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RESEARCH ARTICLE

Analyzing mathematics teachers' proactive behaviors in teaching mathematics among non-math interested learners

Adelyn L. Tonalete[1*], Donabelle D. Mongao[2], Magna Anissa A. Hayudini[3], Sharifa M. Jalaidi[4], Rumida J. Muktar[4]

[1] *School of Engineering, Biliran Province State University, Naval, Biliran 6560, Philippines*

[2] *College of Education, Iloilo State University of Fisheries Science and Technology Dumangas Campus, Dumangas 5006, Philippines*

[3] *College of Health Sciences, Mindanao State University-Sulu, Jolo, Sulu 7400, Philippines*

[4] *College of Education, Mindanao State University-Sulu, Jolo, Sulu 7400, Philippines*

*** Corresponding author:** Adelyn L. Tonalete, adelyn.tonalete@bipsu.edu.ph

ABSTRACT

Proactive behaviors in teachers embody a forward-thinking approach essential for addressing the challenges inherent in the teaching profession. Proactive teachers are committed to continuous professional growth, willingly adapting their instructional methods to meet the evolving needs of their students and the demands of modern education. This exploratory study analyzed the experiences of mathematics teachers in managing their classrooms, especially those students with minimal interest in mathematics. Mathematics teachers (n=16) were purposively sampled through online preliminary data gathering. Narratives from interview were gathered and reflexively analyzed to identify key themes and codes. The findings indicated that teaching mathematics to learners who are not naturally inclined toward the subject presented distinct challenges, including mathematics anxiety and disinterest. Mathematics anxiety, often rooted in negative past experiences, manifested as a fear of failure and a reluctance to engage with mathematical tasks also exacerbated by the potential stigma of making mistakes, created a paralyzing barrier to learning. To mitigate this, teachers adapted their strategies to enhance engagement and alleviate learners' anxiety, employing socio-emotional responsiveness, personalized learning, practical application, and collaboration. These strategies reflect key dimensions of proactive behavior: anticipation, change orientation, and barrier prevention. They created supportive environments by celebrating effort, avoiding pressure for perfection, and demonstrating patience. Personalized learning catered to varying student proficiency levels, incorporating visual aids, technology, and real-world contexts to bridge understanding gaps. Project-based learning connected math to students' interests and everyday lives while collaboration developed a team-oriented environment. These strategies involved anticipating challenges, predicting outcomes, and adapting interactions based on students' learning preferences and feelings towards the subject. Having a supportive and adaptable learning environment, teachers can prevent negative behaviors and promote a positive attitude towards mathematics, which encourage student engagement and commitment. This study contributes to a deeper understanding of how proactive behaviors can be intentionally cultivated to create more engaging and supportive mathematics learning environments.

Keywords: classroom management; learning engagement; math anxiety; proactive behavior

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1. Introduction

Educational environments across different systems are influenced by multiple factors that require careful consideration [1]. The role of teachers is particularly significant in this context, as their instructional approaches significantly impact student outcomes. Traditional teaching methods in mathematics education, which often emphasize lower-order cognitive skills and neglect connections to students' everyday experiences, have been identified as major barriers to student achievement and contribute to negative attitudes towards the subject[2-4]. This is particularly problematic among learners with low intrinsic interest in mathematics, for whom disengagement can perpetuate cycles of underachievement.

Poor performance in international mathematics assessments is intrinsically associated with deficiencies in teaching practices, particularly manifesting as educators' constrained understanding of both the mathematical content and the appropriate pedagogical strategies necessary for effective instruction[2]. Al-Shammari and Al-Arini[5] further emphasize the critical role of teachers in educational reforms, highlighting that effective instructional practices account for up to 60% of the success of such initiatives. Thus, teachers' limited knowledge and subpar teaching methodologies are directly correlated with poor student outcomes and the overall success of educational reforms.

Addressing such challenges requires more than the application of well-established "best practices." This study applies the concept of proactive behavior to the teaching of mathematics, defined here as self-initiated, future-oriented, and change-focused actions aimed at anticipating and addressing potential barriers before they arise[6,7]. A proactive personality reflects an individual's tendency to actively initiate various actions and responses aimed at meeting high and quickly changing needs and delivering quality outcomes[8]. It is also associated with a sense of personal responsibility for driving constructive change and the extent to which a person feels accountable for their performance[9]. In organizational behavior literature, proactive individuals are characterized by their ability to foresee emerging issues, initiate constructive change, and take ownership of outcomes. Translating this to the educational context, a proactive teacher is not only responsive to existing classroom needs but also anticipates possible student challenges, whether motivational, cognitive, or emotional, and deliberately adapts instruction to prevent these from hindering learning.

This framing distinguishes proactive teaching from generic effective teaching. While both may employ strategies such as personalized instruction or collaborative learning, a proactive approach involves intentional foresight (e.g., predicting when math anxiety may spike and preemptively structuring supportive activities), change initiation (e.g., altering lesson formats before disengagement sets in), and barrier prevention (e.g., embedding relevance to counteract anticipated perceptions of irrelevance). The degree of proactivity can be assessed by the frequency with which teachers implement anticipatory strategies, the extent to which they modify their teaching in response to predicted challenges based on student feedback and performance data, and the breadth of barriers they proactively address.

The existing literature has extensively examined the impact of various teaching behaviors on educational effectiveness across different contexts. For instance, McArthur[10] focused on the influence of online teaching nonverbal cues on teaching effectiveness. Al Rawahi and Yousef[11] investigated the teaching behaviors of physical education teachers, analyzing the impact of initial classroom organization, instructional content delivery, practice supervision, question–answer discussions, and closing routines. In the context of language teaching, Hoi[12] stressed the need to combine audible language with behavioral language to enhance knowledge transmission. Teachers should adapt their methods, create a conducive classroom environment, and engage actively in communication to improve teaching effectiveness[13]. Ayçiçek and Yanpar Yelken[14] demonstrated the positive impact of the flipped classroom model on language learning.

Although proactive behavior has been widely examined in organizational and entrepreneurial settings[15-19], its application in education, particularly mathematics teaching, remains underexplored. The typical traits of proactive individuals, such as the ability to identify problems, seek out new opportunities, and persist until change is achieved, are essential for teachers to assimilate problems and employ problem-solving skills effectively. By applying a proactive behavior lens, this study moves beyond simply identifying effective teaching strategies. It examines the intentionality and future-oriented thinking that drive teachers to implement these strategies before problems arise, offering a more nuanced understanding of teacher agency and innovation in mathematics education. While existing frameworks often focus on what teachers do (e.g., implement collaborative activities), this study delves into why they do it, revealing the underlying proactive mindset that shapes their actions. This is particularly crucial in mathematics, where deeply ingrained anxieties and negative attitudes can significantly impede learning, requiring teachers to go beyond conventional approaches to create truly engaging and supportive learning environments.

