The systematic literature review of the link between mathematical teaching strategies and students' mathematics anxiety.

The link between Mathematics teaching strategies and students' anxiety: A systematic literature review.

ABSTRACT

This study focused on the link between Mmathematicsal teaching strategies and students' mathematics anxiety in school. This study follows a qualitative approach, using a systematic literature review by evaluating and summarizing the relevant research results on students' mathematics anxiety and Mmathematicsal teaching strategies. Online databases were searched and ten studies were selected, and only the studies that were published between 2000 and 2022 were included in this study..tThe studies reviewed examined how students' mathematics anxiety is affected by Mmathematicsal teaching strategies such as the followings: problem-based teaching style, direct teaching style, single instructional approach, systematic and structured approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, inquiry-based learning, and student-centred learning methods of teaching. The study concluded that there is a relationship between Mmathematicsal teaching strategies and students' mathematics anxiety. Student-centred education, problem-based teaching approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, and inquiry-based

learning were found to reduce mMathematics' learning anxiety. Based on the findings, this systematic literature review suggests that a positive and welcoming environment should be created by mMathematics teachers so that concepts in mMaths can be discussed by students without being afraid of failing, thereby reducing their anxiety in mathematics.

Keywords: Mathematics anxiety, Student-centred approach, problem-based approach, creative and discovery approach, inclusive instructional strategy, instructional strategies, inquiry-based learning

1. INTRODUCTION

Mathematics is one of the branches of knowledge that focuses on critical thinking, calculation, space, and design which requires abilities in basic reasoning and computations [1]. In addition to the physical and scientific studiesciences, mMathematics is utilized to study the humanities, social sciences, languages, and vocational fields [2]. In general, the role played by mMathematics in every aspect of life is essential, but the significant contribution of mMathematics is in the field of education. Mathematics is perceived as one of the subjects that are very difficult to learn as a result of its dynamic, abstract, and complex nature [3, 4].

One of the critical success subjectselements in academic disciplines ranging from tTechnology, and sScience to eEconomics is mMathematics. Therefore, for high school students to pursue mMathematics at a higher level, excellent qualifications are necessary. In developing countries, the current curriculum needs to be evaluated and reviewed continually to produce a world-class mMathematics education system and improve the quality of education. However, one of the variables that can stop students from benefiting from skills they can acquire from mMathematics in school is students' mathematics' anxiety. Anxiety is a taught behaviour that typically appears early in a person's educational journey, and if it takes root, its negative effects will continue throughout the academic years if it is not managed. Students' Mathematics' anxiety has persistently hampered students' ability to learn mathematics [2]. Students who struggle with mMathematics' anxiety may also actively avoid quantitative-based tasks. *(Break the paragraph here).*Students' Mathematics anxiety is a possible hindrance to positive components related to mMathematics. Alam al-Hoda[5] explains mathematics' anxiety as a mental status that individuals attain when managing mathematical content, whether in learning and educating situations or assessing mathematical behaviour and solving mathematical problems[5]. Anxiety, as defined by Makari [6], is the general term for several disorders that cause worrying, apprehension, fear, and nervousness[6]. The fear of failing mMathematics or the fear that mMathematics is too complex or not solving mathematical problems often stems from a lack of confidence. Mathematics' anxiety influences how high school students act and feel. Mathematics' anxiety is fostered by high school students who have had regular terrible encounters learning mMathematics since they have been made to conclude that they do not have the mental ability to do it.

Mathematics teachers, through social and cognitive aspects like their teaching quality as teaching too fast or poorly explaining, professional development, interaction, experience, skills, and material knowledge [7, 8] may hinder high school students from having proper math experience, and this might also lead to long-lasting mathematics anxiety [9]*(Revise the content of this sentence to make easy comprehension)*. For high school students to experience Mmaths learning that will improve their performance in mMathematics and reduce mathematics anxiety, the teaching methods of mMathematics' teachers should be properly examined.

