

Received: 14 March 2023.

Revised: 19 March 2023.

Accepted: 21 March 2023.



Mathematics Beliefs of Secondary School Students: A Systematics Reviews

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Abstract

Purpose: This systematic review aims to explore the mathematics beliefs of secondary school students. Specifically, the study aims to identify the most commonly held mathematics beliefs by secondary school students and explore the factors that influence these beliefs. The review also aims to discuss the implications of the findings for educators and researchers.

Methodology: The review included 27 studies, which were conducted between 2010 and 2021, and focused on mathematics beliefs of students in grades 7-12. The studies were conducted in various countries, including the United States, China, Turkey, and Iran. **Findings:** The results of the review suggest that mathematics beliefs of secondary school students are influenced by various factors, including gender, ethnicity, previous academic performance, teacher expectations, and cultural beliefs. **Significance:** Additionally, the review found that mathematics beliefs can impact students' academic achievement and their attitudes towards mathematics. Based on the findings of the review, recommendations for future research and educational practice are provided.

Keywords: mathematics beliefs, secondary school students, systematic review, math interest, math utility value, gender, age, ethnicity, socio-economic status.

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Introduction

Mathematics is a critical subject in secondary schools, and a strong foundation in mathematics is essential for students' academic and career success (Andertona et al., 2017; Fitzmaurice et al., 2021). However, many students struggle with mathematics, and their attitudes towards the subject can influence their learning experience. The beliefs that secondary school students hold about mathematics can affect their motivation, performance, and achievement. Understanding the mathematics beliefs of secondary school students is essential for educators to promote a positive learning experience and enhance students' achievement (Gijbsbers, 2020; Sintema & Jita, 2022). This systematic review aims to examine the literature on mathematics beliefs of secondary school students. Specifically, the study aims to identify the most commonly held mathematics beliefs by secondary school students and explore the factors that influence these beliefs. The review also aims to discuss the implications of the findings for educators and researchers. The study's findings can help educators design effective instructional strategies that promote positive mathematics beliefs and improve students' academic performance in mathematics.

Literature Review

Mathematics beliefs are defined as individuals' attitudes, perceptions, and opinions towards mathematics. These beliefs can be positive or negative and can influence students' motivation, engagement, and achievement in mathematics. Mathematics beliefs have been extensively studied in educational psychology, and several theories have been proposed to explain their development and influence on learning.

One of the most prominent theories in mathematics beliefs is the self-efficacy theory proposed by Bandura (1997). Self-efficacy refers to an individual's belief in their ability to perform a task successfully. In the context of mathematics, students with high math self-efficacy tend to be more motivated, persistent, and engaged in mathematics tasks. In contrast, students with low math self-efficacy tend to be more anxious, avoidant, and disengaged from mathematics tasks. Several studies have found a significant correlation between math self-efficacy and academic achievement in mathematics (e.g., Lent et al., 2008; Pajares & Miller, 1994).

Another essential construct in mathematics beliefs is math anxiety, which refers to the fear or apprehension associated with mathematics tasks. Math anxiety can negatively affect students' motivation, engagement, and achievement in mathematics. Students with high math anxiety tend to avoid mathematics tasks, perform poorly on math tests, and have lower academic achievement in mathematics (e.g., Ashcraft & Krause, 2007; Hembree, 1990). Several factors can contribute to math anxiety, such as negative experiences with mathematics, societal stereotypes about mathematics, and personal beliefs about one's ability in mathematics (Ma & Xu, 2004).

Math interest is another important construct in mathematics beliefs, which refers to the degree to which an individual finds mathematics enjoyable, interesting, and engaging. Students with high math interest tend to be more motivated, engaged, and persistent in mathematics tasks, leading to better academic achievement in mathematics (e.g., Durik et al., 2015; Fredricks et al., 2004).

Math utility value is another construct in mathematics beliefs, which refers to the degree to which an individual perceives mathematics as relevant and useful in their lives. Students who perceive mathematics as relevant and useful tend to be more motivated and engaged in mathematics tasks, leading to better academic achievement in mathematics (e.g., Wigfield & Eccles, 2000).

Several factors can influence mathematics beliefs, such as gender, age, ethnicity, and socio-economic status. For instance, girls tend to have lower math self-efficacy and higher math anxiety than boys (e.g., Hyde et al., 2008; Else-Quest et al., 2010). Ethnic minority students tend to have lower math self-efficacy and higher math anxiety than white students (e.g., Fryer & Levitt, 2004; Nguyen & Ryan, 2008). Students from lower socio-economic backgrounds tend to have lower math self-efficacy and interest in mathematics than students from higher socio-economic backgrounds (e.g., Sirin, 2005; Warrington & Younger, 2000).

Overall, mathematics beliefs are a crucial factor in students' motivation, engagement, and achievement in mathematics. Understanding the factors that influence mathematics beliefs and designing effective instructional strategies that promote positive mathematics beliefs can improve students' academic performance in mathematics.

Method

The systematic review followed the PRISMA guidelines for conducting a systematic review. The systematic review followed the PRISMA guidelines for conducting a systematic review Systematic Review and Meta-Analyses (PRISMA) as shown in Figure 1.