This theoretical grounding sets the stage for the study's two focal aims: identifying the key challenges teachers encounter with disinterested mathematics learners and analyzing how their reported strategies reflect the dimensions of proactive behavior, namely, anticipation, change orientation, and barrier prevention. Ultimately, this study seeks to contribute to a more nuanced understanding of effective mathematics teaching by illuminating the proactive behaviors that distinguish truly innovative and impactful educators.

2. Literature review

Proactive behavior, first conceptualized by Bateman and Crant[6], is defined as self-initiated, future-oriented action intended to anticipate and address potential challenges before they arise. Parker and Collins[7] expanded this framework by identifying three core dimensions: anticipation (recognizing problems and opportunities before they occur), change orientation (initiating improvements without waiting for external prompts), and barrier prevention (taking steps to prevent anticipated problems from materializing). These dimensions can be observed through specific teacher actions, such as the documented frequency of pre-emptive lesson adjustments, the detailed planning of interventions before predictable student struggles, and the consistent application of strategies designed to foster a positive learning environment.

Grant and Ashford[15] emphasized the role of personal initiative in sustaining these behaviors, while Verzat et al.[16] described the persistence and adaptability needed to navigate dynamic environments. Dung[17], Gultom et al.[18], and Trifiletti et al[19] have demonstrated that proactive individuals often seek out opportunities, initiate change, and persist in overcoming challenges, even in uncertain contexts. In organizational psychology, such behaviors are shaped by both individual dispositions and contextual factors, including ethical climates and leadership practices[20].

While proactive behavior research is well established in organizational settings, its application to education is relatively new. Related constructs such as teacher agency and anticipatory classroom management overlap significantly with proactive behavior. Teacher agency refers to educators' capacity to act purposefully and constructively to shape their work and its conditions[21,22]. Wilcox and Lawson[23] note that school systems characterized by distributed leadership, shared decision-making, and professional discretion tend to foster accountable autonomy, enabling teachers to take proactive action in implementing systems-changing innovations. However, while teacher agency focuses on the capacity to act, proactive behavior theory emphasizes the intentionality and future-oriented thinking that drive those actions. It provides a framework for understanding why teachers choose to act proactively in specific situations.

In the realm of classroom management, Škodová[24] illustrates proactive awareness through the concept of withitness, a teacher's constant awareness of classroom activities and readiness to intervene before off-task behavior escalates. This aligns closely with the anticipation dimension of proactive behavior. Similarly, McArthur[10] demonstrates how non-verbal cues in online teaching can anticipate and reduce learner disengagement, while Al Rawahi and Yousef[11] highlight the role of structured classroom organization in preventing discipline problems before they occur.

In mathematics education, proactive behavior often involves preemptively addressing conceptual and motivational challenges. Awaji et al.[2], Wakhata et al.[3], and Yin et al.[4] emphasize that disengagement and poor performance are often linked to traditional, procedure-heavy instruction that fails to connect with students' experiences. Ozen[25] provides evidence that conceptual understanding influences procedural fluency, suggesting that proactive teaching in math may involve ensuring conceptual mastery early to prevent downstream performance issues.

Examples of change-oriented mathematics instruction include designing collaborative activities that build peer support networks before students lose confidence anticipating that students who struggle with a new concept may become discouraged and withdraw from class participation, or embedding real-world applications at the start of units to counteract perceptions of irrelevance based on prior experience with students questioning the practical value of abstract mathematical concepts. Barrier prevention strategies might involve anticipating points of likely confusion and using pre-planned analogies or scaffolding.

Studies in other subject areas reinforce this proactive framing. Hoi[12] stressed the importance of combining audible and behavioral language in instruction, while Cheng et al.[13] highlighted the role of active teacher–student communication in building supportive learning environments. Ayçiçek and Yanpar Yelken[14] showed that flipped classrooms can proactively engage learners by exposing them to content ahead of class sessions.

The literature indicates that while proactive behavior theory originates in organizational psychology, its principles are highly applicable to teaching. This study adapts the three dimensions of proactive behavior, anticipation, change orientation, and barrier prevention, as a framework for analyzing how mathematics teachers engage students who are not naturally inclined toward the subject. By synthesizing insights from both organizational and education-specific studies[20,23-25], the present research addresses a critical gap in understanding how proactive strategies manifest in mathematics instruction and how they can be intentionally cultivated.

3. Objectives

This paper analyzed teachers' challenges and instructional approach in teaching mathematics to students. This paper identified different instructional practices that showed teachers' proactive behaviors in adapting to academic challenges they encounter. Below are the specific research objectives established in this study.

(a) Determine challenges in teaching mathematics among non-math enthusiast learners.

(b) Determine behavioral adaptation of teachers in teaching math among non-math enthusiast learners.

To clarify, objective (a) focuses on identifying the specific difficulties teachers encounter, while objective (b) analyzes the nature of their responses to these difficulties through the lens of proactive behavior (anticipation, change orientation, barrier prevention).

4. Methods

4.1. Research design

This study explored the experiences of high school mathematics teachers in managing classrooms with non-math interested learners. An exploratory study, frequently utilized to examine phenomena that are not comprehensively understood, serves as an essential process for generating preliminary insights and establishing in-depth understanding[26,27]. This approach is particularly valuable when addressing emerging issues as it employs adaptable and open-ended strategies to collect data while ensuring an impartial exploration of participants' perspectives[28]. In social sciences, exploratory research systematically identifies critical patterns and core elements that underpin sociocultural or psychological phenomena[29,30]. A distinct advantage of exploratory designs lies in their capacity to adapt to dynamic and evolving information, which is indispensable when investigating topics with minimal prior scholarly attention[31]. With adjustments in the methods based on emerging data, these studies allow researchers to refine and adapt approaches and deepen their understanding of the subject matter under inquiry[32,33]. Despite critiques concerning potential limitations in methodological rigor, the contributions of exploratory research to the development of conceptual frameworks and hypothesis generation remain significant[34,35]. These studies act as precursors to more structured investigations, offering a scaffold for subsequent inquiry and contributing substantially to the formulation of future research agendas[36,37]. This study does not make causal claims about proactive behaviors "preventing" disengagement but rather describes how teachers anticipate and address potential challenges in the classroom. Furthermore, the exploratory design allowed for the identification of key variables and relationships that can be further investigated in future studies with more rigorous methodologies. This paper answered one critical question in mathematics learning: *how do teachers manage classrooms for students less interested in learning mathematics*? This understanding would enable the development of effective pedagogical changes to meet the needs of disinterested students and support their learning process.

