

ANALYSIS OF BEHAVIORAL ASPECTS RELATED TO STUDENTS' MATHEMATICAL SELF-EFFICACY

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ABSTRACT

This research endeavors to identify behavioral categories associated with students' mathematical self-efficacy. Utilizing a systematic literature review approach, this study aims to develop a comprehensive categorization of behaviors linked to mathematical self-efficacy. Initially, a total of 2075 articles were screened using the keyword "mathematics self-efficacy." In the subsequent stage, the researchers restricted the selection to articles relevant to the realm of primary education, resulting in 534 articles. Subsequently, articles were meticulously chosen based on both the quality of the journal publishers and the pertinence of the subject matter, culminating in the selection of 10 articles for in-depth analysis. The findings of this research delineate the behavioral facets associated with mathematical self-efficacy as follows: 1) Confidence in one's mathematical abilities; 2) Decision-making in the face of mathematical challenges; 3) Goal-setting in the context of learning mathematics; 4) Exertion of effort in the pursuit of mathematical proficiency; 5) Resilience in the face of difficulties encountered during mathematical learning; and 6) Cultivation of interest in mathematics.

Keywords: *mathematics self-efficacy; attitude toward mathematics; productive disposition.*

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INTRODUCTION

Teaching mathematics encompasses more than just enhancing students' cognitive abilities; it also entails fostering their enthusiasm for learning mathematics. This notion is exemplified by the National Council of Teachers of Mathematics (NCTM) 2000 standards, which encompass conceptual understanding, procedural fluency, problem-solving, reasoning, and productive disposition as key mathematical skills. Productive disposition is a domain that

pertains to the affective aspect, emphasizing that nurturing students' affection for learning mathematics is an essential component of enabling their proficiency in the subject.

One critical aspect within the affective domain of mathematical education is mathematical self-efficacy. Self-efficacy refers to an individual's personal assessment of their capacity to perform tasks under specific circumstances, as defined by Schunk in 1984. In the realm of mathematics education, mathematical self-efficacy is regarded as an individual's belief in their own mathematical capabilities, as recognized by Liu et al. (2022), Pajares and Miller (1997), and Stevens et al. (2004).

Extensive research has established a strong correlation between mathematical self-efficacy and students' academic achievements in mathematics (Ayotola & Adedeji, 2009; Kvedere, 2014). For instance, Schöber et al. (2018) discovered a reciprocal relationship between self-efficacy and students' academic performance. In contrast, a study conducted by Herman et al. (2023) demonstrated that challenges students encounter while studying mathematics can lead to anxiety about the subject, which, in turn, affects their learning achievements. Consequently, it is crucial for educators to comprehensively understand and consider students' mathematical self-efficacy when teaching mathematics.

Despite numerous studies in the field of mathematics education emphasizing the significance of mathematical self-efficacy, there remains a scarcity of research results that specifically explore the relationship between mathematical self-efficacy and the behavioral aspects influenced by it. As a result, this research endeavors to take a fresh perspective by conducting an in-depth examination of the behavioral categories associated with mathematical self-efficacy. Specifically, this study aims to answer the research question: "What behavioral aspects are linked to students' mathematical self-efficacy?"

METHOD

This study was conducted by following the five sequential steps of a systematic literature review, as illustrated in Figure 1.

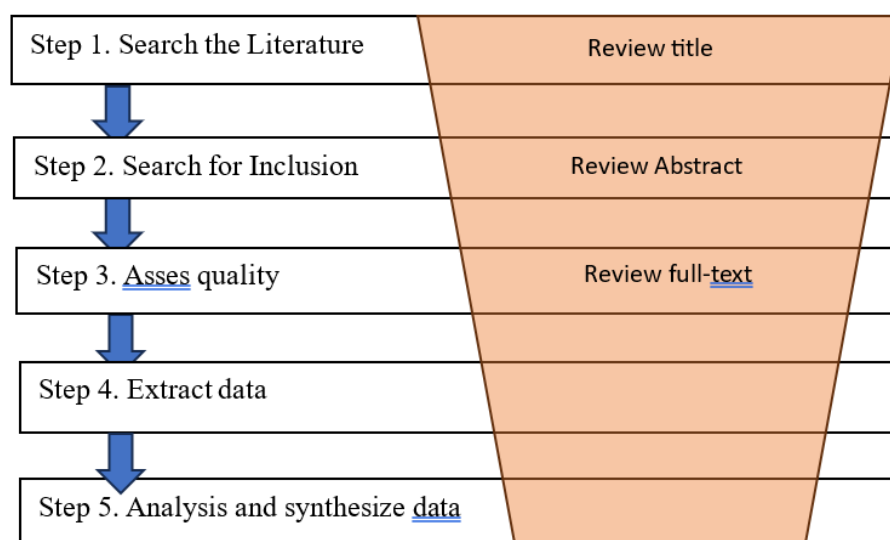


Figure 1. Processes of Systematics Literature Review (Xiao & Watson, 2019)

Search the Literature

In this initial stage, researchers systematically search for relevant academic publications. This search is typically conducted through ERIC databases using specific keywords and criteria related to the research topic.

