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Research Paper

Mathematics Phobia: Factors Contributing to Mathematics Phobia among Students

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ABSTRACT

Mathematics is the most essential subject for students at every stage. It is helpful in developing critical thinking, logic, reasoning ability and rational thinking among students. But the most significant barrier of mathematics learning is the fear of failure to succeed or poor performance in mathematics. This fear can develop mathematics phobia among students. Mathematics phobia is defined as uneasiness, stress, panic, nervousness and negative feeling at the time of solving mathematics problems. There exist various factors which creates fear of mathematics among students. This paper highlights the various factors contributing to mathematics phobia on the basis of review of literature concentrating on studies related to mathematics anxiety, mathematics phobia and factors contributing to mathematics phobia. 20 papers between the years 2002 to 2023 from the research gate and Google scholar database are reanalyzed to find the factors contributing to mathematics phobia. The review shows that factors contributing to mathematics phobia is resulted from personal factors, educational factors, psychological factors and socio-economic factors.

Keywords: *Mathematics education, Mathematics phobia, Factors contributing to mathematics phobia*

"Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality." ***-(Richard Courant)***

Mathematics is a very essential subject for every individual. Mathematics provides a base for most of the subjects like Science, Technology, Social sciences, Art, Physical education and Language (National Curriculum Framework for School Education 2023). Mathematics is known as the mother of all sciences. Mathematics helps students in visualizing, analyzing, synthesizing, organizing, manipulating, and managing. Mathematics is not limited to numbers, facts, and theories but is also helpful in the exact interpretation of individuals' ideas and concepts. With the help of mathematics education, students are able to develop their creativity, reasoning ability, problem-solving ability, spatial thinking, logical thinking, and rational thinking among. It is also helpful in finding and explaining patterns, communicating precisely and computational thinking (NCFSE

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2023). Mathematics is not only useful for everyone's professional life but also useful for educational and daily life. Keeping in mind the necessity of mathematics, National Education Policy (National Education Policy 2020) has verified the importance of mathematical thinking and problem-solving ability in preparing students for the challenges of the 21st century. It advocates for a holistic and interdisciplinary approach to mathematics education, integrating it with other subjects and real-world applications to develop critical thinking and analytical skills. In addition to this National Curriculum Framework- 2005 had recommended that the main aim of mathematics education is to develop the 'Mathematization' ability of children's. It can help students to develop the skills such as optimization, estimation, abstraction, approximation, visualization and representation.

Although mathematics is very crucial for our daily life but also it is known as most rigorous subject. Students feel more confused and overburdened at the time of learning mathematics and they experienced anxiety or phobia (Ashcraft and Moore, 2009; Luttenburger et al., 2018). NCF 2005 had also stated that students have a lot of fear of mathematics. The national curriculum framework for school education (NCFSE 2023) also underlined that mathematics is a very challenging subject in the Indian education system, and students have a great fear of mathematics. For numerous students, mathematics is perceived as equally formidable as a monster. They have a myth that mathematics is a very difficult and complex subject (Estonanto and Dio, 2019). Many students strongly feel that they are unable to perform good in mathematics subject, it is only for brilliant students. Numerous students experience exhaustion immediately upon engaging with mathematical tasks. Their attainment in mathematics is notably deficient. They accept failure by asserting their incapability to overcome the challenges presented by the subject. Regrettably, avoidance of mathematical activities results in diminished competence, limited exposure, and reduced opportunities for mathematical practice, thereby leaving students more apprehensive and inadequately prepared to achieve their educational objectives (Estonanto and Dio,2019). Consequently, this leads to the development of a fear of mathematics. This fear can range from anxiety and nervousness to extreme fear, and this extreme fear is called phobia (Kumar, Bajpai and Thakur,2019). Phobia can be termed as the type of mental illness or anxiety disorder that makes a person very anxious about any incident or issues that affects their life. It involves an excessive fear of something or an irrational fear of a specific circumstances, activity, event and object or a compulsion to avoid it (American Psychiatric Association,2013). The term phobia comes from Greek word 'phobos' which means fear or panic. Simply phobia is defined as fear (Hafiz et al.,2022). Therefore, Mathematics phobia is termed as fear of mathematics.

