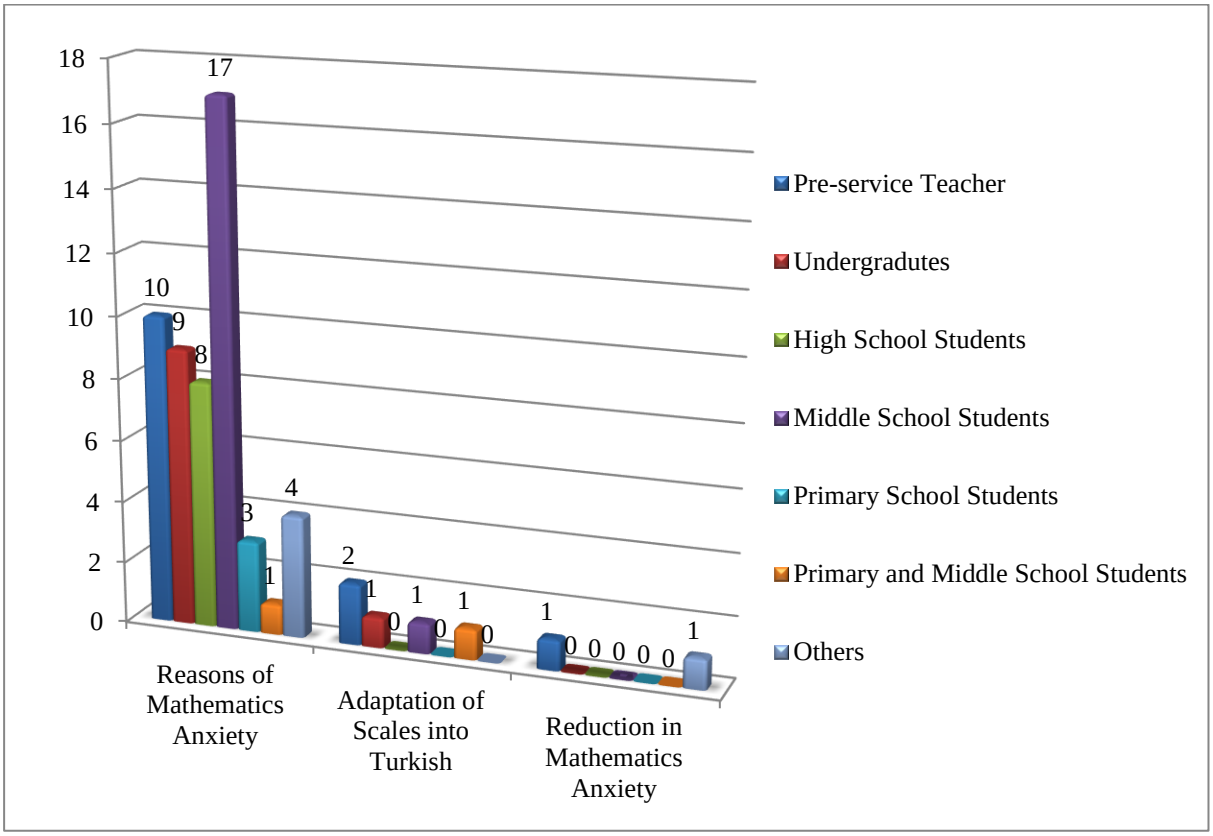

Figure 2. Themes emerged from reviewed research

It is seen in Figure 2 that almost all studies' results are related with the theme *'reasons of mathematics anxiety'*. The highest number of studies within this theme conducted with middle school students. The review results indicate that such factors as the level of achivement in mathematics, teachers' and parents' lack of support, students' fear, self-efficacy and beliefs and metacognitive awareness in mathematics can cause mathematics anxiety (see Table 4).

In some studies reviewed under the theme *'reasons of mathematics anxiety'*, it can be seen that results about the effect of gender on mathematics anxiety show contradictions. For instance, İlhan & Öner Sünkür (2013) stated that girls are more anxious in mathematics compare to boys. On the other hand, the results of studies conducted by Birgin, Baloğlu,

Çatlıoğlu & Gürbüz, (2010), Çatlıoğlu, Gürbüz & Birgin (2014) & Taşdemir (2015) emphasized that students' anxiety is not related with their being a girl or boy (see also Table 4).

