A systematic review of primary school class teachers views of mathematics teaching and learning

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The current study aimed (1) to analyse teachers' view profiles from positive to negative based on the analysis of influencing factors and (2) to investigate the most studied concepts and methods in this context. According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines, we conducted a comprehensive review of 25 peer-reviewed articles published between January 2010 and December 2022. Our findings show a landscape in which concepts related to mathematics teaching and learning often intersect with other domains. Nevertheless, a distinction exists in the definition of the fundamental concept, with limited attention given to mathematics learning and the role of students in contrast to the focus on mathematics teaching and the role of teachers. Our research highlights the necessity of thorough exploration of the dynamic factors that influence these views and their associated outcomes, categorised as (A) mutual consistency, (B) weak consistency, and (C) inconsistency, each providing distinct implications for support needs. Additionally, from an ontological perspective on affect, many studies overlook the notion of 'view' as a state or trait characteristic, potentially leading to inappropriate method selection. Therefore, we propose recommendations for future research, advocating for methodological precision, expanded object exploration, dynamic profiling, and the inclusion of diverse teacher categories.

Keywords: Mathematics teaching, mathematics learning, view of mathematics, systematic review, PRISMA

ARTICLE DETAILS

LUMAT General Issue
Vol 11 No 2 (2023), 60–87

Received 6 June 2023
Accepted 25 October 2023
Published 31 October 2023

Pages: 28
References: 48

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https://doi.org/10.31129/LUMAT.11.2.2055

1 Introduction

Primary school class teachers' views of mathematics teaching and learning strongly influence their teaching actions and students' learning (Hannula et al., 2016; Heffernan & Newton, 2019; Ingram et al., 2018). Specifically, numerous studies are concerned about teachers' problematic views related to anxiety, failure, difficulty or frustration and low levels of self-efficacy or self-image towards mathematics (e.g. Bekdemir, 2010; Schaeffer et al., 2021). Therefore, many researchers have developed interventions to support teachers' positive views of mathematics along with mathematical knowledge. Although they have contributed to separately exploring teachers' views of mathematics in the cognitive, motivational and affective areas, some have argued for the preferential exploration of the structure of views of mathematics, which concerns three questions about who (subject), what (object) and how (affect) (Hannula et al., 2005; Rösken et al., 2007).

To explore empirical evidence regarding the abovementioned questions and to identify view profiles among teachers who need further support, we systematically analysed peer-reviewed articles published between January 2010 and December 2022 regarding primary school class teachers' views of mathematics teaching and learning. According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines, studies were deemed eligible for final inclusion via a sequential process of identification, screening, evaluation and data extraction. The current study aimed (1) to analyse teachers' view profiles from positive to negative based on the analysis of the objects and the factors (influencers and outcomes) and (2) to investigate the most studied concepts and methods in this context.

2 Theoretical Background

2.1 Overview of studies in the view of mathematics

The view of mathematics is rooted in various concepts, such as beliefs, attitudes and emotions, which are often used interchangeably (Shilling-Traina & Stylianides, 2013) and departmentalised into beliefs of the self to learn or teach (self-efficacy), beliefs of self (self-concept) and positive or negative emotions (e.g. enjoyment and anxiety). Although the view of mathematics cannot be clearly defined in a scientific research field (Hannula et al., 2005), it is obvious that we, as humans, are beings who think, feel, create and reflect on our daily lives in relation to the subject of mathematics.

The cognitive area has mainly focused on the concept of 'belief'. However, some studies define it as a comprehensive mind, including attitude, knowledge or even emotions towards mathematics (e.g. Pehkonen, 1998), whereas others insist on accepting only the concept of 'cognitive belief'. For example, Hannula et al. (2005) clearly distinguished beliefs from emotions or feelings as ordinary cognitive statements. In addition, beliefs, as a crucial part of the view, can be interpreted as conscious or nonconscious statements in one's belief system (Perkkilä, 2003). A belief system is not just the belief itself but the structure of perceiving certain objects related to mathematics and their affects.

