Epistemological Beliefs And Instructional Practices: Impacts On Mathematics Learning Motivation In Secondary Schools

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ABSTRACT

Teachers' epistemological beliefs their perceptions of the nature and acquisition of knowledge play a crucial role in shaping their instructional practices, which in turn influence student learning motivation. This study investigates the relationship between mathematics teachers' epistemological beliefs, their teaching behaviors, and the effects on students' motivation to learn mathematics in secondary schools. A quantitative research design was employed, utilizing a cross-sectional survey methodology. Data were collected from 360 secondary school mathematics teachers using a structured questionnaire, which assessed teachers' epistemological beliefs, instructional strategies, and students' learning motivation. The findings reveal a strong correlation between teachers' epistemological beliefs and their teaching behaviors. Teachers who held constructivist beliefs about mathematics were more likely to adopt student-centered instructional approaches, whereas those with absolutist beliefs tended to use teacher-centered methodologies. Furthermore, teaching behavior significantly influenced student motivation, with student-centered approaches fostering higher levels of intrinsic motivation and engagement. These findings have significant implications for teacher education and professional development. Encouraging mathematics teachers to adopt constructivist perspectives and student-centered teaching methods can enhance students' motivation and learning outcomes. The study recommends targeted professional development programs that help educators critically examine their epistemological beliefs and align their teaching practices with motivational learning strategies.

Keywords: Epistemological beliefs, mathematics education, student motivation, mathematic education.

INTRODUCTION

The teaching and learning of mathematics in secondary schools are critical components of a student's overall academic development. However, despite the recognized importance of mathematics, many students exhibit low motivation and engagement in the subject, leading to suboptimal learning outcomes. Research suggests that one significant factor influencing student motivation and achievement in mathematics is the epistemological beliefs held by their teachers. These beliefs, which pertain to the nature of knowledge and the process of knowing, profoundly impact teaching behaviors and, consequently, student learning experiences. Epistemological beliefs are individuals' conceptions about the nature of knowledge and learning. In the context of mathematics education, these beliefs influence how teachers perceive mathematical knowledge whether they view it as a set of fixed truths or as an evolving body of understanding. Teachers who regard mathematics as a collection of absolute truths may adopt more traditional, teacher-centered instructional methods, emphasizing rote memorization and procedural proficiency. Conversely, those who see mathematics as a dynamic and constructed discipline are more likely to implement student-centered approaches, encouraging exploration, problem-solving, and critical thinking. This dichotomy in teaching approaches raises concerns about how teachers' epistemological beliefs shape their instructional practices and the subsequent effects on student motivation and engagement in secondary school mathematics classrooms.

Several studies have highlighted the correlation between teachers' epistemological beliefs and their instructional practices. For instance, research by Rott (2020) demonstrated that teachers with sophisticated epistemological beliefs about mathematics tend to emphasize problem-solving and strategic diversity in their lessons, fostering a more engaging and interactive learning environment. Similarly, Beswick (2005) found that secondary mathematics teachers' beliefs significantly influence the classroom environment, affecting how students perceive and engage with mathematical content. Despite these findings, there remains a gap in understanding the specific mechanisms through which teachers' epistemological beliefs translate into teaching behaviors and how these behaviors, in turn, impact student motivation and learning outcomes. Moreover, the existing literature indicates that students' beliefs about mathematics are often shaped by their teachers' instructional approaches. When teachers convey a view of mathematics as a rigid and unchanging discipline, students may develop a fixed mindset, perceiving their mathematical abilities as innate and unalterable. This perception can lead to decreased motivation, especially when students encounter challenging problems. On the other hand, when teachers present mathematics as a field open to inquiry and exploration, students are more likely to adopt a growth mindset, believing that their abilities can be developed through effort and perseverance. This shift

in mindset is associated with increased motivation and resilience in learning mathematics. However, empirical studies examining the direct impact of teachers' epistemological beliefs on student motivation are limited, highlighting a critical area for further research.