Search for Inclusion

After gathering a list of potential sources, researchers carefully evaluate each one to determine its relevance to the research question or topic. Inclusion criteria are applied to filter out sources that do not meet the specific requirements, ensuring that only pertinent studies are considered.

Asses Quality

This stage involves a critical assessment of the selected sources to evaluate their quality and methodological rigor. Researchers assess the credibility, reliability, and validity of each study, considering factors like research design, sample size, data collection methods, and potential bias. High-quality studies are prioritized for inclusion in the review.

Extract Data

Once the quality sources are identified, researchers extract relevant information and data from these studies. This data extraction process typically involves recording key findings, methodologies, sample characteristics, and other pertinent details. Researchers organize the data to facilitate subsequent analysis.

Analysis and Synthesis Data

In the final stage, researchers analyze the extracted data to identify trends, patterns, and relationships among the included studies. This stage may include quantitative or qualitative data analysis methods, such as statistical analyses or thematic coding. The goal is to synthesize the information and draw meaningful conclusions based on the collective evidence from the selected sources.

RESULT AND DISCUSSION

Result

Search the Literature

During this phase, the researcher performed a literature search using the ERIC (Education Resources Information Center) publication search database, employing the search term "mathematics self-efficacy." Following the conducted search, a total of 2075 articles were retrieved, and their publication periods are detailed in Figure 2.

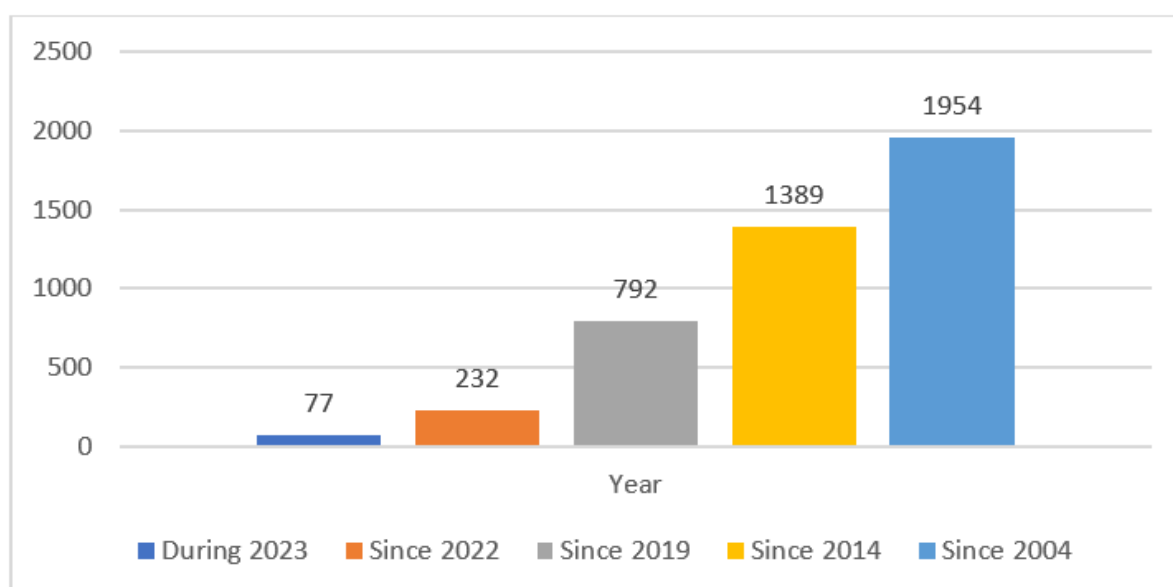


Figure 2. Distribution of Relevant Publications by Year

The data presented in Figure 2 indicates that there are 77 articles published in 2023 pertaining to mathematics self-efficacy. Furthermore, between 2022 and the present, a total of 232 articles have been published, and there have been 792 articles released since 2019. Over the past decade, from 2014 onwards, there have been 1389 articles published in the domain of mathematics self-efficacy. Moreover, within the last two decades, starting from 2004, a total of 1954 articles have been published on this subject.