In the early stage, research on the view of mathematics mainly analysed this topic as behavioural reactions against cognitive and affective factors (Thompson, 1992). Then, a new interest in cognitive and affective areas emerged to examine the view of mathematics as a belief system. However, the research direction varied depending on the position of the beliefs between the affective and cognitive areas. If beliefs are close to the affective area, they are regarded as attitudes with fixed reactions towards mathematics, whereas if beliefs are near the cognitive area, they play a role in the connections between beliefs and knowledge in the structure of personality. Similarly, some studies (Hannula et al., 2005; Pehkonen, 1998; Rösken et al., 2007) stated that beliefs represent the regulating system of teachers' views of mathematics, which are related to controlling the ways of teaching, understanding students' learning and organising lesson plans. For instance, one teacher who believes in transmitting mathematical knowledge and mechanisms tends to follow strict teaching models, whereas another teacher believes that mathematics learning is a process constructed by one's understanding of one's desire to create active learning environments.

Therefore, many studies have hypothesised that teachers' views of mathematics determine their teaching instructions. For example, Chamberlin (2013) confirmed the necessity of changing teachers' perspectives from a traditional (e.g. re-explanation and clear instruction to understand) or perception-based view to a conceptional view (e.g. providing students with opportunities to explore mathematics and make the meaning of concepts). As a result, many pre-service class teachers have emphasised providing their future students with clarified experiences for perceiving mathematics ideas from a perception-based view, thereby preventing them from struggling.

Another hypothesis is to determine the causes behind students' negative views and low performance in mathematics, especially in the inactivated teaching ways of teachers with a lack of knowledge and negative views (e.g. high level of anxiety and low level of teaching confidence) (e.g. Heffernan & Newton, 2019; Schaeffer et al., 2021). These studies have explored the possibility of a change in the teachers' perspectives and the factors that disturb such a possibility. According to the systematic review of Kayan Fadlelmula (2022), despite the educational trends that emphasise mathematical thinking and problem-solving skills, some teachers are still reluctant to shift from teacher-centred to student-centred learning. In addition, two factors interrupted positive changes in teachers' views: internal (e.g. anxiety and self-efficacy) and external (e.g. curriculum, test, time, and materials) factors.

However, Cady et al. (2006) observed that many reform-oriented teachers resist providing opportunities for students to challenge mathematics, and that such teachers are likely to be traditional teachers when coming to the classroom. Moreover, many studies have demonstrated a substantial disconnect between teachers' views of mathematics and their classroom practices (e.g. Hart, 2004), in contrast to the consistency of teachers' views and behaviours raised by previous hypotheses. Hence, Thompson (1992) warned us not to assume a simple cause-and-effect relationship between views and practice. Furthermore, Hannula et al. (2005) and Rösken et al. (2007) argued for the need to understand the structural mechanisms of how the cognitive and psychological areas of individual perspectives on mathematics can be interpreted in dynamic ways.

2.2 Structural mechanisms of the view of mathematics

Hannula et al. (2005) identified three factors through which we can understand the view of mathematics: *who is the subject of the view*, *what is the object of the view* and *how does the view work with affect*? Subjects, either as students or teachers, have different views of mathematics, depending on their experiences in learning or teaching this subject. For example, Rösken et al. (2007) examined secondary school students' views of mathematics as the structure of their mathematical beliefs and 'as a result of their experiences as learners of mathematics' (Rösken et al., 2007, p. 1). Thus, students' views of mathematics can be investigated through their beliefs about mathematics and themselves as learners and users in the context of mathematics learning (Joutsenlahti, 2005). To identify the relationship between the dimension of the view of mathematics and the structure, Rösken et al. (2007) confirmed three main factors that are significantly related to personal beliefs: competence (to do mathematics as a subject), confidence (to teach and learn mathematics about future success) and effort (hard work, getting good grades and having a good attitude).

Otherwise, teachers are mostly expected to teach mathematics effectively in the classroom, regardless of their learning experiences in the past. This means that the objects of teachers' views should include oneself as a teacher and mathematics teaching itself (Joutsenlahti, 2005). Hannula et al. (2005) explored the structure of pre-service class teachers' views of mathematics as a result of their experiences as learners and future teachers of mathematics. Although their participants had little teaching experience, it was clear that a strong relationship existed between the teachers' views of mathematics and their ways of teaching mathematics. In their study, the view of mathematics was interpreted as one's beliefs about oneself, beliefs about mathematics and their emotional relationship with mathematics. Moreover, there are several lines of mathematics research related to teachers' views (Hannula et al., 2016): (1) pre-service primary teachers, (2) pre-service mathematics teachers, (3) in-service primary teachers, (4) in-service mathematics teachers and (5) teacher educators, including research about mathematics coaches. Thus, we agree with the constructive outlook for follow-up studies that design the target groups according to the experience of advanced mathematics, their related majors and the position teaching level.