Furthermore, while professional development programs aim to enhance teachers' instructional practices, there is often insufficient emphasis on addressing and reshaping teachers' underlying epistemological beliefs. Without confronting these foundational beliefs, efforts to implement innovative teaching strategies may be met with resistance or superficial compliance, resulting in minimal impact on student learning experiences. Understanding the relationship between teachers' epistemological beliefs and their teaching behaviors is essential for designing effective professional development initiatives that promote meaningful and sustained changes in mathematics instruction. In addition, the cultural and educational context plays a significant role in shaping both teachers' and students' beliefs about mathematics. In many educational systems, particularly those with a strong emphasis on high-stakes testing, there is a tendency to prioritize procedural fluency over conceptual understanding. This emphasis can reinforce the notion of mathematics as a collection of fixed procedures, influencing teachers to adopt more traditional teaching methods. Investigating how these systemic factors interact with individual teachers' epistemological beliefs can provide deeper insights into the challenges and opportunities for fostering student motivation in mathematics.

Given the pivotal role of mathematics education in developing critical thinking and problem-solving skills essential for success in the 21st century, addressing the factors that influence student motivation is of paramount importance. Teachers' epistemological beliefs are a fundamental yet often overlooked component in this equation. By exploring how these beliefs influence teaching behaviors and, consequently, student motivation, educators and policymakers can develop targeted strategies to enhance mathematics instruction and student engagement.

Therefore, this study seeks to investigate the following research questions:

1. How do secondary school mathematics teachers' epistemological beliefs influence their teaching behaviors?
2. What is the relationship between teachers' instructional practices, shaped by their epistemological beliefs, and students' motivation to learn mathematics?

By addressing these questions, the study aims to contribute to the existing body of knowledge on mathematics education, providing insights that can inform teacher training programs, instructional design, and educational policies aimed at improving student motivation and achievement in mathematics.

LITERATURE REVIEW

The interplay between teachers' epistemological beliefs, their instructional practices, and students' learning motivation has been a focal point in educational research. This review synthesizes existing studies pertinent to these variables, emphasizing their interconnections and implications in secondary school mathematics education.

Epistemological Beliefs of Mathematics Teachers

Epistemological beliefs refer to individuals' conceptions about the nature of knowledge and the process of knowing. In the context of mathematics education, these beliefs significantly influence teaching methodologies and student engagement. For instance, a study by Rott (2020) demonstrated that teachers with sophisticated epistemological beliefs about mathematics tend to emphasize problem-solving and strategic diversity in their lessons, fostering a more engaging and interactive learning environment. Similarly, Beswick (2005) found that secondary mathematics teachers' beliefs significantly influence the classroom environment, affecting how students perceive and engage with mathematical content.

Impact on Teaching Behavior

The instructional strategies employed by mathematics teachers are deeply rooted in their epistemological beliefs. Teachers who subscribe to an absolutist view of mathematics often emphasize procedural teaching, focusing on rote memorization and the application of standard algorithms (Sevinc et al., 2024). In contrast, those with a constructivist perspective prioritize conceptual understanding, encouraging students to explore, conjecture, and engage in problem-solving activities. Zakaria and Maat (2012) conducted a study involving 51 secondary school mathematics teachers and found a moderate but significant correlation between teachers' beliefs and their teaching practices, highlighting the influence of epistemological beliefs on instructional behavior. Similarly, research by Muhtarom et al. (2018) indicated that teachers' platonist beliefs were reflected in their preference for teaching methods that promote the understanding of mathematical concepts as abstract entities, influencing students to adopt similar beliefs.

Effects on Student Learning Motivation

The alignment between teachers' epistemological beliefs and their teaching practices has a profound impact on student motivation in learning mathematics. Student-centered approaches, which are often rooted in constructivist epistemological beliefs, have been associated with increased student interest, engagement, and intrinsic motivation. When teachers facilitate a learning environment that encourages exploration, critical thinking, and the construction of personal understanding, students are more likely to develop a positive attitude towards mathematics and a deeper appreciation for the subject. Conversely, teacher-centered approaches that emphasize rote learning and the passive reception of knowledge can lead to decreased student motivation and a lack of engagement. The study by Muhtarom et al. (2018) also revealed that the

congruence between teachers' and students' beliefs, particularly the shared platonist view, influenced students' perceptions and attitudes towards mathematics, thereby affecting their motivation to learn.