4.2. Participants and sampling

Sampling participants in exploratory studies is a critical process, often defined by the need to gather rich, qualitative data that allows for the refinement of broad concepts into specific and actionable themes[31]. These studies are typically conducted on small, carefully curated samples, prioritizing depth of insight over statistical generalizability, which aligns with their primary objective of understanding complex phenomena[38,39]. In qualitative research, particularly within frameworks like phenomenology, narrative inquiry, and case studies, sample sizes generally range from one to 20 participants, reflecting the emphasis on the intricacies of individual experiences or specific cases rather than population-level trends[40]. Purposive sampling, a widely used non-probability method in qualitative research, is especially suited to exploratory designs due to its targeted and flexible approach[41,42]. This strategy enables researchers to select participants based on characteristics directly relevant to the research objectives, thereby ensuring that the collected data is both meaningful and aligned with the study's aims[39]. Math teachers were sampled through online purposive sampling[43], seeking preliminary responses about their demographics and experiences in teaching disinterested students. Three major sampling criteria was used: (1) teachers' experience (>5 years), (2) mathematics major (basic calculus, algebra, geometry), and (3) has clear experience in teaching disinterested students. There were 46 mathematics teachers who responded to the online sampling but on 16 teachers were sampled. The decision to limit the sample to 16 participants was also influenced by resource constraints and the time-intensive nature of qualitative data collection and analysis. While this sample provided rich qualitative data, it is acknowledged that the small size and limited demographic diversity (e.g., school type, region) restrict the generalizability of findings; this is discussed further in the study's limitations. **Table 1** presents the summary information of the sampled participants.

Table 1. Summary information of 16 sampled teachers

Name	Sex	Age	Teaching Experience (Years)	Experience in Teaching Disinterested Students in Math
Anna	Female	35	10	Students often show low motivation due to lack of confidence in math skills.
Brian	Male	42	12	Learners tend to get easily distracted and express a dislike for math.
Carla	Female	38	9	Many students struggle with basic concepts, leading to disengagement.
David	Male	50	20	Students frequently complain that math is irrelevant to their lives.
Emma	Female	31	6	Learners often express frustration and give up quickly when challenged.
Francis	Male	44	15	Students are reluctant to participate, often fearing judgment from peers.
Grace	Female	48	18	Many students have difficulty concentrating due to external distractions.
Harry	Male	52	22	Learners frequently skip assignments and demonstrate apathy in class.
Isabella	Female	36	8	Students often rely heavily on rote memorization without deeper understanding.
Jacob	Male	39	10	Disinterest arises from misconceptions about math being overly difficult.
Karen	Female	40	12	Learners display a lack of enthusiasm and avoid participating in activities.
Leo	Male	45	17	Many students feel overwhelmed and disengaged during problem-solving tasks.
Monica	Female	34	7	Some learners openly express boredom and lack of relevance in math topics.
Nathan	Male	50	20	Students exhibit resistance to learning due to previous failures in math.
Olivia	Female	55	25	Many learners display anxiety and fear toward math assessments.
Paul	Male	60	30	Disinterest often stems from a lack of foundational skills in early math.

4.3. Instrumentation

This study developed an interview guide that elicit the responses from the participants. Developing a semi-structured interview guide begins with a thorough understanding of the research objectives and contextual knowledge, which provides a foundation for formulating initial questions[44,45]. These questions are designed to be open-ended, encouraging participants to narrate their experiences and perspectives, which encourage them to share rich, detailed responses that align with the thematic goals of the study[46]. The semi-structured approach is particularly advantageous in qualitative research, as it combines structure with flexibility. This format ensures that key topics are addressed while allowing interviewers to respond to the flow of the conversation by probing deeper into emergent themes or clarifying ambiguous responses[47,48]. Such adaptability enables the capture of in-depth insights that might otherwise remain unexplored in more rigid interview formats[49]. An essential step in developing the guide is the iterative process of pilot testing. Pilot testing evaluates the clarity, relevance, and effectiveness of the questions in eliciting unbiased and meaningful responses[50,51]. Further, expert validation contributes to the guide's coherence and relevance, ensuring that it adheres to both theoretical and methodological rigor[44]. After pilot testing and expert validation, **Table 2** presents the final interview questions designed to gather responses.

Table 2. Open-ended interview guide questions

Objectives	Questions
Determine challenges in teaching mathematics among non-math enthusiast learners.	1. What learning characteristics do you observe among non-math enthusiast learners? Elaborate more. 2. What challenges have you encountered in teaching non-math enthusiast learners? Explain further

Objectives		Questions
	3.	How did you manage your behavior towards non-math enthusiast learners? Elaborate more.
Determine behavioral adaptation of teachers in teaching math among non-math enthusiast learners.	1.	Generally, what behaviors of a teacher is expected in teaching mathematics? Explain more.
	2.	How should non-math enthusiast learners view a teacher to be an effective math instructor? Explain in situations.
	3.	Which among these behaviors of math teachers can reverse the uninterested behaviors of students towards math? Explain how it can reverse.