Teachers have different teaching approaches and styles to ensure that students learn and participate in the subject. However, the teaching methods adopted by a teacher in the mMathematics classroom are influenced by the teacher's social backgroundsuch as, mastery of the subject, personality, educational background, or experiences in the field*(Cite authority for this assertion)*. In learning mMathematics, the teacher's teaching method is one of the crucial factors lon how the students will feel about the subject, retain the knowledge or understand the subject. McKinney et al. [10] noted that some Mmaths teachers use teacher-directed instruction and appear to lecture more frequently than teach Mmaths using student-centred methods[10]. There might be less anxiety if Mmaths teachers engage the students in rich problem-solving mathematical experiences. McKinney et al. [10] also found that the "pedagogy of poverty" is implemented by teachers in high-poverty schools when they teach their mMathematics[10]. They defined "pedagogy of poverty" as a fixed sequence curriculum, a curriculum that did not focus on problem-solving and reasoning but concentrated on just teaching the students basic skills [10]. Considering the damage anxiety in mMathematicslearning can cause in high school students, investigating the link between the teaching methods of mMathematics teachers and anxiety in mathematics among high school students is most important at this time.

The Cycle of Math Avoidance *(This sextion is relocated here from below)*

In the first phase, as stated in this model, adverse reactions to Mmaths situations are experienced by the students [15]. These might result from past negative experiences of the students with mMathematics teaching, which leads to the second phase of this model where the students avoids anything that involves mMathematics. And avoiding Mmaths situations can lead to poor mMathematics preparation, which is the third phase of this model. This poor preparation leads to phase four,which is poor Mmaths performance. More negative experiences with mMathematicslearning are then generated and these go back to phase one of this model. The repetitions of this cycle can make the anxious persons conclude that they cannot learndomMathematics, and the Cycle is rarely broken [16]. SomeThebiological studies concluded that there is a deficient inhibition mechanism for mathematics-anxious individuals whereby task-irrelevant distracters consume working memory resources [17]. Preis and Biggs [18] noted that students that perform poorly in examinations and tests affirm that they become confused, keep thinking about how their poor performance in mMathematics, or are unable to concentrate on the task at hand[18]. Mathematics anxiety degrades the accuracy of working memory and slows down performance because the ongoing, task-relevant activities of working memory are disrupted*(Please cite authority for this assertion)*.

Study objective.

According to Jackson and Leffingwell[11], some mMathematics teachers are part of the cause of mathematics anxiety because students tend to internalize the interest of their teachers and enthusiasm for teaching Mmaths which is shown in the teaching methods adopted by their teachers[11]. Timss[12] established that when it comes to teaching mMathematics in schools, Africa is among the worst[12]. Mounting indicators on the learning

of mMathematics and school performance show poor teaching of mMathematics in most of the schools understudied [13]. Lack of confidence in a particular teaching method or teachers' bad attitudes about mMathematicssubject can trigger anxiety in high school students. Investigating the link between the teaching methods of mMathematics teachers and anxiety in mMathematics can reduce anxiety mathematics among high school students. There have been many studies on the effect of mMathematics anxiety on the performance of students in the subjectmathematics, and many scholars have studied the causes of mathematics anxiety, but not much has been done on how teaching methods of mMathematics teachers affect anxiety in mMathematicslearning in schools*(You can only assert this for your locality, therefore revise this statement. This sstatement even contradicts the focus of this study. You may may have to expunge the statement outright).*,Tthis study will examine the link betweenMmathematicsal teaching strategies and students' mathematics anxiety in school by reviewingstudying the precious studies.

The Cycle of Math Avoidance

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2. METHODOLOGY

The systematic literature review will be used to examine the link between mMathematicsal teaching strategies and students' mathematics anxiety in order to have a comprehensive and clear overview from of the evidences available. The systematic literature review aims to summarize and evaluate the identified findings of relevant individual studies [19] on Mmathematicsal teaching strategies and students' mathematics anxiety.,Tthis will make the evidences available more clear and understandable to decision-makers. Published literature on Mmathematicsal teaching strategiesand influence on students' mathematics anxiety was searched. The studies that were searched were published between 2000 and 2022. Students in secondary schools and students in higher institutions of learning were study respondentsparticipants in the studies that were included. Studies that included information on teaching strategies of mMathematics teachers in secondary and tertiary institutions were also included. Google Scholar, ScienceDirect, JSTOR, ERIC, and EBSCO were the databases used for the data collection. The search keywords used to find articles were: Mathsanxiety, Mmathematicsal teaching strategies, and Students'mathematics anxiety, teaching methods, Mmathematicsal belief, the effect of Students'mathematics anxiety, fear of mMathematics, and mMathematics teachers' styles.