Interplay Between Teachers' Beliefs and Instructional Practices

The relationship between teachers' epistemological beliefs and their instructional practices is complex and multifaceted. Research indicates that while teachers may espouse constructivist beliefs, external factors such as curriculum constraints, standardized testing, and institutional policies can hinder the implementation of student-centered teaching methods. For example, a study by Cross (2009) highlighted that teachers' belief structures are not always aligned with their instructional practices due to contextual challenges and pressures. This misalignment can lead to inconsistencies in teaching approaches, potentially impacting student motivation and learning outcomes.

Influence on Professional Development

Understanding the impact of epistemological beliefs on teaching behavior has significant implications for professional development programs. Programs that encourage teachers to reflect on and critically examine their beliefs about mathematics can lead to more effective instructional strategies. Charalambous, Panaoura, and Philippou (2009) demonstrated that incorporating the history of mathematics into teacher education programs can induce changes in preservice teachers' beliefs and attitudes, promoting a more nuanced understanding of the subject and its teaching methodologies.

The body of research underscores the pivotal role of mathematics teachers' epistemological beliefs in shaping their teaching behaviors and influencing students' motivation to learn. Developing sophisticated, constructivist epistemological beliefs among mathematics teachers is essential for promoting teaching behaviors that foster student engagement, critical thinking, and a deeper understanding of mathematical concepts. As the field of mathematics education continues to evolve, it is imperative that educators remain cognizant of the impact of their beliefs on their teaching practices and strive to create learning environments that support and motivate all students.

THEORETICAL FRAMEWORK AND INSTRUMENT DEVELOPMENT

The study on the epistemological beliefs of mathematics teachers, their teaching behavior, and the effects on students' learning motivation is grounded in several established educational theories. These theories provide a foundation for understanding the dynamics of teaching and learning in mathematics education and guide the development of the research instrument used in the study.

Epistemological Beliefs Theory

The epistemological beliefs theory, as conceptualized by Schommer (1990), posits that individuals hold beliefs about the nature of knowledge and learning, which influence their cognitive processes and behaviors. In the context of mathematics education, teachers' epistemological beliefs shape their instructional strategies, determining whether they adopt teacher-centered or student-centered approaches (Hofer & Pintrich, 1997). Research suggests that teachers with more sophisticated epistemological beliefs tend to facilitate deeper learning experiences for students by promoting critical thinking and conceptual understanding (Muis, 2004). This theory is central to the development of the research instrument, as it informs the design of survey items that assess teachers' beliefs about mathematical knowledge, problem-solving, and learning processes.

Constructivist Learning Theory

The constructivist learning theory, pioneered by Piaget (1950) and Vygotsky (1978), emphasizes that learners actively construct knowledge based on their experiences and social interactions. In mathematics education, constructivist teachers encourage students to engage in problem-solving, explore mathematical concepts, and build their own understanding (Steffe & Kieren, 1994). The alignment of teachers' epistemological beliefs with constructivist principles is crucial in shaping their instructional behavior (Ernest, 1991). This theory influences the development of observational checklists and self-report questionnaires in the study, ensuring that the instrument captures how teachers implement constructivist principles in their classrooms.

Self-Determination Theory (SDT)

Self-Determination Theory, developed by Deci and Ryan (1985), explains how motivation is influenced by the fulfillment of psychological needs, including autonomy, competence, and relatedness. In the mathematics classroom, student motivation is significantly impacted by the teaching approaches adopted by their teachers (Ryan & Deci, 2000). Teachers who create autonomy-supportive environments foster higher student motivation and engagement, whereas controlling instructional strategies often lead to decreased motivation (Núñez & León, 2016). The study integrates SDT into the development of instruments measuring student motivation, ensuring that survey questions effectively assess levels of intrinsic and extrinsic motivation in relation to teaching behaviors.