Table 2. (*Continued*)

4.4. Data gathering procedure

One-on-one interviews were the primary data gathering procedure carried out in this study. The primary aim is to create an environment conducive to open dialogue, where participants feel encouraged to share their experiences and perspectives[52,53]. This is often achieved through one-on-one interviews, which allow for a conversational tone that encourage natural expression, mitigating the constraints of formal communication and yielding richer data[54,55]. Although interviews are inherently flexible, the use of a semi-structured interview guide is crucial for ensuring alignment with the study's goals. Such a guide typically comprises thematic questions addressing the core areas of inquiry while allowing space for follow-up questions to probe deeper into participant responses[56,50]. This flexibility enables the interviewer to maintain focus while adapting to the subtleties of the conversation, ensuring that critical insights are not overlooked[57]. Participants should be thoroughly informed about the study's purpose, ethical considerations, confidentiality measures, and how their data will be used[49,52]. Prior to the commencement of the interviews, informed consent was obtained from all participants. This involved providing them with a detailed explanation of the study's purpose, procedures, potential risks and benefits, and their right to withdraw from the study at any time without penalty. Participants were given ample opportunity to ask questions and were provided with a consent form to sign, indicating their voluntary agreement to participate. To address potential social desirability bias, participants were reassured that their responses would remain anonymous, encouraged to discuss both successful and less effective strategies, and reminded that the study was not an evaluation of their performance. To ensure anonymity, all participant names and identifying information were removed from the interview transcripts and replaced with pseudonyms. Any potentially identifying details about their schools or districts were also removed or generalized. The data was stored securely on a password-protected computer and only accessible to the researchers involved in the study. To ensure the integrity of the data collected, researchers must adhere to three key principles: preserving the flow of participants' narratives without unnecessary interruptions, building rapport to develop a comfortable and trusting interaction, and minimizing interviewer bias to maintain the authenticity of responses[58]. By demonstrating engagement with participants' accounts, researchers affirm the value of their experiences, which encourages more comprehensive and reflective responses[59]. Probing and reflective questioning techniques further enrich the narrative data. These approaches encourage participants to explore ideas, articulate implicit meanings, and reflect on their experiences[60]. Such techniques not only facilitate a deeper understanding of the phenomena under investigation but also reinforce the dynamic and iterative nature of qualitative interviewing. With participants consent, the interviewer recorded notes, codes and preliminary themes in a Microsoft Excel sheet and recorded the entire conversation using phone recorder.

4.5. Data analysis

Reflexive thematic analysis is a robust qualitative method designed to uncover and interpret patterns of meaning within narrative data, particularly when investigating lived experiences. This approach extends beyond surface-level categorization to illuminate shared meanings and deeper conceptual insights[61]. Its dynamic and flexible nature allows for the evolution of codes as the researcher gains understanding of the data, emphasizing the subjective and interpretative aspects of analysis[62]. Reflexivity, a fundamental principle of this approach, requires researchers to actively examine how their own values, experiences, and assumptions influence the analytic process, which enriches the depth and rigor of the findings[63,64]. This acknowledges that subjectivity is not a limitation but a valuable resource that, when reflexively managed, enhances the analytic process[61,63]. The study adopted an inductive, data-driven approach, wherein themes and codes emerged organically from the data rather than being imposed by pre-existing theoretical frameworks. This method ensures that the findings remain grounded in the participants' narratives, with effective representation of their experiences and minimizing researcher bias[65,66]. Such an approach is particularly well-suited for exploratory research, where the aim is to generate reflective and context-sensitive insights into participants' perspectives[53,67]. To maintain methodological rigor, the analysis followed the six-phase framework of reflexive thematic analysis (**Figure 1**) proposed by Braun and Clarke[68]. These phases include: (1) familiarization with the data, (2) generation of initial codes, (3) identification of themes, (4) refinement and review of themes, (5) definition and naming of themes, and (6) production of the final report. This iterative process allowed the researcher to move systematically from basic descriptive coding to advanced interpretative analysis, ensuring that the themes captured both explicit and implicit dimensions of the data[67,69]. Each phase facilitated continuous engagement with the data, enabling the emergence of themes through iterative reflection and refinement[70,64]. Proactive behaviors were classified using three theory-derived dimensions from Bateman & Crant[6] and Parker & Collins[7] : (1) Anticipation – teacher actions taken in advance of foreseeable challenges; (2) Change Orientation – deliberate, self-initiated modifications made before problems arise; and (3) Barrier Prevention – strategies aimed at preventing predicted obstacles from occurring. Behaviors that were purely reactive, addressing issues only after they emerged, were not coded as proactive. The inductive nature of this approach ensures that the analysis remains deeply connected to the data itself, allowing themes and patterns to emerge naturally rather than being constrained by preconceptions.

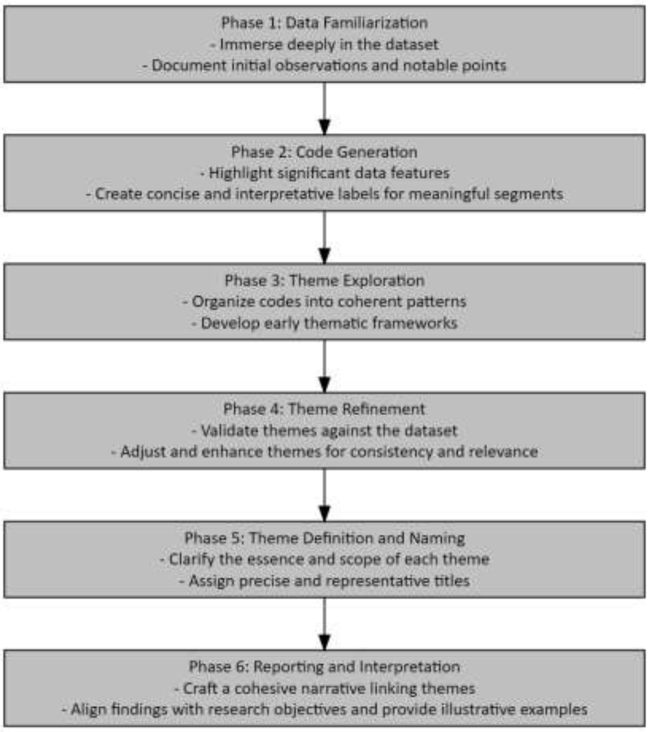

Figure 1. Workflow of thematic analysis

5. Results

Objective 1: Determine challenges in teaching mathematics among non-math enthusiast learners.

Teaching mathematics to learners who are not naturally inclined toward the subject presented distinct challenges that demand careful pedagogical consideration. Two prominent themes emerged in this context: students' anxiety and disinterested learning. Mathematics anxiety, often rooted in previous negative experiences, manifests as a fear of failure and a reluctance to engage with mathematical tasks, further exacerbating students' hesitation to participate actively in class. This fear, coupled with the potential stigma of making mistakes, creates a paralyzing barrier to learning. On the other hand, disinterest in mathematics stems from students' inability to perceive its relevance to their lives, which diminishes motivation and causes disengagement. Many learners expressed low confidence in their mathematical abilities, leading to avoidance behaviors and a lack of perseverance in problem-solving.