There are few studies under the themes *'adaptation of scales into Turkish'* and *'reduction in mathematics anxiety'* as given in Figure 2. The adaptation of scales related with mathematics anxiety into Turkish done for pre-service teachers, undergraduates, middle school students and both for primary and middle school students. According to the results of reviewed studies on this topic, it can be said that R-MARS, BAI, MARS-SV, MAAS and MARS-E are valid and reliable for selected samples (see Table 4).

The results about the theme *'reduction in mathematics anxiety'* indicate that there are only two studies under this theme. One of these studies is done with pre-service teachers whereas the other one is done with primary school teachers. As seen in Table 4, the study conducted by Zengin (2017) suggested that the learning and teaching process designed according to GeoGebra software can reduce the level of pre-service teachers' anxiety in mathematics. In addition to this, in Alkan's (2013a) study it is found that supporting students' motivation and comprehension in mathematics, using examples and exercises and games could be helpful to reduce the level of primary school students' anxiety in mathematics.

Table 4. Main outcomes emerged from the reseach

Participants	Themes	Main Outcomes	Examples
Pre-service teacher	*Reasons of Mathematics Anxiety*	*- The causes of mathematics anxiety* o *Teachers' negative attitudes and practices;* o *Students' fear of making a mistake and asking a question to their teachers*	∗ Bekdemir, 2007 ;
	Reasons of mathematics anxiety	*- Negative relationship between mathematics anxiety and mathematical self-concept*	∗ Işıksal, Curran, Koç & Askun, 2009;
	Reasons of mathematics anxiety	*- The level of anxiety in mathematics changes according to gender, the level of class and the university*	∗ Aydın, Delice, Dilmaç & Ertekin, 2009;
	Reasons of mathematics anxiety	*- Positive relationship between epistemological beliefs and mathematic anxiety*	∗ Delice, Ertekin, Aydın & Dilmaç, 2009;
	Reasons of mathematics anxiety	*- Positive relationship between mathematics anxiety and mathematics teaching anxiety*	∗ Peker & Ertekin, 2011
	Adaptation of scales into Turkish	*- Adapted form of R-MARS is valid and reliable to be used with pre-service teachers*	∗ Akın, Kurbanoğlu & Takunyacı, 2011
	Reasons of mathematics anxiety	*- Mathematics anxiety is moderately related with self-efficacy and this relation is affected by gender.*	∗ Doruk & Kaplan, 2013

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
	Reasons of mathematics anxiety	- *The lower mathematics anxious one has the higher mathematical beliefs.*	∗ Hacıömeroğlu, 2013
	Reasons of mathematics anxiety	- *Gender has no effect on mathematics anxiety. Achievement and anxiety in mathematics has negative relationship.*	∗ Çatlıoğlu, Gürbüz & Birgin, 2014
	Adaptation of scales into Turkish	- *Adapted version of BAI is reliable and valid for measuring pre-service teachers' anxiety level.*	∗ Akçakın, Cebesoy & İnel, 2015
	Reasons of mathematics anxiety	- *Metacognitive awareness has relation with mathematics anxiety. The increase in negative metacognition level causes anxiety in mathematics.*	∗ Kaçar & Sarıçam, 2015
	Reasons of mathematics anxiety	- *There is a positive relationship between metacognitive awareness and mathematics anxiety.*	∗ Gökbulut & Akdağ, 2016
	Reduction in mathematics anxiety	- *The learning and teaching process designed with GeoGebra software enable pre-service teachers to overcome mathematics anxiety and mathematics teaching anxiety.*	∗ Zengin, 2017
Undergraduates	Reasons of mathematics anxiety	-*Relationship between mathematics anxiety and attitudes* ○ *Positive attitude increases anxiety decreases*	∗ Yenilmez, Girginer & Uzun, 2007
		○ *The increase in the level of anxiety in mathematics causes negative attitude towards mathematics so that lowers self-efficacy*	∗ Akın & Kurbanoğlu, 2011