Search for Inclusion

Following the literature search, and based on the data depicted in Figure 1, the researcher proceeded with a selection process aimed at identifying pertinent articles. During this phase, the researcher imposed restrictions by focusing on research studies that specifically addressed the subject of mathematics self-efficacy within the context of primary education. The outcomes of this selection process are consolidated in the data illustrated in Figure 3.

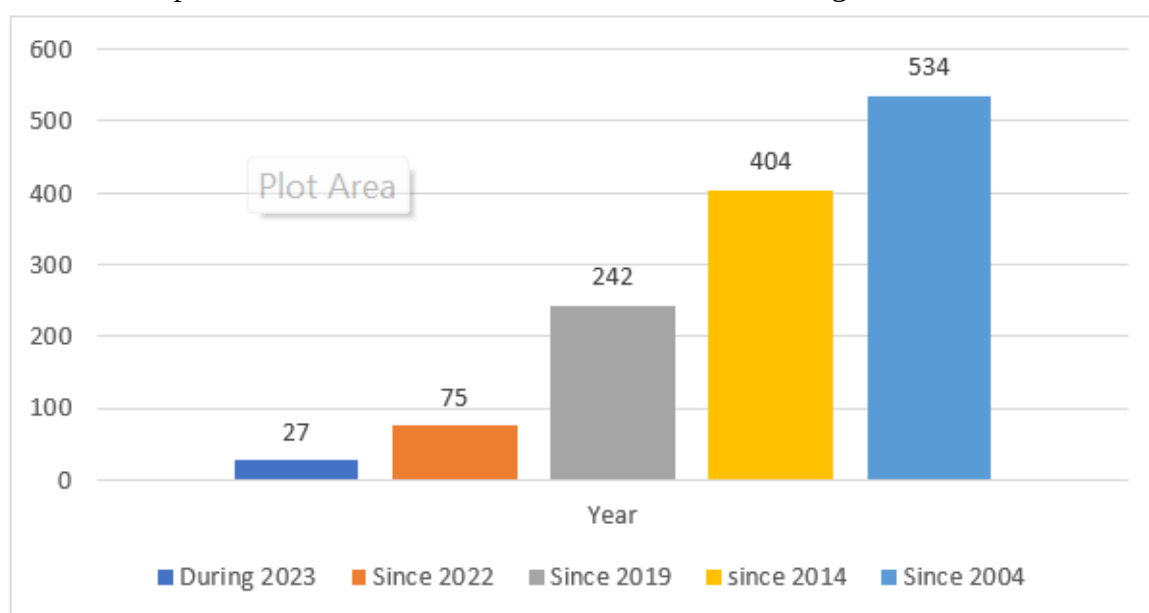


Figure 2. Distribution of Relevant Publications by Year after Inclusion

Analyzing the information presented in Figure 3, it becomes apparent that there are a total of 534 articles that have been published over the last two decades, starting from 2004. These articles are linked to mathematics self-efficacy and are centered on the primary education level. Moreover, in the past decade, 404 articles were identified that pertain to the keyword "mathematics self-efficacy" and focus on primary education. Subsequently, these articles will undergo a quality-based selection process to facilitate an in-depth analysis.

Asses Quality

In this phase, the researcher engaged in a meticulous selection process, with a particular focus on the quality of the previously sorted articles. The articles chosen for in-depth analysis adhere to the following specific criteria: 1) They were published in esteemed international journals, and 2) They exhibit relevance to the subject of mathematical self-efficacy. Consequently, following this rigorous selection process, the researcher identified a total of 10 articles that met the predefined quality standards. These 10 articles will serve as the basis for comprehensive scrutiny and investigation in the subsequent stages of this study.

Extract Data

In this phase, we have proceeded to extract data from the carefully selected articles earmarked for in-depth analysis. The outcomes of this data extraction process are meticulously documented in Table 1.

Table 1: The Interrelation between Articles and Behavioral Categories

Artikel	Behavioural Aspects					
	Belief	Choice of Activity	Goals	Effort	Persistence	Interest
Stevens et al. (2004)	x			x	X	x
Sheu et al. (2010)		x	x			x
Lau et al. (2018)	x			X	x	
Mozahem et al. (2021)				x	x	
Zakariya et al. (2022)				x	x	x
Du et al. (2021)				x		x
Mensah et al. (2023)		x		x		
Nuutila et al. (2020)	x					x
Zhang & Wang (2020)	x		x			
Doménech-Betoret et al. (2017)			x			

Table 1 presents the association between the chosen articles and the various behavioral categories. This table serves as a valuable resource for our comprehensive investigation into the relationship between mathematical self-efficacy and behavior, as outlined in the research objectives.