Mathematics phobia is defined as the negative feelings of students at the time of solving mathematical problems (Khasawneh, et al., 2021). It is characterized by feelings of uneasiness, boredom, nervousness, stress, panic, and dread that inhibit the mathematical ability (Ramirez, Shaw and Malony,2018; Luttenberger et al., 2018). Mathematics anxiety is defined as the feeling of stress, panic, apprehension, or fear that interrupts the mathematical performance (Ashcraft, 2002; Ashcraft and Moore, 2009). According to the American Psychological Association, mathematical anxiety is related to testing anxiety. This anxiety frequently causes distress, disrupts the working memory for maintaining mathematical tasks in a focused way, and also negatively affects achievement scores. This potentially results in dislike and avoidance of all math-related tasks. An individual tormented by math phobia may not necessarily lack proficiency in mathematics; rather, their full potential is hindered by the symptoms of anxiety that disrupt their abilities (Kumar,2020). The acquisition of math phobia is often attributed to parental and educator influence rather than direct personal

encounters, as indicated by a variety of experts. Some studies found that mathematics phobia develops among students due to several factors like past negative experiences in mathematics, poor and overloaded content of mathematics, non-supportive classroom environment, teachers' personalities, lack of motivation, etc.

Research questions

What are the factors that contribute to mathematics phobia among students?

METHODOLOGY

Search Strategy:

The literature review was conducted through systematic searches on Google Scholar and ResearchGate using Boolean combinations of the following keywords and search strings: "mathematics phobia" AND "anxiety", "maths anxiety" AND "students", "causes of math phobia", "factors contributing to mathematics anxiety", "mathematics fear in school children", and "math anxiety education". Only peer-reviewed journal articles published in English were considered.

Inclusion/Exclusion Criteria:

The inclusion criteria were: (1) publications between 2002–2023, as this period reflects significant growth in empirical research on math anxiety; (2) articles directly related to school or college students and math phobia; (3) peer-reviewed journal articles only, as they offer scholarly rigor and validated findings. Exclusion criteria included articles: (1) not published in English; (2) that were conference proceedings, theses, or non-peer-reviewed; (3) having no substantive focus on math anxiety or phobia.

Screening Process:

An initial pool of 68 papers was retrieved based on keyword matches. Titles and abstracts were screened to remove duplicates and irrelevant studies, reducing the number to 37. After full-text assessment, 22 journal articles were selected that closely addressed the research topic and aligned with the defined criteria.

Analysis Method:

The selected studies were analyzed using thematic content analysis. This method involved coding the literature for recurring themes and categorizing the contributing factors into four domains: personal, educational, psychological, and socio-economic. Factors were extracted based on their recurrence and emphasis in at least three or more of the reviewed studies.

Findings:

After reviewing the literatures researcher has found few factors which contribute to mathematics phobia. Researcher found four main factors such as personal, educational, psychological and socio cultural that affects mathematics learning. These factors consists of many aspects such as personal factors included mindset, prior experiences, self-confidence, perfectionism, self-esteem, learning style and motivation. Educational factors include the aspects, pedagogical method, curriculum design, teacher students interactions, teaching strategies, assessment practices. Psychological factors include negative self-talk, cognitive interference, fear of failure, perceived threat. And socio-cultural factors include gender stereotype, cultural context, socio economic status, cultural perceptions parental support, societal expectation and educational policies and practices.

Factors contributing to mathematics phobia

According to the NCFSE - 2023, fear of mathematics is a very challenging issue in the Indian education system. Most of the students avoid mathematics due to this fear which hinders their career advancement and intellectual endeavor. Knowing the factors that contribute to mathematics phobia is a very challenging and demanding task because there exist various factors by which fear of mathematics occurs. After reviewing the literature, researcher found some of these factors include personal, psychological, socio-cultural, and educational factors etc. These factors include various aspects such as mindset, motivation, self-confidence, teaching methods, classroom environment, parental support, societal expectations, teacher-student relationships, overburdened curriculum, structure of math course, etc. Two major aspects of fear of mathematics are discussed in NCFSE 2023 are as follows- the nature of mathematics and how it is taught and assessed and the second one is societal expectations and perceptions.