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
Undergraduates	Reasons of mathematics anxiety	- *Positive correlations between the subjective and objective measures of mathematics anxiety level*	∗ Baloğlu, 2008
	Reasons of mathematics anxiety	-*The causes of mathematics anxiety* ○ *Teachers' negative attitudes and practices;* ○ *Students' fear of making a mistake and asking a question to their teachers*	∗ Bekdemir, 2009
	Adaptation of scales into Turkish	- *Adapted form of MARS-SV can be used for undergraduates*	∗ Baloğlu, 2010;
	Reasons of mathematics anxiety	- *Online students are more anxious than on-campus students*	∗ Pamuk & Karakaş, 2011
	Reasons of mathematics anxiety	- *Mathematics anxiety and achievement is related with geography achievement positively*	∗ Bekdemir & Başıbüyük, 2011
	Reasons of mathematics anxiety	- *The level of anxiety in mathematics does not change according to gender. Students from vocational school are more anxious than those from other.*	∗ Taşdemir, 2013
	Reasons of mathematics anxiety	- *There is a positive relationship between mathematics teaching anxiety and mathematics anxiety. Self-efficacy beliefs have negative relation both with mathematics anxiety and mathematics teaching anxiety.*	∗ Ünlü, Ertekin & Dilmaç, 2017
	Reasons of mathematics anxiety	- *Students' personality, their interaction with teachers and school facilities cause mathematics anxiety.*	∗ Özdemir & Sezginsoy Şeker, 2017

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
High School Students	Reasons of mathematics anxiety	- *The level of anxiety in Mathematics* ○ *There isn't a high relation between mathematics anxiety and variables like gender and grade*	* Dede and Dursun, 2008
	Reasons of mathematics anxiety	*- The level of students' achievement motivation and social comparison has an impact on mathematics anxiety*	* Erdoğan, Kesici & Şahin, 2011
	Reasons of mathematics anxiety	*- Students' anxiety in matematics can be changed according to the type of schools but students' gender does not affect anxiety*	* Kurbanoğlu & Takunyacı, 2012
	Reasons of mathematics anxiety	*- Performance oriented assessment environment has positive whereas learning oriented assessment environment has negative relation with mathematicsanxiety.*	* İlhan, 2015
	Reasons of mathematics anxiety	*- The basic psychological needs had an impact on mathematics anxiety.*	* Durmaz & Akkuş, 2016
	Reasons of mathematics anxiety	*- The level of anxiety in mathematics changes according to the type of school. High school students have moderate level anxiety in mathematics.*	* Uysal & Selışık, 2016
	Reasons of mathematics anxiety	*- Mathematics anxiety is related with achievement in mathematics and the socio-economic level of parents.*	* Erten Tatlı, Atalan Ergin & Demir, 2016
	Reasons of mathematics anxiety	*- There is a slight relationship between mathematics anxiety and organizing strategies and rehearsal strategies. There is a moderate relationship between mathematics anxiety and the other learning strategies (elaboration, comprehension monitoring and affective strategies).*	* Arslan, Güler & Gürbüz, 2017

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
Middle School Students	Reasons of mathematics anxiety	- *The level of students' achievement motivation and social comparison has an impact on mathematics anxiety*	∗ Kesici & Erdoğan, 2010
	Reasons of mathematics anxiety	- *There is not a relation between gender and mathematics anxiety but is a relation with grade level and mathematics anxiety. Perceived enjoyment of mathematics has an effect on mathematics anxiety*	∗ Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010; Taşdemir, 2015
	Reasons of mathematics anxiety	- *Negative relation between mathematics anxiety and students' achievement. Teacher support is significant predictor of success and anxiety in mathematics.*	∗ Erden & Akgül, 2010
	Adaptation of scales into Turkish	- *MAAS is valid and reliable to be used with middle school students*	∗ Özdemir & Gür, 2011
	Reasons of mathematics anxiety	- *There is not a relation between gender and is a slight relation between grade and mathematics anxiety*	∗ Aydın, 2011
	Reasons of mathematics anxiety	- *Mathematics anxiety has an impact on learning, positive perfectionism has relation with achievement whereas negative perfectionism has relation with anxiety*	∗ İlhan & Öner Sünkür, 2012
	Reasons of mathematics anxiety	- *Girls are more anxious than boys. There is a difference in the level of anxiety according to the grades*	∗ İlhan & Öner Sünkür, 2013
	Reasons of mathematics anxiety	- *Test and mathematics anxiety is moderatetly telated with each other*	∗ Oksal, Durmaz & Akın, 2013
	Reasons of mathematics anxiety	- *Geometry Garden has an impact on students' learning so that their being anxious in mathematics*	∗ Kurt & Özel, 2013
	Reasons of mathematics anxiety	- *There is a negative relation between mathematics anxiety and attitudes towards mathematics.*	∗ Karadeniz & Karadağ, 2014