The publications that did not address the study question and inclusion criteria were discarded after two reviewers independently read through the articles. addressing those criteria. Both of the reviewers then screened the final list. The literature that did not fit the requirements was eliminated after discussion and agreement. For instance, studies that only discussed predisposing factors, such as a student's financial background or the number of children in the family of the student or the gender of the students, without providing data on how the methods adopted by the teachers influence the student's anxiety; including studies that were based on students'mathematics anxiety and how it affects student's academic performance but did not address how Mmathematicsal teaching strategies affects the students' mathematics anxietywere discarded.

Data Collection

The complete search from allboth researchers turned up 265 pieces of literature, of which 236 were found appropriate using the five databases, and 29 were found by manually examining journal reference listsinappropriate. After duplicates*(Revise the choice of the word underlined)* were eliminated and abstracts were scrutinized, 154 full-text articles were evaluated for eligibility and 48 were excluded after checking the publication date. Out of these 106 studies that were considered to be suitable.,10 papers were included in the final review as a resultconsequence of the agreement between the first researcher and second reviewers over the omitted publications*(Revise the structure of this statement for clear understanding)*. The literature included articles that demonstrated the relationship between Mathematicsal teaching strategies and students' mathematics anxiety in school. Figure 1 summarizes the article selection process.

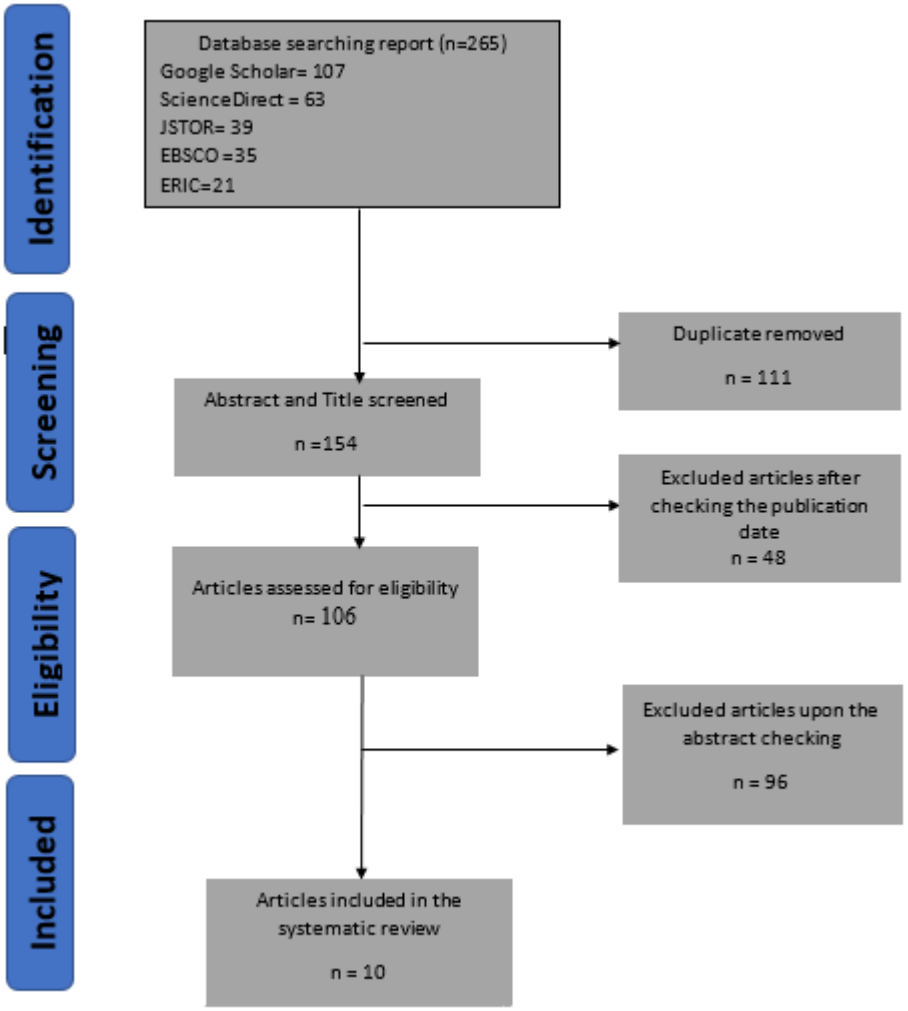

Figure 1: Systematic Search Strategy in Accordance with PRISMA [20].
Source: Author's compilation

3. RESULTS AND DISCUSSION

(You should be able to present concrete study findings to support any conclusion you are making here. You should present here facts in figures particularly on how many of the literature reviewed support your findings. How many literatures recommend types of teaching methods. Data should be presented here please.)