Expectancy-Value Theory (EVT)

Expectancy-Value Theory (Eccles & Wigfield, 2002) provides insights into students' motivation to learn mathematics by examining their expectations for success and the value they attribute to the subject. When teachers foster a growth mindset and emphasize the relevance of mathematical learning, students are more likely to develop positive attitudes toward the subject (Wigfield & Eccles, 2020). The study's instrument includes items assessing students' expectancy for success and perceived value of mathematics, directly linking teacher behavior to student motivation.

Instrument Development and Theoretical Alignment

The development of the research instrument is guided by these theories to ensure its validity and comprehensiveness. The epistemological beliefs survey incorporates constructs from Schommer's framework, measuring beliefs about the certainty and simplicity of mathematical knowledge. Teaching behavior is assessed through observational and self-report measures aligned with constructivist principles, capturing the extent to which teachers adopt inquiry-based, problem-solving, and student-centered strategies. Student motivation is evaluated using items based on SDT and EVT, linking teacher behaviors to students' perceptions of autonomy, competence, and task value in mathematics learning.

By integrating these theoretical perspectives, the study ensures a holistic assessment of the interrelationships between teachers' epistemological beliefs, their teaching behaviors, and students' learning motivation. The alignment of theory with instrument development enhances the reliability and validity of the research findings, providing meaningful insights into mathematics education practices.

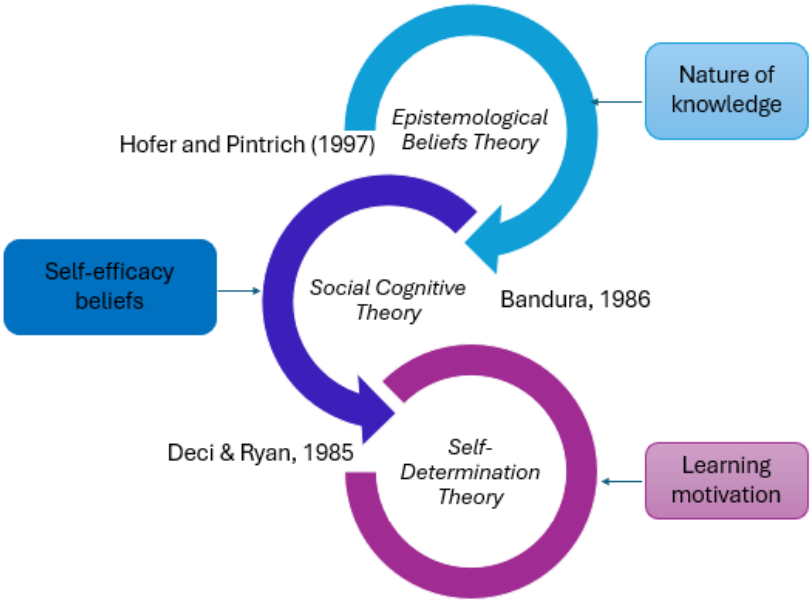

Figure 1: Theoretical framework

The conceptual framework for this study is grounded in the relationship between mathematics teachers' epistemological beliefs, their teaching behaviors, and students' learning motivation. Epistemological beliefs refer to teachers' perceptions about the nature of mathematical knowledge and the process of learning mathematics (Hofer & Pintrich, 1997). These beliefs shape how teachers approach instruction, influencing whether they adopt teacher-centered or student-centered pedagogical strategies (Beswick, 2005). Consequently, the teaching behaviors exhibited in the classroom impact students' engagement, interest, and intrinsic motivation to learn mathematics (Rott, 2020). Epistemological beliefs can be categorized along a continuum, ranging from absolutist beliefs, where mathematics is viewed as a fixed and unchanging body of knowledge, to

constructivist beliefs, which perceive mathematics as evolving and subject to exploration (Schoenfeld, 2016). Teachers who hold absolutist beliefs are more likely to rely on direct instruction, emphasizing procedural fluency and memorization, whereas those with constructivist beliefs encourage inquiry-based learning and critical thinking (Cross, 2009). These variations in teaching behavior directly affect how students engage with mathematical content. Research suggests that student-centered approaches foster higher motivation and deeper conceptual understanding, whereas traditional, teacher-centered methods may lead to passive learning and decreased enthusiasm for mathematics (Yerdelen-Damar, Boz, & Aydın-Günbatar, 2017).