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
Middle School Students	Reasons of mathematics anxiety	*-Self-regulation and mathematics anxiety has negative relationship.*	∗ İşleyen, 2015
	Reasons of mathematics anxiety	*- There is a negative relationship between mathematics anxiety and mathematics anxiety of gifted student.*	∗ Sarıçam & Ogurlu, 2015
	Reasons of mathematics anxiety	*- The sources of self-efficacy have an impact on gifted students' anxiety level in mathematics.*	∗ Yurt & Kurnaz, 2015
	Reasons of mathematics anxiety	*- There is a significant relationship between self-efficacy, mistake-handling learning and mathematics anxiety.*	∗ Aksu, Özkaya, Gedik & Konyalıoğlu, 2016
	Reasons of mathematics anxiety	*- Middle schools students' level of mathematics anxiety is moderate. There is a negative relationship between anxiety and self-efficacy and attitudes in mathematics.*	∗ Doruk, Öztürk & Kaplan, 2016; Adal & Yavuz, 2017
	Reasons of mathematics anxiety	*- Achievement in mathematics has a negative impact on mathematics anxiety. The relation between test and mathematics anxiety is weak.*	∗ Yılmaz & Bindak, 2016
Primary School Students	Reasons of mathematics anxiety	*- Parents' lack of knowledge in mathematics, teachers support, students' self-efficacy and interaction with peers can cause anxiety in mathematics*	∗ Alkan, 2011
	Reasons of mathematics anxiety	*- Gender, satisfaction with the lesson and the teacher, and attitudes can be predictos of mathematics anxiety.*	∗ Peker & Şentürk, 2012
	Reasons of mathematics anxiety	*- There is a slightly negative relation between attitudes and anxiety in mathematics. The higher success the lower anxiety in mathematics*	∗ Hacıömeroğlu,2017

Table 4. Main outcomes emerged from the reseach (Cont.)

Participants	Themes	Main Outcomes	Examples
Primary and Middle School Students	Adaptation of scales into Turkish	*- Adapted version of MARS-E is reliable and valid to measure anxiety in mathematics*	∗ Baloğlu & Balgalmış, 2010
	Reasons of mathematics anxiety	*- Achievement and anxiety in mathematics has negative correlation. Fourth graders are more anxious than seventh graders. Gender has no impact on the level of attitudes and anxiety in mathematics.*	∗ Şimşek, Şahinkaya & Aytekin, 2017
Others (Primary School Teachers, Mothers, Documents)	Reasons of mathematics anxiety	*- Mathematics anxiety is the reason of students' personality, peers, parents and interaction with teachers*	∗ Alkan, 2010
	Reduction in mathematics anxiety	*- In order to reduce mathematics anxiety, primary school teachers support students' motivation and comprehension in mathematics. Use examples and exercises beside games to support students' effective learning*	∗ Alkan, 2013a ∗ Alkan, 2013b
	Reasons of mathematics anxiety	*- Mothers' ignoring anxiety, lack of knowledge, lack of support causes students' mathematics anxiety at primary school*	
	Reasons of mathematics anxiety	*- Pre-school teachers being anxious in mathematics has no effect on students' anxiety.*	∗ Aslan, Gürgah Oğul & Taş, 2013
	Reasons of mathematics anxiety	*- There is a negative relations between achievement and anxiety in mathematics*	∗ Şad, Kış, Demir & Özer, 2016,

4. CONCLUSION AND IMPLICATIONS

This systematic review research was focused on studies about *'mathematics anxiety'*. By this study, it is believed that crucial points in regard to *'mathematics anxiety'* are determined for future studies. Since a whole descriptive picture of mathematics anxiety in educational settings and its relation with such factors is provided with this review.