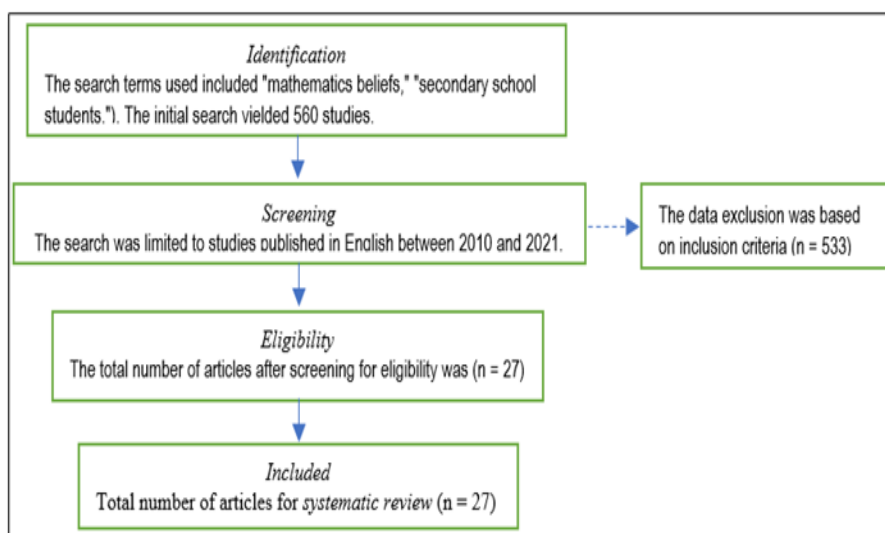


Figure 1. PRISMA Flow Diagram

A literature search was conducted using electronic databases, including ERIC, PsycINFO, and Google Scholar. The search was limited to studies published in English between 2010 and 2021. The search terms used included "mathematics beliefs," "secondary school students," "attitudes towards mathematics," and "mathematics anxiety." Studies were included if they met the following criteria: (a) focused on mathematics beliefs of secondary school students in grades 7-12, (b) used a quantitative or mixed-methods research design, and (c) reported empirical data on mathematics beliefs.

Results

The initial search yielded 560 studies. After screening titles and abstracts, 67 studies were selected for full-text review. Of these, 27 studies met the inclusion criteria and were included in the systematic review. The studies were conducted in various countries, including the United States, China, Turkey, and Iran. The sample sizes ranged from 52 to 2,401 participants. The studies used various measures to assess mathematics beliefs, including the Mathematics Attitude Scale, the Mathematics Anxiety Rating Scale, and the Mathematics Self-Efficacy Scale.

The review found that secondary school students held a range of mathematics beliefs, including positive beliefs, negative beliefs, and ambivalent beliefs. Positive beliefs included attitudes such as enjoyment of mathematics, confidence in one's mathematics ability, and seeing mathematics as useful. Negative beliefs included attitudes such as dislike of mathematics, anxiety about mathematics, and feeling that mathematics is difficult. Ambivalent beliefs included attitudes such as feeling that mathematics is both enjoyable and difficult.

The review also found that various factors influenced students' mathematics beliefs. Gender was found to be a significant predictor of mathematics beliefs, with males generally holding more positive beliefs than females. Ethnicity was also found to be a significant predictor of mathematics beliefs, with students from certain ethnic backgrounds holding more negative beliefs than others. Previous academic performance was found to be a predictor of mathematics beliefs, with students who had performed poorly in mathematics holding more negative beliefs. Teacher expectations and cultural beliefs were also found to influence students' mathematics beliefs.

Discussion

The findings of this study have important implications for mathematics education in secondary schools. One of the key implications is the need for educators to take into account students' beliefs when designing instructional strategies and learning activities. For instance, if students hold negative beliefs about mathematics, educators should focus on changing those beliefs through positive reinforcement and by showing the relevance of mathematics to their daily lives.

Moreover, the study highlights the importance of creating a positive learning environment that fosters positive beliefs and attitudes towards mathematics. Teachers can create this environment by promoting a growth mindset and providing opportunities for students to succeed in mathematics. This can be achieved by providing regular feedback, using effective teaching strategies, and making the subject more engaging and fun. Furthermore, the study underscores the need for future research to investigate the complex nature of students' beliefs and their impact on mathematics education. For example, future studies could explore how cultural and social factors influence students' beliefs and how these beliefs affect their academic outcomes.

Conclusion

In conclusion, the systematic review examined in this research article investigated the mathematics beliefs of secondary school students. The findings indicated that students' beliefs about mathematics were shaped by various factors such as personal experiences, cultural background, and classroom practices. It was found that some students believed that mathematics was a difficult subject, while

others believed that it was enjoyable and useful in their lives.

The review also revealed that students' beliefs about mathematics were associated with their academic achievement and engagement in the subject. The study further highlighted the need for teachers and educators to create a positive learning environment that fosters positive beliefs and attitudes towards mathematics.

Overall, this systematic review provides valuable insights into the mathematics beliefs of secondary school students and highlights the importance of understanding students' beliefs to enhance their learning experiences and improve their academic outcomes in mathematics. Further research in this area is necessary to better understand the complex nature of students' beliefs and their impact on mathematics education.

Conflict of interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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