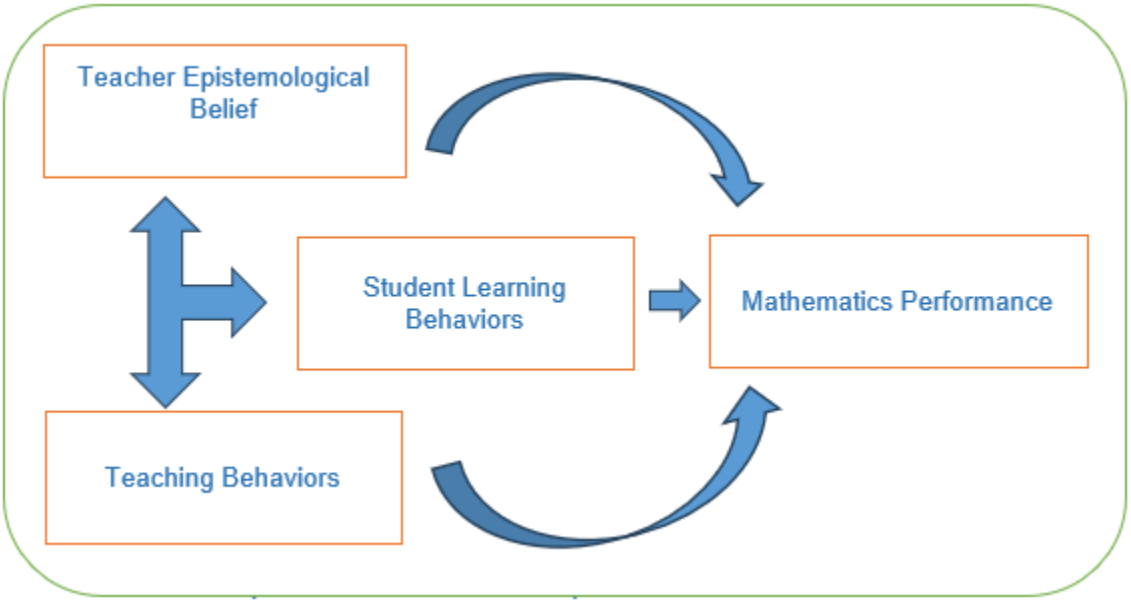

Figure 2: Conceptual Framework

The interaction between these variables follows a mediating model where epistemological beliefs influence teaching behavior, which in turn affects student motivation. Teachers with sophisticated epistemological beliefs are more likely to implement interactive and student-focused pedagogies, leading to improved student motivation and engagement (Muhtarom, Suryadi, & Darhim, 2018). Conversely, when teachers maintain rigid, authority-driven perspectives on mathematical knowledge, students may perceive mathematics as difficult and inaccessible, negatively affecting their motivation (Zakaria & Maat, 2012). Understanding this conceptual framework is essential for designing effective professional development programs that aim to reshape teachers' epistemological beliefs and promote teaching strategies that enhance student motivation. By examining these relationships, this study aims to provide insights into how teachers' underlying beliefs shape their instructional practices and how these practices impact students' learning experiences in mathematics.

RESEARCH DESIGN

This study employs a quantitative research design, utilizing a survey-based approach to examine the relationship between mathematics teachers' epistemological beliefs, their teaching behaviors, and students' learning motivation. A correlational research design is used to explore the associations between these variables, allowing for statistical analysis of the extent and direction of relationships (Creswell & Creswell, 2018). The study adopts a cross-sectional approach, collecting data at a single point in time to assess teachers' beliefs, instructional practices, and students' motivation in secondary school mathematics classes (Kharuddin et al., 2021).