Theme 1: Students' Anxiety

Findings highlighted a pervasive emotional barrier that hindered learners' engagement with mathematics. Participants consistently described how students' *fear of making mistakes* often stemmed from *prior negative experiences,* which contributed to a *paralyzing apprehension* about attempting mathematical tasks. This *fear of failure* was particularly pronounced among non-mathematics enthusiasts, resulting in a marked *reluctance to engage with mathematical material*.

> "My students often carry a fear of making mistakes due to prior negative experiences. They may feel overwhelmed by the idea of being wrong, which paralyzes their willingness to attempt problems."
>
> "Many non-math enthusiasts experience math anxiety, which can lead to a fear of failure and a reluctance to engage with the material."

Further, the findings revealed that *social pressures,* such as the concern of being ridiculed by peers for errors, further intensified learners' *anxiety towards mathematics.* This fear created an environment where students were hesitant to participate, as the *prospect of humiliation* for mistakes overshadowed their willingness to attempt problem-solving.

"I can feel that students are anxious in learning mathematics. Some of the say they are afraid to commit mistakes as others will make fun of them."

These reflected the impact of emotional distress on students' willingness to actively participate in mathematical problem-solving, emphasizing the need for interventions that mitigate fear and develop a supportive learning environment.

Theme 2: Disinterested Learning

Findings revealed significant challenges in engaging students who lacked enthusiasm for mathematics. A primary factor contributing to this disengagement was the perceived *irrelevance of mathematics* to students' daily lives and future aspirations. Participants noted that learners often failed to establish a meaningful connection between mathematical concepts and their personal or professional goals, which weakened their intrinsic motivation to engage with the subject.

> "I think students might disengage because they do not see the relevance of mathematics in their lives. Learners frequently exhibit low self-efficacy regarding their math skills."

Teachers observed that students frequently exhibited *low self-efficacy* in their mathematical abilities, characterized by doubts about their capacity to succeed in math-related tasks. This lack of confidence often led to *avoidance behaviors,* where students deliberately distanced themselves from mathematical activities to circumvent feelings of inadequacy or failure. The relation between perceived irrelevance and diminished self-efficacy created a *cycle of disengagement,* where learners not only avoided participation but also struggled to recognize the value of effort in improving their mathematical competence.

> "They may doubt their ability to succeed in math tasks, which can lead to avoidance behaviors and disengagement from learning."

> "I see that students often fail to see the relevance of math in their daily lives. Without understanding how math connects to their interests or future goals, motivation wanes."

Objective 2: Determine behavioral adaptation of teachers in teaching math among non-math enthusiast learners.

The findings revealed that teachers employed strategies to develop engagement and alleviate learners' anxiety, emphasizing socio-emotional responsiveness, personalized learning, practical application, and collaboration. Teachers demonstrated a socio-emotional response by cultivating non-judgmental environments, celebrating effort over accuracy, and prioritizing patience to reduce fear and build student confidence. Through personalized learning, teachers tailored their lessons to students' interests and varying skill levels, incorporating visual aids and technology to bridge gaps in understanding. The application of math to real-world scenarios further enhanced engagement, with strategies such as project-based learning and the use of relatable, practical examples to make abstract concepts tangible. Finally, collaboration was highlighted as a vital approach, where group tasks empowering social relations, reduced individual pressure, and encouraged peer learning.

Theme 1: Socio-emotional Response

Teachers recognized that *specific situations triggered math anxiety* and intentionally avoided actions or language that could exacerbate such fears. Strategies such as *avoiding pressure or embarrassment for incorrect answers* and *celebrating students' attempts rather than focusing on perfection* were employed to create a more supportive learning environment.

> "Teachers often observe that specific situations can trigger math anxiety in students."

> "I avoided pressuring students or embarrassing them for wrong answers."

> "I celebrated their attempts and focused on effort rather than perfection because I believe that reducing anxiety makes learners more willing to engage and explore math concepts."

Furthermore, teachers utilized *validating language* and ensured that students felt *safe to share their answers,* developing an inclusive classroom dynamic that reduced the fear of failure. Exhibiting *patience* and understanding the varying paces at which students learned were identified as essential practices to build confidence and encourage participation.

> "I avoided phrases like, 'This is easy,' which could discourage students struggling with a concept."

> "I used language that validated their efforts. I also ensured students felt safe to share their answers, even if they were unsure. No one should feel ashamed for being wrong because a non-judgmental environment encourages participation and reduces fear of failure."

> "I should exhibit patience, recognizing that students may struggle with mathematical concepts. Understanding that each student learns at their own pace is essential. This behavior develops a supportive environment where students feel comfortable asking questions and seeking help."

Teachers also emphasized the importance of establishing *positive relationships* with students, recognizing that showing care and respect for them as individuals promoted engagement and cooperation. Finally, teachers maintained a *positive attitude,* using encouragement and constructive feedback to influence students' perceptions of mathematics and motivate them to participate actively in the learning process.

> "When students know we care about them as individuals, they're more likely to stay engaged and respect the classroom environment. I always believe that positive relationships create a foundation for mutual respect and cooperation."

> "I create an inclusive and safe space where students feel comfortable making mistakes. I show enthusiasm for math to make it contagious and motivate students."

> "A positive attitude can significantly influence students' perceptions of math. I encourage students, celebrate their successes, and provide constructive feedback."

Theme 2: Personalized Learning

Teachers demonstrated efforts to *design lessons that catered to varying levels of proficiency,* ensuring that both advanced and struggling students received appropriate support. An integral aspect of personalization involved *identifying students' interests*, such as sports, fashion, gaming, or social media, and *embedding mathematical concepts within these familiar contexts,* such as using *basketball statistics to teach averages* or *game mechanics to explain probability.* Recognizing that students exhibited *different learning styles and paces,* teachers employed designed approaches, including *one-on-one support* and *small group work,* to provide targeted assistance.

> "I design lessons to meet the learning needs from advanced to struggling students."

> "I always start by figuring out what my students are interested in, sports, fashion, gaming, or even social media. Then I find ways to embed math concepts into those areas. For example, using basketball statistics to teach averages or using game mechanics to explain probability."

> "I often highlight the need to recognize that students have different learning styles and paces. I try to observe how each student approaches problems. Some understand concepts quickly, while others need more time. I adapt their teaching to meet those needs, whether it's through one-on-one support or small group work."