Consequently, we value the findings about specific structures and profiles of view of mathematics in the study by Hannula et al. (2005). They surveyed 269 pre-service class teachers at three Finnish universities and identified the ten principal components of their views of mathematics. Among the components, three factors significantly affected the teachers' views of mathematics: beliefs in one's talent, beliefs regarding the difficulty of mathematics and one's liking of mathematics. Upon performing cluster analysis, they profiled three main types of beliefs in pre-service class teachers: positive, neutral and negative beliefs. We summarised the results in Table 1.

Table 1. Three types of belief profiles and objects in Hannula et al. (2005)

Objects / Belief profiles	**Self (one's talent)**	**Difficulty of mathematics**	**Liking of mathematics**
Positive	Talented, hard-working, confidence to teach and learn	Easy	Enjoyable, good memories of previous teachers
Neutral	Modest confidence	Mixed	Neither liked nor hated
Negative	Not talented, lack of confidence to teach and learn	Difficult	Dislike, negative memories of previous teachers

Each belief profile has two subgroups showing noticeably high points compared with other groups. First, those with positive beliefs were (1) *encouraged* by family and had (2) *autonomy*, complemented by hard work and confidence to teach and learn. Next, those with negative beliefs experienced (1) *hopelessness* in learning mathematics and tended to show (2) *laziness* in overcoming some difficulties related to the subject. Some of them felt insecure as future teachers, which was influenced by poor memories of their previous teachers. Finally, those with neutral beliefs showed moderate confidence and neither liked nor hated mathematics. However, they were less (1) *diligent* about learning mathematics than they were (2) *pushed* to study it by their families.

2.3 Ontological approaches to conceptualising affect

The last question about how we can explore the connection between one's views (belief system) and reasonable outcomes can be explored using three ontological approaches to conceptualise affect (Hannula, 2007). Specifically, Hannula reviewed Finnish articles published since the 1990s concerning affects in mathematics related to theory and methods, as well as their respective findings. First, affective responses can be explored with respect to human physiology, such as neural activation and brain structure. Second, affective experiences can be explored with respect to human psychology, including feelings, thoughts, meanings, goals and beliefs. Third, affect can be explored with respect to social norms regarding social interactions and communication, specifically in the classroom. These approaches are also considered differently in terms of the stability of ontology, such as a state or a trait, as described in Table 2.

Table 2. Three ontological approaches to 'affect' that are connected to conceptualisation and methods (Hannula, 2007, p. 10)

Ontology Stability	**Affect as physiological**	**Affect as psychological**	**Affect as social**
Affect as a state	Concepts: Neural activation, physiological adaptation, Methods: Facial expression coding systems, brain imaging techniques, skin conductance, animal studies	Concepts: Feelings, emotions, thoughts, meanings, goals Methods: think-aloud protocols, video-stimulated recall interviews	Concepts: Social interaction, communication Methods: Observations, interviews
Affect as a trait	Concepts: Brain structure, neural connections, endocrine system Methods: Brain injury case studies, reaction time measures, hormonal level measures, animal studies	Concepts: Attitudes, values, beliefs, motivational orientation Methods: Interviews, questionnaires	Concepts: Norms, social structures, power, discourse Methods: Discourse analysis, comparative studies, interviews

Regarding methodological approaches, Hannula (2007) summarised useful ideas in previous studies and divided these into quantitative, qualitative and mixed methods. He pointed out that quantitative methods can provide reliable results to use diversely, whereas qualitative instruments (e.g. in-depth case studies, fiction-writing, drawing tasks, pictorial tests and the Dionné triangle method) can be considered depending on the number of participants and their educational levels. Finally, he strongly recommended mixed methods as a powerful approach in which large surveys are supported by qualitative data.

Consequently, we adopted psychological affect as an ontological approach to a systematic analysis of the most studied concepts and methods. Although physiological and sociological approaches to exploring one’s view of mathematics are likely to be developed in a multidisciplinary research area, we could collect a significant amount of data in the area of psychology, wherein the concept of view is identified. Therefore, the study aims to answer the following research questions:

1. What concepts are most frequently studied in primary school teachers' views of mathematics teaching and learning?
2. What objects are most frequently studied in primary school teachers’ views of mathematics teaching and learning?
3. What factors influence primary school teachers' views of mathematics, and how do these factors interact?
4. What research methods are commonly used to study primary school teachers' views, and what are the suggestions for further research?
5. What types of primary school teachers can be categorised by view profiles interconnected with influencers and expected outcomes?