Personal factors:

Mathematics phobia often stems from personal experiences and perceptions. These factors can be described as students related factors. These factors include prior knowledge or prior experiences, labour, interest, practices and seriousness of students (Acharya, 2017; Blyth, 2022). Personal experience and perception show how students perceive things in their way. In developing individuals' attitudes towards mathematics, their personal experience plays a pivotal role. Individuals may develop anxiety or fear towards math due to past failures, negative feedback, fixed mindset and low self-confidence in their mathematical abilities (Lucietto et al., 2020). Personal factors such as self-esteem, motivation, and learning styles play significant roles in shaping one's attitude toward mathematics (Yanzhi He,2020).

- **Mindset:** When an individual has thought that mathematics is a very complex subject, average students are not capable of doing mathematics problems and they have inability to get success in mathematics subject, then they feel more anxious (Denhere,2015; Blyth,2022). The students place themselves at risk of failure because they start avoiding mathematical tasks and never try to understand and resolve the mathematical problems (Lucietto, 2020).
- **Prior experiences/ personal experiences**: Personal experiences, such as past failures or negative feedback in mathematics, can significantly impact an individual's perception of their mathematical abilities (Denhere,2015; Blyth, 2022). Lack of prior knowledge in mathematics among students is responsible for students failure in mathematics (Acharya,2017). Repeated struggles with math problems or receiving poor grades may reinforce the belief that one is not capable of succeeding in math (Ahmed, 2013; Ramirez, Shaw & Malony, 2018).
- **Self-confidence**: Self-confidence plays a crucial role in mathematics performance. Individuals with low self-confidence may doubt their abilities to solve mathematical problems or handle mathematical concepts, leading to heightened anxiety when faced with math-related tasks (Lucietto,2020; Estonanto and Dio, 2019). If students have positive personality aspects like self-confidence, courage, diligence, they have positive attitude towards learning but when students have negative personality trait like low self-confidence, inferiority, fear and pessimism then there performance in mathematics is not good (Yanzhi he, 2020; Ashcraft,2002).
- **Motivation**: Motivation is another personal aspect that influences mathematics phobia. The student's mathematics learning is affected by their motivation (Ashcraft, 2002). Lack of interest or motivation towards math can exacerbate anxiety levels, as individuals may perceive math as irrelevant or unimportant to their goals (Yanzhi He, 2020).

- **Learning styles**: Personal learning styles also impact mathematics phobia. Some individuals may struggle with traditional teaching methods and benefit more from alternative approaches, such as visual aids or hands-on activities. When learning styles are not aligned with instructional methods, it can contribute to feelings of frustration and anxiety (Mutodi and Ngirande, 2014).
- **Self-esteem**: Self-esteem defined as belief about the self. Mathematics phobia often correlates with low self-esteem. Individuals who perceive themselves as incapable or inadequate in math may experience heightened anxiety when faced with mathematical challenges, further perpetuating negative self-perceptions (Kumar, Bajpai & Thakur, 2019).
- **Perfectionism**: Perfectionist tendencies can intensify mathematics phobia. If students have a pressure to become perfect in mathematics due to this pressure, their performance can affected and this lower performance develops fear among students (Hafiz, et al., 2022). The fear of making mistakes or not meeting high standards can create immense pressure, leading to avoidance of math-related tasks and increased anxiety levels (NCFSE 2023).

Educational factors:

The educational environment significantly influences the development of mathematics phobia. Pedagogical methods, curriculum design, and teacher-student interactions all contribute to either alleviating or exacerbating math anxiety (Ashcraft & Moore, 2009). Inadequate teaching strategies, excessive emphasis on memorization, and lack of practical application can heighten students' fear of math (Ramirez, 2003). Moreover, high-stakes testing and performance pressure may intensify anxiety levels among students.