The use of *visual aids, manipulatives, and technology tools* emerged as a critical component of these strategies, making abstract mathematical concepts more accessible and engaging. These methods *bridged gaps in understanding* and catered to non-math enthusiasts who often *gravitated towards visual and practical tools* over purely symbolic or procedural methods.

"Using visual aids and technology tools has proven to be a game-changer in math instruction, especially for non-math enthusiasts. These strategies bridge gaps in understanding, cater to varied learning styles, and make abstract math concepts more concrete and relatable."

Incorporating *diagrams, graphs, and storytelling* into lessons resonated with learners who excelled in areas emphasizing *creativity and real-world applications.* By leveraging these personalized approaches, teachers successfully developed a learning environment that accommodated the unique preferences and needs of each student, enhancing their engagement and comprehension in mathematics.

> "Non-enthusiasts often gravitate towards visual aids, manipulatives, or simulations rather than purely symbolic or procedural methods. Diagrams, graphs, and storytelling in math contexts resonate more deeply with them. Many students might excel in subjects that emphasize creativity or practical applications over abstract reasoning."

Theme 3: Application

Teachers prioritized *connecting mathematical concepts to students' everyday lives,* leveraging contexts such as sports, gaming, and social media metrics to illustrate the practical relevance of mathematics. This approach not only enhanced comprehension but also increased learners' interest by making math relatable. For instance, *project-based learning strategies* allowed students to solve *real-world problems,* such as planning community events that required *budgeting, scheduling, and resource allocation.* These activities provided authentic opportunities for learners to apply mathematical principles meaningfully.

> "I focused on showing students how math applies to their everyday lives. For example, I connected lessons to sports, gaming, or social media metrics. I use project-based learning strategies where students solve real-world problems or explore math in contexts they care about."

> "I make sure to connect math to real-world scenarios that students care about. For example, students who are uninterested in geometry become intrigued when I explain how angles are essential in designing video game graphics. Students who enjoy creative subjects begin to appreciate math as a tool for enhancing their artistic pursuits."

> "We advocate for project-based learning as a way to engage students with real-world applications of math. For instance, a project that involves planning a community event can require students to use math for budgeting, scheduling, and resource allocation."

Teachers further demonstrated the importance of *contextualizing math concepts* to align with students' interests. Examples included illustrating *the role of geometry in video game design* to captivate disinterested students and highlighting the *use of math in artistic endeavors* to engage those with creative inclinations. The inclusion of *real-life objects,* such as grocery receipts, menus, and bank statements, made abstract topics like percentages and interest rates *tangible and relevant.*

"Bringing real-life objects like grocery receipts, menus, or bank statements to create relatable problems. When I teach percentages, they use real-life examples like calculating discounts during shopping or interest rates on savings. It immediately makes the concept tangible for students."

The integration of *technological tools* such as Excel, Google Sheets, and online databases enabled students to work with *real-world data and statistics.* These tools facilitated activities like *analyzing trends in* *hashtags, follower growth, and scatter plots,* which not only underscored the practical utility of math but also bridged the gap between theoretical knowledge and its application. Through these strategies, teachers effectively demonstrated the relevance of mathematics, transforming it into a practical and accessible discipline for learners.

"I integrated tools like Excel, Google Sheets, and online databases so students could work with real-life data and statistics. Analyzing trends in hashtags, likes, or follower growth using scatter plots and regression analysis are some of the examples they used."

Theme 4: Collaboration

Collaboration was utilized as a strategy to *build connections* among students, encouraging a *team-oriented* environment. Encouraging students to work in pairs or groups, teachers aimed to *leverage collective knowledge* and *enhance mutual support* in addressing mathematical challenges. This collaborative approach not only *reduced individual pressure* but also *nurtured a sense of community* among learners, making the learning environment more conducive to engagement and participation.

> "Collaboration helps build connections and makes problem-solving a team effort. So, I encouraged students to work in pairs or groups."

Teachers strategically designed *group tasks* that required *diverse skill sets*, recognizing that *enthusiastic students* could serve as *motivators and role models* for their peers. This arrangement allowed *non-enthusiastic learners* to *contribute meaningfully*, thereby enhancing their sense of *involvement and value* in the learning process. The *exchange of ideas* and *collaborative problem-solving* were encouraged as these activities facilitated the *sharing of thought processes* and *collective exploration of solutions*, ultimately *reducing anxiety* associated with learning and develop an inclusive classroom dynamic. Through these collaborative efforts, teachers aimed to *cultivate a positive and supportive learning atmosphere* that was essential for effective mathematical education.

> "Those who were more enthusiastic about math often inspired others. I used strategies like designing group tasks that require different skill sets, allowing non-enthusiasts to contribute meaningfully."

> "I encourage students to work in pairs or small groups because when they collaborate, they can share their thought processes and help each other through challenges."

> "Creating opportunities for students to work together, reducing individual pressure, this builds a sense of community and reduces anxiety."

6. Discussion

Math anxiety is a state of discomfort, which reflects fear, aversion, nervousness, worry, and frustration when engaging with mathematical tasks[71,72]. It is a prevalent negative academic emotion with cognitive underpinnings in children and adolescents, often linked to adverse academic outcomes such as reduced mathematics achievement[73]. A critical factor contributing to students' learning is their motivational constructs, including their perceived competence and the value they attribute to learning mathematics[74]. For math teachers, math anxiety and learning disengagement are significant challenges in teaching mathematics. Teachers believed that math anxiety emerged is an emotional barrier that hindered learners' engagement with mathematics.

This paper believed that teachers should be proactive in developing positive learning environment to reduce the emergence of math anxiety among students. Teachers are integral figures in students' development, occupying a central role in the educational process and forming the primary social and academic connections for students throughout the school day, aside from their parents[75]. Their instructional strategies, emotional support, and guidance are fundamental in shaping students' attitudes towards learning, including their engagement with mathematics[76].