With a prior coding process based on the literature, we established the variables and codes, including the participants, as shown in Table 3.

Table 3. The variables and codes used in the study

Participants	Concept	Object	Methods	Influencer	Expected outcomes
1. Pre-service class teacher	1. View (perspective, perception)	1. Mathematics teaching	1. Qualitative	1. Mathematical knowledge	1. Teachers’ actions
2. In-service class teacher	2. Beliefs	2. Mathematics learning	2. Quantitative	2. Past school experiences	2. Teachers’ knowledge
3. Both (heterogeneous)	3. Attitudes	3. The role of a teacher	3. Mixed	3. New experiences in teacher education	3. Teachers’ views
4. Both (homogeneous)	4. Feelings	4. The role of a learner		4. Teaching years	4. Students’ learning
	5. Anxiety			5. Other views	5. Students’ views
	6. Self-efficacy			6. Specialisation in mathematics	
	7. Self-concept				

The term ‘anxiety’, which represents negative emotions, has been intensively studied as an independent variable so far. Thus, it was coded separately from other positive or general feelings in this study. Additionally, we included knowledge as a minor variable to minimise the effects of mathematical knowledge on the results obtained from a psychological viewpoint.

3 Methodology

This systematic review analysed and interpreted all available empirical evidence related to the research questions according to the PRISMA 2020 guidelines. The PRISMA statement consists of a 27-item checklist, which provides a set of explicit and systematic methods to improve the transparency and rigour of the review process (Fan et al., 2022; Page et al., 2021).

3.1 Data sources and search procedures

The area of mathematics education was searched in three major databases (Proquest, Ebsco and Scopus) between January 2010 and December 2022. Additional sources included Google Scholar and a reference list of relevant articles. Regarding the search in Google Scholar, the initial result yielded 57900 volumes, from which the first 300 papers were investigated (see, e.g. Haddaway et al., 2015; Margot & Kettler, 2019).

To select and define the topic, ‘primary school teacher’ (primary OR elementary AND teacher) AND ‘views’ (OR perspective* OR belief* OR attitude* OR emotion*OR feeling*OR anxiety* OR self-*) AND ‘math*’ were screened in the titles, abstracts and keywords with identifying words in English. We then established the inclusion criteria (Figure 1). The results of the initial search are shown in Table 4.

Table 4. The results of the initial search and the first stage of screening

Search terms	Database	Search limiters	Hits
(primary OR elementary) AND teacher	Proquest	Scholarly (peer-reviewed) Journals Published: 2010–2022	232
AND math*	Ebsco	Scholarly (peer-reviewed) Journals Published: 2010–2022	867
AND view* OR perspective* OR belief* OR attitude* OR emotion*OR feeling*OR anxiety* OR self-*	Scopus	Scholarly (peer-reviewed) Journals Published: 2010–2022	260
	Google Scholar	Scholarly (peer-reviewed) Journals Published: 2010–2022	22
	Total with duplications removed		768

After the initial search, we screened 768 articles by their titles, keywords and abstracts with Rayyan online screening tool (an automatic computing system according to the author’s decision-making process; Ouzzani et al., 2016), according to the aim of the study. For instance, studies should be designed to explore the teachers’ views of mathematics teaching and learning for pre- and in-service primary school teachers.

A total of 108 articles were included in the first stage of screening. Then, we exported the references extracted from Rayyan back into the reference management software Zotero and double-checked them individually. The following criteria were used sequentially to select articles in the study based on the article abstract:

- Criteria 1: Study published between 2010 and 2020 in English.
- Criteria 2: Study published in a peer-reviewed scholarly journal.
- Criteria 3: Study participants included pre- and in-service primary teachers.
- Criteria 4: Study is empirical (qualitative, quantitative and mixed methods).
- Criteria 5: Study aligns with the current study's focus.

For the second screening, we excluded the intended interventions to explore influencers other than the intervention itself. Hence, the intended interventions were defined as any courses, programmes or planned activities that were undertaken to improve the main concepts of the view. In contrast, the natural study setting, as non-intended interventions, included one-time and more than two rounds of measurements (e.g. longitudinal) throughout the whole teacher education programme or in a homogenous group. The entire screening process is shown in Figure 1.