The reviewed studies indicated that nearly all studies done with students. Additionally, most of these students were selected from middle school levels. These findings, on the one hand suggest that students have significant role in defining anxiety and in determining its possible reasons in mathematics. Therefore, it can be said that the data gathered from this group provides a valuable insight to the area. On the other hand, it is seen that there is a need to do studies with

students from different school levels in order to delineate the anxiety in mathematics at various levels. Some of the reviewed studies done with middle school students stressed divergent results. For instance, in the study conducted by İlhan and Öner Sünkür (2013), it is claimed that girls are more anxious compare to boys whereas other studies done by Birgin, Baloğlu, Çatlıoğlu & Gürbüz (2010), Çatlıoğlu, Gürbüz & Birgin (2014) and Taşdemir (2015) emphasized that there is no significant relation between gender and mathematics anxiety. These results show that there is a need to conduct study with big samples at middle school levels and also at other levels to establish the relationship between these. Alternatively, a small sample study understanding the phenomenon deeply from different genders from all type of school levels could provide new insight into the area.

The result emerged from the reviewed studies emphasizes the role of teachers. Considering mathematics anxiety in educational settings, teachers' role in either creating or reducing anxiety in mathematics is also crucial. This means, further studies can focus on investigating mathematics anxiety according to teachers' views. In studies conducted by Alkan (2011, 2013), some points like, parents' and teachers' lack of support, interaction between teachers and students, friends and mothers are highlighted as factors of causing mathematics anxiety. These results propose that in Turkish context, further studies need to investigate mathematics anxiety from different perspectives like teachers, mothers or friends. Moreover, it could be good to conduct study with different combinations of participants such as teacher-student or student-teacher-parents.

Most of the reviewed studies aimed to measure the level of anxiety in mathematics and to find out causes of mathematics anxiety. In addition to this, in some studies while identifying anxiety, its relationship with genders, school types, students' capabilities and attitudes in mathematics are explored. However, other issues like the impacts of friends, teachers and parents or students' personalities on students' mathematics anxiety are need to be studied in detail. Another contribution of this review is that it helps to discover the lack of studies about such topics as reducing or overcoming mathematics anxiety and developing Turkish mathematics anxiety scales for various school levels.

Concerning all reviewed studies it can be said that most of them designed according to quantitative research methodology. The results emerged from these studies show that scales are commonly used data collection tools. It can be accepted that these quantitative studies provide productive information to the literature. Additionally, the scales used in these quantitative studies are useful to reach many participants at a specific period and also to maintain conclusive results. Nevertheless, it can be also seen that there is a lack of studies designed in terms of mixed method and qualitative research methodologies. For this reason, it can be said that mixed method and qualitative research studies could bring fruitful knowledge to the area. Moreover, such data collection tools as interviews, observations, focus groups are needed to be used to comprehend students' feelings about mathematics anxiety as well as to define and to exemplify anxiety in mathematics. On the other hand, it is seen that using metaphors (see e.g. Özdemir & Sezginsoy Şeker, 2017) to draw students' anxiety in mathematics could provide interesting insight into the area.

In conclusion, it is seen that most of the studies under the review designed according to the quantitative research methodology as well as obtained the data based on students' perceptions by scales. Students' anxiety in mathematics can be measured or clarified by their perceptions or perspectives, but there should be studies considering other groups of participants like teachers, parents or friends. According to the results of reviewed studies, it can be said that most of the studies conducted to find out nearly similar aims. This suggests that there should be studies focusing on special topics relating with *'mathematics anxiety'*. It might be concluded that future studies related to *'mathematics anxiety'* need to widen the scope of the topic, to use

multiple data collection tools and to gather data from various groups of participants in order to discover the whole picture of mathematics anxiety in educational settings in Turkey. This will also support triangulation of findings and enhance the trustworthiness of the results.

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