Discussion

Based on the findings extracted from various studies as mentioned, we would like to share several noteworthy conclusions within the categories of belief, activity choices, goals, effort, persistence, and interest. In a study by Stevens et al. (2004), which applied a path analysis approach to analyze the predictive properties of mathematics self-efficacy for ninth and tenth-grade students in Texas, it was demonstrated that self-efficacy acts as a mediator for ability (achievement), mathematics performance (effort in learning mathematics), interest, and choice of subjects (activities). These findings align with the research conducted by Sheu et al. (2010), which affirms a significant correlation between self-efficacy and interest, activity choices, and expected outcomes in the context of mathematics learning. Similarly, Lau et al. (2018) asserted that students' academic efficacy has a profound impact on three crucial aspects: academic achievement, resilience in facing challenges, and tenacity when encountering demanding situations. These findings are consistent with research by Mozahem et al. (2021), underscoring the pivotal role of mathematical self-efficacy in determining students' level of effort, persistence, and resilience when tackling various mathematical challenges and activities.

Furthermore, mathematical self-efficacy has been established to be intricately linked to student behaviors, particularly their effort and persistence when engaging with mathematics. The results from research conducted by Zakariya et al. (2022) unveiled a causal relationship between self-efficacy and students' learning approaches. High self-efficacy propels students to delve deeper into mathematics learning, whereas low self-efficacy restricts students to surface-level comprehension of concepts. This notion is substantiated by research from Du et al. (2021), affirming that mathematical self-efficacy significantly influences students' interest in mathematics. Students with high mathematical self-efficacy tend to exhibit strong interest in learning mathematics compared to those who grapple with mathematical anxiety. Additionally, the findings from research by Mensah et al. (2023) reinforce the link between self-efficacy and activity choices and academic effort.

Another noteworthy behavioral facet identified in this research underscores the connection between self-efficacy and students' enthusiasm for learning mathematics. As observed in a study by Nuutila et al. (2020), there exists a reciprocal relationship between self-efficacy, student performance in solving mathematical problems, and their interest in learning mathematics. These observations are further supported by research conducted by Zhang and Wang (2020), providing evidence of a positive relationship between interest in mathematics and mathematical achievement, with mathematical self-efficacy moderating this connection. Furthermore, self-efficacy plays a pivotal role in shaping an individual's goals for learning mathematics, as demonstrated by research conducted by Doménech-Betoret et al. (2017). Their findings suggest that expectancy-value beliefs, encompassing subject values, process expectations, achievement expectations, and cost expectations, are intertwined with academic self-efficacy and academic achievement. These results furnish empirical insights that enhance our understanding of the mechanisms that mediate the relationships between self-efficacy, achievement, and course satisfaction.

CONCLUSION

Based on the extensive research findings, it is evident that mathematical self-efficacy is intricately linked to several crucial behavioral dimensions, which include: 1) Self-Confidence: A strong belief in one's mathematical abilities exerts a profound influence on self-efficacy. Individuals who exhibit high confidence in their mathematical skills are more likely to surmount challenges in mathematics effectively; 2) Decision-Making in Problem-Solving: The ability to make judicious choices when confronted with mathematical problems holds significant importance. Selecting appropriate strategies or actions tailored to the specific situation contributes to an augmented sense of self-efficacy; 3) Goal Setting in Mathematics Learning: Establishing clear and specific objectives within the realm of mathematics learning serves as a focal point and a wellspring of motivation. Students with well-defined goals are more likely to experience a heightened sense of effectiveness in attaining their desired outcomes; 4) Perseverance: The degree of effort invested in learning mathematics carries substantial weight. The increased effort exerted tends to bolster self-efficacy, reflecting the interplay between persistence and efficacy; 5) Resilience: The capacity to persist and endure in the face of mathematical challenges embodies resilience. This quality maintains a positive correlation with self-efficacy, as resilience enhances an individual's self-confidence, particularly when tackling mathematical difficulties; 6) Interest in Learning Mathematics: The level of enthusiasm exhibited toward mathematics constitutes a pivotal factor in self-efficacy. A strong interest in mathematics enhances an individual's perception of efficacy in the learning process. These behavioral dimensions collectively contribute to the holistic understanding of how mathematical self-efficacy functions in education. By acknowledging and fostering these dimensions, educators can effectively nurture students' mathematical self-efficacy, ultimately facilitating their success in the subject.

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