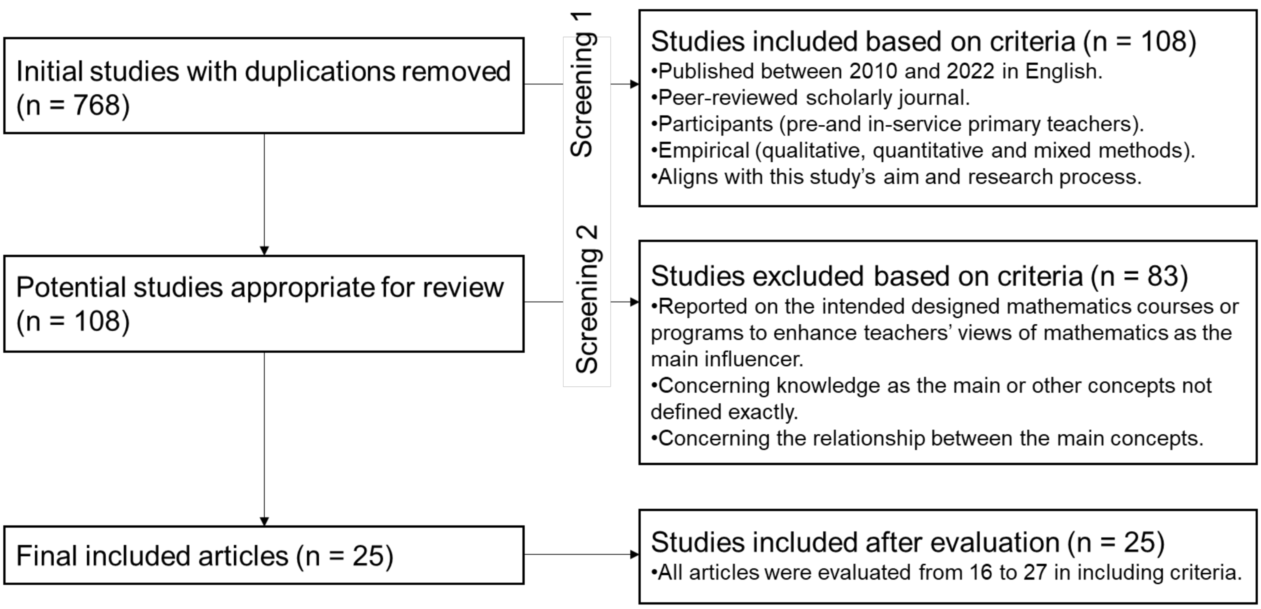

Figure 1. Flow diagram for the study, including the screening criteria and the evaluation process.

Note: The study by Leavy, Bjerke and Hourigan was accepted to the journal in August 2022 and was published in March 2023. Thus, we updated the references as follows: Leavy et al. (2023).

The first author examined all the papers one by one, and the other authors managed half of each paper; then, we compared them to decide the criteria until a high percentage of intercoder reliability was achieved. Next, we proceeded with an anonymous decision-making process to include or exclude papers. The first compromise rate was approximately 90% of the cases, and we discussed the remaining cases to reach an agreement regarding the reasons for exclusion. Examples of exclusion from research include the ‘wrong object case’ focusing on knowledge and mindset; ‘wrong design’, such as a methodological approach; and a lack of explanation between the concepts. The total number of final articles was 25, and the full texts were secured and extracted for evaluation by the study’s co-authors.

3.2 Evaluation

To evaluate the quality of the retained articles, we obtained a rubric that examined the seven elements (i.e. purpose, review of literature, theoretical or conceptual frameworks, participants, methods, results and conclusions and significance) of each study based on the standards of quality reporting (Margot & Kettler, 2019; Mullet, Rinn, & Kettler, 2017). The rubric featured a 4-point scale ranging from 1 = ‘Does not meet the standard’ to 4 = ‘Exceeds the standard’ (described in the quality assessment rubric; Margot & Kettler, 2019, p. 6). The total possible score range was 7–28, and any article that scored equal to or less than 14 or 1 point on any factor was excluded from the list (Margot & Kettler, 2019). The first and second authors evaluated all the retained articles, and none of them were excluded. Any disagreement was resolved through a discussion with all the authors.

3.3 Data extraction

The general information was extracted from each selected study (i.e. title, authors, published year, study place and participants with its scope). Based on the prior codes (see Table 3), the first author checked the entire article and the second and third authors each processed half of the total paper. All data were independently extracted using standardised Microsoft Excel and shared with other authors using an organisational data drive. The first compromise was 80%, and each discordant variable was investigated with reasonable evidence. Finally, we agreed on the extraction results (see the Appendix).