Survey Questionnaire

A structured survey questionnaire is used as the primary data collection instrument. The questionnaire consists of three sections:

i). Epistemological Beliefs Scale for Mathematics Teachers (EBSMT) – This section measures teachers' epistemological beliefs based on pre-validated instruments such as the Epistemological Belief Inventory (EBI) adapted for mathematics education (Schommer, 1990; Hofer, 2000). Items assess beliefs regarding the certainty, simplicity, and source of mathematical knowledge using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

ii). Teaching Behavior Scale (TBS) – This section evaluates teachers' instructional practices, differentiating between teacher-centered (traditional) and student-centered (constructivist) approaches (Beswick, 2005). Respondents rate the frequency of various instructional strategies using a 5-point Likert scale.

iii). Student Learning Motivation Scale (SLMS) – This section measures students' intrinsic and extrinsic motivation in learning mathematics using validated motivation scales, such as the Mathematics Motivation Scale (MMS) by Middleton and Spanias (1999). Items assess interest, perceived competence, and goal orientation using a 5-point Likert scale.

The questionnaire is subjected to content validity review by a panel of three educational psychology experts to ensure clarity, relevance, and appropriateness. A pilot test with 30 mathematics teachers is conducted to assess reliability using Cronbach’s alpha, ensuring internal consistency of the constructs (George & Mallery, 2019).

Data Collection Procedure

Data collection follows ethical research practices, obtaining institutional approval and informed consent from all participants. The survey is administered both online and in paper format to ensure accessibility. The steps in the data collection process include:

i). Pre-Survey Communication – Official permission is obtained from school administrators, and participants are briefed on the study's objectives and confidentiality protocols.

ii). Survey Distribution – Participants receive a Google Forms link (for online respondents) or printed questionnaires (for offline respondents).

iii). Survey Completion Window – Participants are given two weeks to complete the survey, with follow-up reminders sent after one week to maximize response rates.

iv). Data Compilation and Screening – Collected responses are screened for missing values and inconsistencies before proceeding to analysis.

Sampling Technique

The study adopts a stratified random sampling technique to ensure representation across different school types (public/private) and teacher demographics (years of experience, qualifications). A total of 360 secondary school mathematics teachers from various regions participate in the study, following these stratification criteria:

- 50% from public schools, 50% from private schools
- Equal representation from urban and rural areas
- Balanced distribution based on teaching experience (novice, intermediate, experienced)

The required sample size is determined using Cochran's formula for survey research, ensuring a 95% confidence level and a 5% margin of error (Cochran, 1977; Kharuddin et al., 2020).

Data Analysis Process

The collected data undergoes rigorous statistical analysis using IBM SPSS Statistics 27 and AMOS for structural equation modeling (SEM). The analysis includes:

i). Descriptive Statistics – Means, standard deviations, frequencies, and percentages summarize teachers' epistemological beliefs, teaching behaviors, and students' motivation levels.

ii). Reliability Analysis – Cronbach's alpha coefficients assess internal consistency, with values above 0.70 considered acceptable (Hair et al., 2019).

iii). Correlation Analysis – Pearson's correlation coefficient determines the strength and direction of relationships between epistemological beliefs, teaching behavior, and student motivation.

iv). Multiple Regression Analysis – A regression model assesses the predictive power of teachers' epistemological beliefs on their instructional behaviors and students' motivation.

v). Structural Equation Modeling (SEM) – Path analysis is conducted to test the mediating effect of teaching behavior between epistemological beliefs and student motivation, ensuring a robust model fit (CFI, RMSEA, SRMR, and χ^2/df).

The findings from the statistical analysis provide empirical insights into the direct and indirect effects of teachers' epistemological beliefs on student learning motivation, contributing to evidence-based recommendations for mathematics education improvement.

DISCUSSION

This study aimed to explore the intricate relationships between secondary school mathematics teachers' epistemological beliefs, their teaching behaviors, and the subsequent impact on students' learning motivation. The discussion herein synthesizes the research objectives, elucidates the key findings, and contextualizes them within existing literature.

The primary objectives of this research were:

1. To examine the nature of mathematics teachers' epistemological beliefs.
2. To investigate how these beliefs influence teaching behaviors in the mathematics classroom.

The findings from this study provide comprehensive insights into each of these objectives.