- **Pedagogical methods**: The methods used to teach mathematics can significantly impact students' anxiety levels. Pedagogical approaches that prioritize rote memorization, repetition, or strict adherence to procedures without emphasizing conceptual understanding may contribute to feelings of confusion and frustration, exacerbating mathematics phobia (Ashcraft & Moore, 2009; Ramirez, Shaw and Malony, 2018).
- **Curriculum design**: The design of the mathematics curriculum can influence students' attitudes towards math. A curriculum that lacks coherence, progression, or relevance to real-world contexts may fail to engage students, leading to disinterest and anxiety toward math topics (Ramirez, 2003; Denhere,2015).
- **Teacher-student interactions**: The quality of interactions between teachers and students plays a crucial role in shaping students' confidence and motivation in mathematics (Mutodi and Ngirande, 2014). If the teachers demand more but support less to their students, it creates anxiety among students (Deleg et al.,2023). Supportive and encouraging teachers who provide constructive feedback and foster a positive learning environment can help alleviate mathematics phobia (Ramirez, 2003).
- **Teaching strategies**: Teaching strategy is another important aspect of educational factor of mathematics phobia. When teachers not uses effective and appropriate teaching materials to teach students, this may lead to mathematics phobia among students (Umameh,2011; Denhere,2015; Deleg et al.,2023). Effective teaching strategies can mitigate mathematics phobia (Mutodi and Ngirande, 2014) by promoting active engagement, conceptual understanding, and problem-solving skills (Acharya, 2017). Incorporating hands-on activities, visual aids, cooperative learning, and real-world applications can make mathematics more accessible and meaningful to students, reducing anxiety levels (Ashcraft & Moore, 2009; Umameh,2011).

- **Assessment practices**: High-stakes testing and performance pressure can heighten mathematics phobia among students (Kumar, Bajpai amd Thakur,2019). Assessment practices that solely focus on memorization or speed of calculations may exacerbate anxiety levels, particularly for students who struggle with timed tests or have test anxiety (NCFSE 2023, NEP 2020).

Psychological factors:

Mathematics phobia is deeply rooted in psychological factors such as fear of failure, perfectionism, and cognitive distortions (Lyons & Beilock, 2012). Cognitive theories suggest that individuals with math anxiety experience cognitive interference, leading to impaired problem-solving abilities (Ashcraft, 2002). Moreover, negative self-talk and maladaptive coping mechanisms further exacerbate math anxiety symptoms (Dowker et al., 2016). Additionally, comorbid conditions such as attention-deficit/hyperactivity disorder (ADHD) or dyscalculia may be the reason behind the severity of mathematics phobia.

- **Fear of failure**: Mathematics phobia often originates from a profound fear of failure in mathematics (NCFSE 2023). Individuals experiencing math anxiety may harbor concerns about making mistakes, receiving poor grades, or facing criticism from peers or authority figures (Ashcraft & Moore, 2009). Students afraid of fear of failure, and they start avoiding mathematics which may develop mathematics anxiety (Estonanto and Dio,2019).
- **Perceived threat**: Math-related situations are often perceived as threatening or intimidating by individuals with mathematics phobia. This perception of threat can trigger physiological stress responses, such as increased heart rate and sweating, leading to heightened anxiety levels (Ashcraft, 2002).
- **Cognitive interference**: Anxiety can interfere with cognitive processes, impairing individuals' ability to think clearly and solve mathematical problems effectively. This phenomenon, known as cognitive interference, results in decreased working memory capacity and impaired information processing (Ashcraft, 2002).
- **Negative self-talk**: Individuals with mathematics phobia often engage in negative self-talk, characterized by self-doubt, self-criticism, and catastrophic thinking. These negative internal dialogues reinforce feelings of inadequacy and perpetuate anxiety toward math (Lyons & Beilock, 2012).

Socio-cultural factors:

The socio-cultural context significantly shapes attitudes towards mathematics. Cultural norms, societal expectations, parental involvement, and gender stereotypes influence individuals' beliefs about their mathematical abilities. Women, for instance, may face gender biases that perpetuate the myth of male superiority in math, contributing to stereotype threat and math anxiety. Moreover, socioeconomic factors such as poverty and access to quality education can exacerbate mathematics phobia among marginalized communities (Lubienski et al., 2013).

- **Gender stereotypes**: Socio-cultural norms and gender stereotypes influence perceptions of mathematical ability. Research has shown that societal beliefs about gender and math, such as the stereotype that males are naturally better at math than females, can contribute to mathematics phobia among women (Luttenberger et al., 2018; Ramirez, Shaw & Malony, 2018; Blyth, 2022). These stereotypes create a stereotype threat, wherein individuals feel pressure to conform to negative stereotypes about their group, leading to increased anxiety and underperformance in math-related tasks.