4 Results

The general information description provides background knowledge of the research process and the results. First, regarding the number of publications in each year, 44% of the total number of retained articles were published from 2020 to 2022, followed by more than one paper per year, except for 2012, 2014 and 2019, which did not have published papers. Next, more than a third of the articles (36%, n = 9) featured studies conducted in the United States. This was followed by Australia, Ireland, Taiwan and Turkey (8%, n = 2 each) and other countries with only one article each. According to a similar publication pattern in the systematic review conducted by Österling and Christiansen (2022), the unequal distribution of publications between continents and countries can be attributed to the limited range of publications written in English. Finally, regarding participants explored in each study, the majority of the 25 articles (60%, n = 15) collected data from pre-service class teachers, and about one-third obtained data from in-service class teachers (32%, n = 8). In addition, Blömeke et al. (2015) explored the mathematical beliefs of 231 German primary school teachers during their pre- and in-service teaching periods, whereas Artemenko et al. (2021) investigated the anxieties and attitudes of pre-and in-service class teachers in Germany and Belgium. The scope of the sample sizes varied from one participant (e.g. Purnomo et al., 2016) to over 1000 teachers and students (e.g. Marbán et al., 2021).

4.1 The most studied concepts and the definition of the view

4.1.1 The concept of the view

Figure 2 displays a network diagram illustrating two types of concepts studied (i.e. single concepts duplicated in 25 studies and multiple concepts in a single study) with node and arrow size and colours, offering research trend insights into interconnected concept attributes. Two-way relationship arrows for multiple concepts were illustrated except for one study (Marbán et al., 2021). The main concepts were investigated in the titles, keywords and abstracts, which were consistently emphasised throughout the entire process. About 68% of the studies (n = 17) studied a single concept, and 32% of the studies (n = 8) explored multiple concepts. In the landscape of primary school teachers' views of mathematics teaching and learning, the concepts that have received the most scholarly attention are beliefs and anxiety (32%, n = 8, respectively). In contrast, there has been a noticeable lack of research on the concepts of self-concept and the broader notion of 'view' in this context (4%, n = 1, respectively).