Sandt and O'Brien [21] focused on two teaching styles, a problem-based teaching style and a direct teaching style[21],.. The study revealed that a problem-based teaching approach may reduce students' mathematics anxiety and thereby boost mathematical skills. The study indicatedconcluded that problem-based teaching styles contribute to the reduction of students'mathematics anxietyon Mathemeaticsin students. Insight into the ability of problem-based education teaching style to reduce students' mathematics anxiety was given by Walker and Leary [22]. Although Hodara's[23] findings showed that a single instructional approach is rarely beneficial for all students, the study found that a problem-based teaching approach significantly reduced students' mathematics anxiety in a course on

Mmathssubjects that was contextualized for use in education[23]. Burghardt, et al. [24] noted that to reduce students' mathematics anxiety, mMathematics teachers need to integrate problem-based teaching methodologies in preparing for their classes.

Thijsse[25] categorize teaching methods into two which are systematic and structured approach, and creative and discovery approach[25]. The study revealed how the teaching approach adopted by mMathematics' teachers can reduce students' mathematics anxiety. The study used the Kumon method as the intervention program, which was developed based on the principles of the late Japanese educator and founder of the Kumon Educational Institute, Toru Kumon. The study observed the changes in anxiety levels of students using the Kumon program. The study found that students in the Kumon program had favourable experiences with the creative and discovery approach. The study discovered that starting at simple levels and practising the material repeatedly improved their ability and confidence in mMathematics because it reduces their mathematics anxiety. The student who displayed an increase in mathematics anxiety demonstrated a decline in performance on the Kumon post-test in classrooms where a systematic and structured approach was used to teach mMathematics. It was discovered that students' mathematics anxiety is influenced by the teaching method adopted by mMathematics teachers. Gresham and Burleigh [26] reported that an inclusive instructional strategy promotes children's confidence in mMathematics and reduces their mathematics anxiety[25]. The study noted that many Mmaths teachers choose a curriculum and/or teaching approach that is solely centred on the teacher without any consideration for students that are anxious about mMathematics.

In the study of Lorenzen [27], the influence of instructional strategies was examined on students' mathematics anxiety. The study affirmed that student-centred learning methods of teaching and traditional methods of teaching are the two instructional styles that teachers frequently employ in mMathematics courses[27]. The study revealed that the inquiry-based learning participants exhibited decreased levels of anxiety after the semester. Individuals in inquiry-based learning showed less self-reported mathematics anxiety than participants in traditional learning. The study concluded that individualsunderin inquiry-based method have more effectchance ofon reducing students' mathematics anxiety. However, these findings contrast with those of Alsup [28], who discovered that students enrolled in mMathematics classes where traditional methods were used showed a greater decline in students' mathematics anxiety than those enrolled in constructivist, active-learning classes [28].

Emanet[29] showed that student-centred teaching strategies can help students who are anxious about mMathematics[29]. Altun, [30] stated that the type of teaching method adopted by mMathematics teachers can have an impact on how the students feel about mMathematics or how anxious they are[30]. This is consistent with the findings of Bekdemir[31] who concluded that students' mathematics anxiety in pre-service elementary teachers is influenced by the poorest and most challenging mMathematicsclassroom experiences because the teachers did not use a student-centred teaching approach[31]. The results demonstrate that many pre-service teachers struggle with mathematics anxiety because of the type of teaching methods adopted by the teachers. Kulkin[32] concluded that most study students believed that Mmaths is difficult because their teachers do not use the student-centred curriculum[32]. The students enrolled in classrooms where a student-centredcurriculum was used by the teachers demonstrated that their mathematics anxiety was reduced. The study added that a student-centred curriculum helps students attain mastery through problem-solving. *(Break the paragraph here).* Gholami, et al., [33] used Mathematics Anxiety Scale-Revised to measure students' mathematics anxiety with 86 students and were grouped into an experimental group and control group[33].,Tthe study found that there is a detrimental correlation between students' mathematics anxiety and teaching methods[33]. Students in the experimental group used a student-centred approach to tackle problems both individually and in groups. Students in the control group received

instruction using the standard approach. The children's aptitude for problem-solving was evaluated using a Mmaths test. The outcomes demonstrated a substantial difference in students' mathematics anxiety and accomplishment scores between the experimental and control groups' means. Student-centred teaching methods were discovered to be an effective technique for boosting the students' capacity for problem-solving and lowering their anxiety.