One of the primary proactive behaviors that teachers developed in managing math anxiety and disinterest among students was positive socio-emotional relation. Teachers recognized that specific situations could trigger math anxiety in students and proactively took steps to mitigate such fears. The influence of teacher support is not merely limited to academic performance but extends to the broader emotional and motivational aspects of students' educational experiences[77-79]. Teachers noted that they intentionally avoided actions or language that could add pressure or embarrassment for incorrect answers, and instead celebrated students' efforts, focusing on the process rather than perfection. One teacher believed that *"…no one should feel ashamed for being wrong because a non-judgmental environment encourages participation and reduces fear of failure."* Early studies affirm to this explaining that supportive environment created encourages a positive learning atmosphere where students feel more comfortable asking questions and exploring mathematical concepts, reducing math anxiety and enhancing engagement[80-82]. For example, teachers utilized validating language to ensure that students felt comfortable sharing their answers. Affirmative language encourages inclusivity and affirmative practices in education as it develops self-reflection and acceptance[83]. Teachers emphasized the importance of establishing positive relationships with students through affirmative language use and positive attitudes, understanding that showing care and respect for them as individuals promoted engagement and cooperation. Maintaining a positive attitude, using encouragement and constructive feedback influence students' perceptions of mathematics. This supportive approach not only reduces math anxiety but also encourages a positive learning environment where students feel comfortable making mistakes, asking questions, and actively participate in the learning process. This proactive socio-emotional response demonstrates anticipation by recognizing potential triggers for math anxiety, such as high-stakes testing situations or public displays of incorrect answers. It also demonstrates barrier prevention by creating a safe and supportive environment where students feel comfortable taking risks and making mistakes, thus reducing the emotional barriers to learning. To further illustrate, teachers might anticipate anxiety triggers by surveying students about their past experiences with math and then proactively design lessons that address those specific anxieties. This proactive approach contrasts sharply with traditional methods that often overlook the emotional dimension of mathematics learning, focusing solely on cognitive skills and content mastery. This aligns with Bateman and Crant's[6] conceptualization of proactivity as taking initiative to improve current circumstances rather than passively adapting to them.

Adopting student-centered approaches were also prominent instructional practices among math teachers. Teachers were intentional about designing lessons that catered to the varied learning needs of their students, aiming to create a supportive and engaging environment for all levels of proficiency. The integration of student-centered approaches in mathematics education marks a shift from traditional teacher-centered methods to a more constructivist paradigm where students actively engage in their own learning[84]. Unlike teacher-centered learning, which relies solely on the teacher, student-centered learning distributes responsibility to students, positioning educators as facilitators[85-87]. Some teachers valued the role of students' interests, like sports, fashion, gaming, or social media, and used this to design their instructional materials. In teaching mathematics, the content initially dictated by the curriculum evolves as teachers give students more input on what they study, gradually shifting towards a student-driven construction of knowledge[88]. With the help of understanding students' interests, teachers were able to adapt their instructional materials and develop their teaching practices. For them, *"...some understand concepts quickly, while others need more time"* which forces them to *"adapt their teaching to meet those needs."* The use of visual aids and technology tools was a crucial component of these strategies. They allowed teachers to present math in a way that appealed to non-math enthusiasts, students who might struggle with abstract reasoning and prefer more practical or visual learning methods. Incorporating storytelling, graphs, and simulations into lessons also resonated with learners who excel in creative and real-world applications. Integrating students' interest and learning preferences into instructional practices could help students to be engaged in learning. Students who are engaged tend to make deeper connections with courses and perform better, as engagement is linked to critical thinking skills, a positive attitude towards fundamental literacy, and enhanced character qualities[89,90]. This student-centered approach reflects change orientation by adapting instructional materials and teaching methods to better meet the diverse learning needs and interests of students. It also demonstrates barrier prevention by addressing potential disengagement that can arise when students feel that the material is irrelevant or too difficult. For example, teachers might change their traditional lecture-based format to incorporate more group work and hands-on activities, or they might prevent disengagement by allowing students to choose projects that align with their personal interests, even if those interests seem unrelated to mathematics at first glance. This proactive shift towards student-centered learning contrasts with traditional, teacher-dominated classrooms where student input is minimal and the curriculum is rigidly prescribed. This demonstrates Parker and Collins'[7] concept of "future focus," as teachers are actively shaping the learning environment to create more positive outcomes for students in the long term.

Math teachers also presented proactivity in instructional practices through problem-based and application-based learning. Teachers have increasingly emphasized the importance of applying mathematical concepts to students' everyday lives, demonstrating how math is not just theoretical but a practical and essential tool. Unlike traditional approaches, which often position learners as passive recipients of information, experiential learning emphasizes student participation, exploration, and collaboration, transforming the learning process into an interactive and dynamic experience[91,92]. Students are encouraged to investigate mathematical concepts through practical activities, real-world applications, and problem-solving exercises that promote both critical thinking and knowledge retention[93,94]. Math teachers display their proactivity through different experience-based learning processes like bringing real-life objects like grocery receipts to create relatable problems, integrate tools like Excel, Google Sheets, and online databases, and connect lessons to sports, gaming, or social media metrics. This proactivity in instructional strategies enabled teachers to integrate learning stimulation among students, exposing them to relatable real-world problems. Studies on high school students engaging in experiential activities to learn arithmetic and geometric sequences revealed significant improvements in both their learning attitudes and academic performance[95]. Through this learning stimulation, teachers were able to *"...it immediately makes the concept tangible for students"* which makes it easier for them to adapt to the learning environment demanded in mathematics education. Teachers' proactive behavior could potentially inspire students to take responsibility for their learning phase, which in turn sparks learning interest within them. Similarly, teachers displayed proactive behaviors by encouraging their students to work collaboratively. They ask their students to work in pairs where they can share their ideas and help other students in need. For them, this helps in *"reducing individual pressure, this builds a sense of community and reduces anxiety."* Interaction with peers stimulates intellectual reorganization, encouraging learners to critically evaluate and reconstruct their existing knowledge base to accommodate new information[96,97]. Having collaboration and social interaction in classrooms creates a supportive learning environment that enhances students' engagement in listening activities within peer communities[98]. Learners who participate in these communities generally demonstrate greater motivation, confidence, and fulfillment than their counterparts who remain uninvolved in such collaborative settings[99]. This application-based learning demonstrates anticipation of student disinterest by connecting abstract mathematical concepts to their everyday lives, making the material more relevant and engaging. It also reflects change orientation by moving away from traditional, rote memorization approaches and embracing more active and experiential learning methods. For instance, teachers might anticipate that students will struggle to understand the concept of compound interest, so they proactively design a project where students create a budget for a real-world scenario, such as planning a vacation or buying a car. This proactive emphasis on relevance and application stands in contrast to traditional mathematics instruction, which often prioritizes abstract theory and procedural fluency over real-world connections, potentially alienating students who struggle to see the value of the subject. This aligns with Parker and Collins'[7] assertion that proactive behavior involves taking action to influence one's environment to achieve desired outcomes, in this case, increased student engagement and understanding.