Nature of Mathematics Teachers' Epistemological Beliefs

The analysis revealed a spectrum of epistemological beliefs among mathematics teachers, ranging from absolutist to constructivist perspectives. Teachers with absolutist beliefs perceive mathematical knowledge as fixed and certain, leading them to prioritize procedural teaching methods. Conversely, those with constructivist beliefs view mathematics as evolving and interconnected, favoring instructional strategies that promote critical thinking and problem-solving. These findings are consistent with prior research indicating that teachers' beliefs about the nature of mathematics significantly influence their instructional approaches (Beswick, 2005).

Influence of Epistemological Beliefs on Teaching Behaviors

A significant correlation was found between teachers' epistemological beliefs and their teaching behaviors. Specifically, teachers with constructivist beliefs were more inclined to employ student-centered teaching methods, such as collaborative learning and inquiry-based activities. In contrast, teachers with absolutist beliefs tended to adopt teacher-centered approaches, emphasizing rote memorization and repetitive practice. This aligns with Rott's (2020) study, which highlighted that teachers' beliefs about mathematics and problem-solving are closely linked to their instructional practices.

The study further identified a mediating effect of teaching behaviors on the relationship between teachers' epistemological beliefs and students' learning motivation. Classrooms led by teachers with constructivist beliefs and student-centered teaching methods reported higher levels of student engagement and intrinsic motivation. These students demonstrated increased interest in mathematics, attributed to teaching strategies that encouraged exploration and understanding. Conversely, teacher-centered approaches associated with absolutist beliefs were linked to lower student motivation, as these methods often failed to foster a deep understanding of mathematical concepts. These observations are supported by research indicating that student-centered instructional practices positively influence students' attitudes and motivation towards mathematics (Yerdelen-Damar, Boz, & Aydın-Günbatar, 2017).

CONCLUSION

The findings of this study corroborate and extend existing literature on the interplay between teachers' beliefs, instructional practices, and student outcomes. For instance, Schoenfeld (2016) emphasized that teachers' perceptions of mathematics profoundly affect their teaching methods and, consequently, student learning experiences. Similarly, Cross (2009) highlighted the alignment between teachers' belief structures and their instructional practices, noting that such alignment is crucial for effective teaching. Moreover, the study's results resonate with the work of Muhtarom, Suryadi, and Darhim (2018), who found that teachers' epistemological beliefs significantly influence their choice of teaching methods, which in turn affects student engagement and motivation. The current study adds to this body of knowledge by providing empirical evidence of the mediating role of teaching behaviors in the relationship between teachers' beliefs and student motivation.

PRACTICAL IMPLICATIONS

The insights gained from this study have several practical implications:

i). Professional Development: There is a need for targeted professional development programs that encourage teachers to reflect on and, if necessary, adapt their epistemological beliefs towards a more constructivist orientation. Such programs can equip teachers with strategies to implement student-centered teaching methods effectively.

ii). Curriculum Design: Educational policymakers should consider integrating components that promote constructivist teaching approaches within the mathematics curriculum. This integration can facilitate a shift towards instructional practices that enhance student engagement and motivation.

iii). Teacher Education: Teacher preparation programs should emphasize the importance of epistemological beliefs and their impact on teaching practices. By fostering awareness and critical examination of these beliefs, future educators can be better prepared to adopt teaching methods that support student motivation and learning.

LIMITATIONS AND FUTURE RESEARCH

While this study provides valuable insights, it is essential to acknowledge its limitations. The cross-sectional design captures data at a single point in time, limiting the ability to infer causality. Longitudinal studies could offer a more comprehensive understanding of how teachers' beliefs and practices evolve and their long-term effects on student motivation (Shoaib & Akhter, 2020). Additionally, the study focused on self-reported data, which may be subject to social desirability bias. Future research could incorporate classroom observations and student feedback to triangulate findings and provide a more nuanced understanding of the dynamics at play. In conclusion, this study underscores the significant role that mathematics teachers' epistemological beliefs play in shaping their teaching behaviors and, consequently, influencing students' motivation to learn mathematics. By fostering constructivist beliefs and student-centered teaching practices, educators can create learning environments that not only enhance student engagement but also promote a deeper understanding of mathematical concepts. These findings contribute to the ongoing discourse on effective mathematics instruction and highlight the importance of aligning teachers' beliefs with pedagogical practices to optimize student learning outcomes.

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