4. CONCLUSION

Given the well-documented evidence emphasizing the benefits of student-centred teachingeducation to students, it is easy to understand that teacher-centred learning on its own cannot effectively address the issues of students' mathematics anxiety. This study shows that teachers that embrace a wholly student-centred approach to curriculum and instruction produce results that are centred on meeting the needs of the students. The problem-based teaching approach was also found to reduce students' mathematics anxiety and boost mathematical skills. The literature reviewed also revealed that an inclusive instructional strategy promotes children's confidence in mMathematics and reduces their mathematics anxiety. However, mMathematics teachers need to adopt balanced teaching strategies to be more inclusive and reduce anxiety in students. To reduce students' mathematics anxiety, mMathematics teachers need to integrate problem-based teaching methodologies in preparing for their classes.

Alkan[34] noted that effective teachers need to consider new strategies for teaching mathematics to improve students' attitudes to mMathematics[34]. Also, a positive and welcoming environment should be created by teachers so that concepts in Mmaths can be discussed by students without being afraid of failing, thereby reducing their anxiety in mMathematics. To reduce mathematics anxiety in students, mMathematics teachers should choose teaching strategies such as using games to impact mathematical knowledge, reviewing the given topic by exercises and examples, making Mmaths relevant, getting support from parents, and motivating pupils. Students should be allowed to form their understanding based on the experiences they have before and reflecting on those experiences is important. With this in mind, rather than just working towards getting the correct answer, the approach should focus on the process of understanding and problem-solving, which is more important. This type of strategy is validated for diverse learners as discovered in this study. As shown by this study, the effective teaching strategy is when teachers provide encouragement to the students and a nurturing environment is created where students are allowed to proceed at their own pace.*(This section should be merged with section undere 'Results and Discussion.)*

COMPETING INTERESTS

No competing interests. We did not receive any financial support from anybody or organization.

CONSENT

This is a systematic literature review; the research is well referenced.

ETHICAL APPROVAL

No confidential, sensitive or deeply personal information was collected from participants.

REFERENCES

1. Kusmaryono I, Gufron AM, Rusdiantoro A. Effectiveness of scaffolding strategiesin learning against decrease in mathematics anxiety level. NUMERICAL: JurnalMatematika Dan PendidikanMatematika. 2020;4(1):13-22.
2. Atoyebi, M., &Atoyebi, S. The causes of anxiety in mathematics among private secondary school students. A case study of students in Egbedore Local Government, Osun state. Nigeria. Adeleke University Journal of Science. 2022;1(2)
3. Haase VG, Guimarães APL, Wood G. Mathematics and emotions: the case ofmathematics anxiety. International Handbook of Mathematical Learning Difficulties. 2019;469-503.
4. Azizah SN, Suhendra. Mathematics anxiety of senior high school students basedon extrovert and introvert personality types. Journal of Physics Conference Series.2020;1521(3).
5. Alam al-Hoda H. Mathematics anxiety. Journal of Psychology and Educational Sciences. 2000;5(1)
6. Makari G. *Brief history of anxiety*. New York Times. 2012;Retrieved 7/14/2012 from http://opinionator.blogs.nytimes.com/2012/04/16/in-the-arcadian-woods/.
7. Stanford G. The effects of teachers teaching styles and experience on elementary students mathematical achievement. *Liberty University*. 2014.
8. Toropova, A., Johansson, S. and Myrberg, E.. The role of teacher characteristics for student achievement in mathematics and student perceptions of instructional quality. Education Inquiry, 2019; 10(4), 275-299.
9. McLeod D. Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), Handbook of research on mathematics teaching and learning. New York: Macmillan. 1992; 575-596.
10. McKinney S, Chappell R, Hickman B. An Examination of the Instructional Practices of Mathematics Teachers in Urban Schools. Preventing School Failure 2009;53(4):278-284.
11. McKinney S, Chappell R, Hickman B. An Examination of the Instructional Practices of Mathematics Teachers in Urban Schools. Preventing School Failure 2009;53(4):278-284.