- **Cultural context**: Cultural factors shape attitudes toward mathematics in diverse ways. Cultural beliefs about the importance of education, parental expectations, and societal values regarding success influence motivation and engagement of individuals in mathematics and it may lead anxiety among students (Blyth, 2022). For example, in cultures where mathematics is highly valued and seen as essential for success, individuals may experience greater pressure to excel in math, which can contribute to mathematics phobia (Ramirez, 2003).
- **Socio-economic status**: Socio-economic aspect such as poverty, access to resources, and quality of education can impact mathematics phobia. Those who have good economic condition, can hire mathematics tutor but these conditions are impossible in lower socio economic family (Acharya 2017). Research has found that students from low socioeconomic backgrounds often face additional challenges in learning mathematics, including limited access to educational resources, inadequate school facilities, and less support at home (Lubienski et al., 2013). These disparities can contribute to feelings of inadequacy and anxiety toward math among marginalized communities.
- **Cultural perceptions of mathematics**: Cultural differences in the perception and value placed on mathematics can influence individuals' attitudes toward the subject. For example, some cultures may view mathematics as abstract and disconnected from everyday life, while others may emphasize its practical applications and relevance (NCFSE 2023). These cultural perspectives shape individuals' motivation and interest in mathematics, affecting their level of engagement and anxiety toward the subject (Kumar,Bajpai and Thakur, 2019).
- **Educational policies and practices**: Socio-cultural factors also intersect with educational policies and practices, shaping the learning environment and opportunities available to students. Disparities in funding, curriculum resources, and teacher quality contribute to inequities in mathematics education, exacerbating mathematics phobia among disadvantaged groups (Lubienski et al., 2013).

CONCLUSION

Mathematics phobia or fear of mathematics is a pervasive issue of Indian education system. It is a multifaceted phenomenon which influenced by confluence of personal, educational, psychological and socio cultural factors. It is deeply rooted psychological condition that can not only limits the mathematical performance of students but also their potential field of study, professional trajectories and future career opportunities. This research clarified that mathematics education is not superficially hatred but it is perceived equally horrible as monster. There exist various factors which contributes in mathematics phobia. Personal factors, such as lack of motivation and interest, makes more difficult to learn mathematics. Lack of prior experience or knowledge, lack of self confidence, lack of self esteem, pressure of perfectionism can creates problem to study mathematics. Personal mindset that mathematics is very rigorous subject, is also contribute to mathematics phobia. Educational factors such as educational system and curricula that emphasis rote learning over conceptual learning also contribute to mathematics phobia. Pedagogical methods, teaching strategies that fail to relate mathematical concepts to real life situations can make the subject irrelevant and abstract in nature also a reason behind mathematics phobia among students. Poor students teacher relationship, non-supportive teacher can develop intense fear of mathematics among students. Psychological factors such as fear of failure in mathematics is a major factor to mathematics phobia. Some perceived threat, negative self-talk and cognitive interference can develop anxiety towards among students. Socio cultural influences also play an essential role in mathematics phobia. Societal stereotype that

mathematics is only for intellectually gifted or brilliant students or generally for male students. Mathematics phobia generally develops in females. Cultural perceptions and expectation towards mathematics plays pivotal role in mathematics phobia. Parental attitudes towards mathematics and their own anxiety can develop mathematics phobia among students.

The intersectionality of these factors highlights the complexity of mathematics phobia and underscores the need for a comprehensive, multi-pronged approach to address it. Interventions should include teacher training programs to foster positive mathematical experiences, curricula reform to emphasize understanding and application, and psychological support to address anxiety and build self-efficacy. Therefore, overcoming mathematics phobia requires a cultural shift in how mathematics is perceived and taught. By fostering an inclusive, supportive, and engaging mathematical environment, it is possible to mitigate the fear of mathematics and cultivate a generation of students who view the subject not as a source of anxiety but as a valuable tool for understanding the world. This transformation is essential not only for individual academic success but also for the broader societal advancement that a mathematically literate population can drive.

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Conflict of Interest

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