Teachers’ closer interactions and less authoritarian requests can alleviate the outward signs of reactance[100]. Apparently, when teachers were less strict and more empathic to their students’ struggles in learning mathematics, it also reduces their math anxiety and increase learning engagement. This is because teachers’ negative attitude could trigger emotions that cause students to fear the subject and be less engaged to it. Proactive strategies help learners to quickly demonstrate commitment by counteracting reactance[101,15]. When teaching mathematics, four prominent proactive strategies emerged, socio-emotional response, personalized learning, application, and collaboration. Proactive behaviors involve decision-making for the future, predicting outcomes, adopting solution strategies, and exploring ways to manage undesirable situations[7]. For example, some teachers first considered their students’ learning preferences which helped them design instructional materials that are appropriate to their students. Others identified how their students feel about the subject, then adapted how they interact with them when teaching to critically engage their students. In this context, proactive strategies are both corrective and preventive, as they are used to adapt and respond to challenges that the teachers encounter. Clunies-Ross, Little, and Kienhuis[102] suggest that proactance on the part of instructors moves towards amending situations that evoke negative behaviors. These proactive strategies include planning to control situations, maintaining a future change orientation, and anticipating possible outcomes[101]. The effectiveness of these strategies could be measured through a variety of methods, including: (a) tracking student participation rates in class discussions and activities; (b) administering pre- and post-surveys to assess changes in student attitudes towards mathematics and their levels of math anxiety; (c) analyzing student performance data on tests and assignments to identify improvements in their understanding of mathematical concepts; and (d) conducting classroom observations to assess the extent to which teachers are implementing proactive strategies and the impact of those strategies on student engagement. While this study provides valuable insights into the proactive strategies teachers use to manage math anxiety and foster engagement, it is important to acknowledge the limitations of the study, which are discussed in detail in the Limitations section. These limitations should be considered when interpreting the findings and drawing conclusions. By framing these strategies through the lens of proactive behavior, this study offers a novel perspective on effective mathematics teaching, highlighting the importance of intentionality, foresight, and adaptability in creating engaging and supportive learning environments. This perspective moves beyond simply identifying effective practices to understanding the underlying mindset that drives teachers to act proactively in the face of student disengagement and anxiety. This aligns with Bateman and Crant's[6] view of proactive individuals as those who create opportunities and take action to influence their environment, rather than passively reacting to circumstances.

7. Limitations

While this study sheds light on the proactive strategies employed by mathematics teachers to engage students who are not naturally inclined towards the subject and to alleviate math anxiety, it is crucial to acknowledge certain limitations that temper the scope and generalizability of its findings. The research was conducted with a relatively small group of sixteen mathematics teachers, a decision aligned with the exploratory nature of the study, which prioritized in-depth understanding over broad statistical representation. However, this limited sample size inherently restricts the ability to generalize the results to a larger population of mathematics educators. Furthermore, the sample exhibited a degree of homogeneity in terms of school type, geographic location, and years of teaching experience. This lack of demographic diversity further constrains the transferability of the findings to different educational settings and teacher populations.

Another factor to consider is the study's reliance on self-reported data gathered through teacher interviews. While these interviews provided rich qualitative insights into teacher practices and perspectives, they are susceptible to social desirability bias, where participants may present themselves in a more favorable light. The absence of corroborating data sources, such as direct classroom observations or student feedback, introduces a potential validity concern. Finally, the exploratory design of the study, while well-suited for generating initial insights and identifying key themes, does not permit causal inferences about the relationship between proactive teaching strategies and student outcomes. The study illuminates associations and patterns but cannot definitively establish whether these strategies directly lead to increased student engagement or reduced math anxiety.

Despite these limitations, this study lays a valuable foundation for future research on proactive teaching in mathematics education. The findings underscore the importance of socio-emotional support, personalized learning, application-based instruction, and collaborative activities in fostering student engagement and mitigating math anxiety. Future investigations can build upon this work by addressing the identified limitations through larger, more diverse samples, the inclusion of multiple data sources, and the implementation of experimental designs to examine causal relationships

8. Conclusion

This study highlighted the critical role of proactive teaching strategies in mitigating math anxiety and fostering student engagement in mathematics. With a supportive and empathetic approach, teachers can cultivate a positive learning environment that encourages students to express their struggles without fear of judgment. Such an environment is essential in reducing anxiety and developing a growth mindset among students, which in turn enhances their emotional and cognitive engagement with mathematics. This study found that teachers who actively sought to understand and address the emotional and cognitive needs of their students were more likely to engage them deeply in the learning process. They used affirmative language and avoided behaviors that may exacerbate anxiety, which fostered an inclusive and non-judgmental atmosphere.

This study also demonstrated that proactive teaching strategies extend beyond emotional support to encompass instructional practices that prioritize student-centered learning, real-world application, and collaborative engagement. Teachers who employed application-based strategies helped students to see the relevance of mathematics beyond the classroom. Collaboration, through peer-to-peer interactions and teamwork, was also shown to be an essential component of a supportive learning environment. These proactive behaviors not only addressed math anxiety but also strengthened student motivation and engagement, which were critical for achieving positive learning outcomes in mathematics.

To further enhance student learning and reduce math anxiety, teachers should continue to develop proactive strategies encompassing both socio-emotional support and innovative instructional practices. This includes actively seeking to understand students' individual needs and anxieties, adapting teaching methods to cater to diverse learning styles, and creating a classroom environment that fosters collaboration, risk-taking, and a growth mindset. Engaging parents and communities in supporting students' mathematics learning can extend the influence of supportive learning environments beyond the classroom. By intentionally anticipating student needs and proactively adapting their instruction, teachers can create more engaging and supportive learning environments.

As with any research, this study is subject to certain limitations. These limitations, which are discussed in detail in the "Limitations" section, include the relatively small sample size, the limited demographic diversity, and the reliance on self-reported data. Future research should address these limitations by employing larger and more diverse samples, incorporating multiple data sources, and utilizing experimental designs to establish causal relationships between proactive teaching strategies and student outcomes. Specifically, future studies could explore the long-term effects of these proactive strategies on student outcomes in mathematics, as well as the role of external factors such as parental involvement and peer influence, and investigate the effectiveness of different professional development models for promoting proactive teaching practices. Future research should also delve deeper into the underlying motivations and thought processes that drive teachers to adopt these proactive strategies, further illuminating the "why" behind their actions.

Conflict of interest

The authors declare no conflict of interest

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