12. Jackson C, Leffingwell R. The role of instructors in creating mathematics anxiety in students from kindergarten through college. Mathematics Teacher. 1999;92:583-587.
13. Trends in International Mathematics and Science Study – TIMSS 2011; (Exhibit 2.1: TIMSS 2011 International Benchmarks of Mathematics Achievement pg. 87)
14. Bernstein, A. McCarthy, J., & Oliphant, R. (2013). Mathematics teaching in SA adds up to multiplying class divisions. Mail & Guardian, October 24, 2013, Johannesburg: M&G Media. 2013
15. Ma, X., Xu, J. The causal ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. J. Adolesc. 2004; 27, 165–179.
16. Carey, E., Hill, F. Devine, A. Szucs, D. The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. Front. Psychol. 2016; 6, 1987.
17. Hopko DR, Ashcraft MH, Gute J, Ruggerio KJ, Lewis C. Mathematics anxiety and working memory: Support for theexistence of a deficient inhibition mechanism. Journal of Anxiety Disorders. 1998;2(4):343-355.
18. Preis, C. & Biggs, B. Can instructors help learners overcome mathematics anxiety? ATEA Journal, 2001; 28, 6-10
19. Siddaway, Andy P., Alex M. Wood, and Larry V. Hedges. "How to do a systematic review: a best practice guide for conducting and reporting narrative reviews, meta-analyses, and meta-syntheses." Annual review of psychology. 2019: 70, 747-770.
20. Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. Journal of Clinical Epidemiology, 2009; 62, 1006-1012.
21. Sandt, S. and O'Brien, S. Impact of Instructor Teaching Style and Content Course on Mathematics Anxiety of Preservice Teachers. Journal of Technology Education. 2017; 29(1)
22. Walker A, Leary H. A problem based learning meta analysis:Differences across problem types, implementation types, disciplines, andassessment levels. Interdisciplinary Journal of Problem-Based Learning.2009;3(1):12-43.
23. Hodara, M. Reforming mathematics classroom pedagogy: Evidence-based findings and recommendations for the developmental math classroom (assessment of evidence series). 2011
24. Burghardt MD, Hecht D, Russo M, Lauckhardt J, Hacker M. A study of mathematics infusion in middle school technology education classes. *Journal of Technology Education*. 2010;*22*(1):58-74.
25. Thijsse, Lynette Joan (2002). The Effects of a Structured Teaching Method on Mathematics Anxiety and Achievement of Grade Eight Learners. 2011; 17
26. Gresham G, Burleigh C. Exploring early childhood preservice teachers' mathematics anxiety and mathematics efficacy beliefs. *Teach. Educ.* 2019;30:217-241.
27. Lorenzen, J. K. The effect of instructional strategies on mathematics anxiety and achievement: A mixed methods study of preservice elementary teachers. 2017
28. Alsup J. A comparison of constructivist and traditional instruction inmathematics. Educational Research Quarterly. 2004;28(4):3-17.

29. Emanet, Elif Ay, and Fatih Kezer. "The effects of student-centered teaching methods used in mathematics courses on mathematics achievement, attitude, and anxiety: a meta-analysis study." Participatory Educational Research. 2020: 8(2), 240-259.
30. Altun, M. *Eğitimfakültelerivelisematematiköğretmenleriiçinliselerdematematiköğretimi [Teaching mathematics in high schools for education faculties and high school mathematics teachers].* Bursa: Alfa Yayınları.2009.
31. Bekdemir M. The pre-service teachers' mathematics anxiety related to depth of negative
experiences in mathematics classroom while they were students. Educational Studies in Mathematics. 2010;75(3):311-328. doi: 10.1007/s10649-010-9260-7
32. Kulkin M. Math is like a scary movie: Helping young people overcome mathematics anxiety.
After School Matters. 2016;23:28-32.
33. Gholami, Hosseinali, et al. "Impact of Lesson Study on Mathematics Anxiety and Mathematics Achievement of Malaysian Foundation Programme Students." *International Journal of Evaluation and Research in Education*, 2021, 10(3): 912-920.
34. Alkan V. Reducing Mathematics Anxiety: The Ways Implemented by Teachers atPrimary Schools. International J. Soc. Sci. & Education. 2013;3(3):795-807.