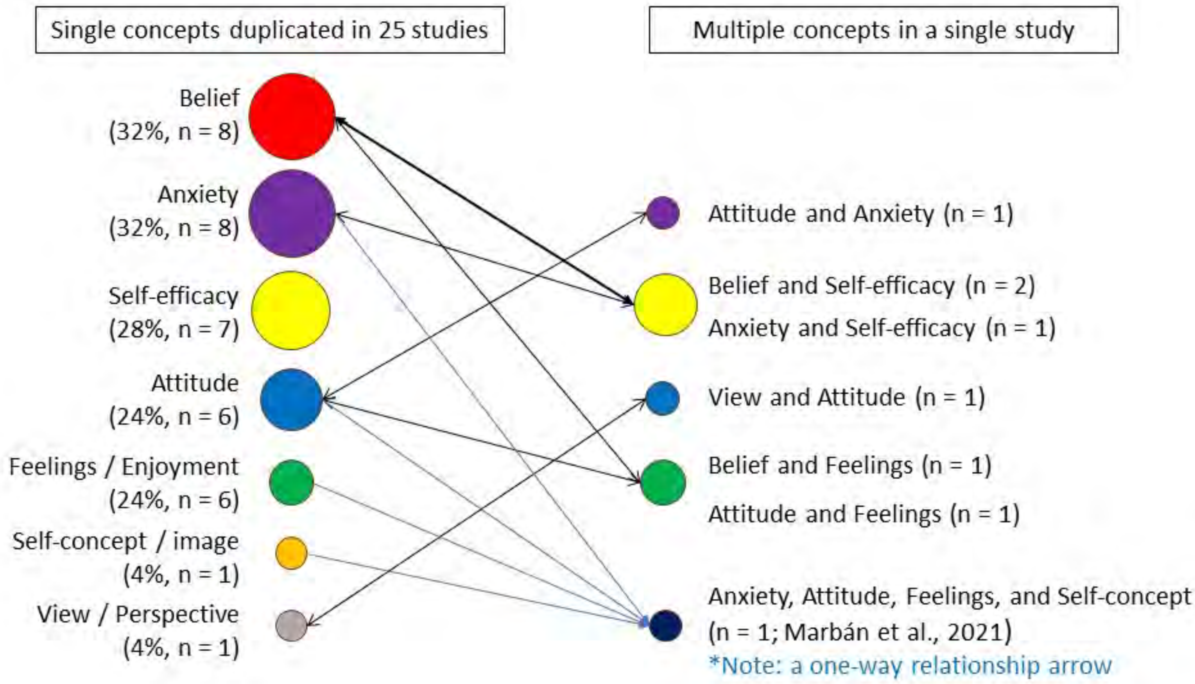

Figure 2. Network diagram for two types of concepts studied in 25 articles

Note: The percentage represents the calculated value for the corresponding frequency compared to 25 studies.

Several studies have explored multiple concepts. For example, Artemenko et al. (2021) delved into anxiety and attitudes, while Russo, Bobis, Sullivan, et al. (2020) examined attitudes and feelings, and the research of Jong and Hodges (2015) focused on perspective and attitude. Furthermore, studies have intertwined beliefs with other dimensions, such as self-efficacy in Hourigan & Leavy (2022) and Leavy et al. (2023) and feelings in Lin (2022). Interdisciplinary investigations also exist, as seen in Marbán et al.'s (2021) comprehensive exploration of attitudes, feelings, anxiety, and self-concept.

4.1.2 Definitions of the concepts

Most studies defined the main concept of view as a guide to individual teaching action. For example, according to Polly et al. (2013), teachers' beliefs towards teaching and learning influenced their decision-making steps regarding how mathematical concepts should be learned in the classroom. The authors categorised belief systems into three types: transmission-oriented (teacher presenting a set of mathematical facts to students), discovery-oriented (students' self-exploration of experience designed by the teacher) and connectionist (teacher–student joint learning to link mathematics concepts with various experiences).

Regarding self-efficacy, some studies subdivided the area of beliefs into teachers' competencies, teaching mathematics and teaching outcome expectations (e.g. Chang, 2015; Gonzalez-DeHass et al., 2017). They agreed with the teaching–learning process, in which teachers' self-awareness of mathematics was linked to their choice of learning activities, classroom management and teaching performance. Yet, Nurlu (2015) identified a gap between teaching self-efficacy and actual teaching expectations in three sub-factors of teachers' self-efficacy beliefs (i.e. the efficacy of mathematics teaching, motivating and responsible students and effective teaching awareness). Moreover, many studies clearly distinguished between personal mathematics teaching efficacy and mathematics teaching outcome expectancy (e.g. Chang, 2015; Giles et al., 2016), whereas Leavy et al. (2023) defined 'teaching efficacy' as teachers' competencies to support students' learning and achievement.

Jong and Hodges (2015) defined the term 'attitudes' as 'one's ways of feeling and thinking about mathematics' (p. 410), but Artemenko et al. (2021) included enjoyment and ease of teaching mathematics as the factors of attitudes. In addition, Perry (2011) described four constructs of attitudes towards mathematics: confidence in learning mathematics, the usefulness of mathematics, mathematics as a male domain and motivation based on the achievement goal approach. Otherwise, Russo et al. (2020) limited teachers' attitudes towards spending time on supportive instructions regarding students' struggles. Furthermore, anxiety represents a negative emotion and has been observed in physical reactions, such as panic, embarrassment, flurry, avoidance, failure and fear associated with a task, peer evaluation, mistake or success (Bekdemir, 2010; Gonzalez-DeHass et al., 2017).

Self-concept was mentioned with feelings and attitudes in only one study (Marbán et al., 2021), indicating that teachers with a high level of mathematics self-concept had the potential to become positive educators. Nevertheless, Jong and Hodge (2015) used the term 'conceptions on mathematics teaching and learning' in an overarching way in relation to attitudes, beliefs and dispositions.

4.2 The objects of the view

The objects of the view were coded into Mathematics Teaching (MT), Mathematics Learning (ML), the Role of a Teacher (RT) and the Role of a Student (RS). Figure 3 illustrates the corresponding frequency and percentage of the study objects. In 16 articles, two or more objects were investigated (64%), while eight articles (32%) analysed a single object. One study (Schaeffer et al., 2021) had no clear object emerge.

Numerous studies have explored the view of mathematics teaching (80%, n = 20), followed by mathematics learning (52%, n = 13), and the role of a teacher (40%, n = 10), with only one article focusing on the role of a student (Purnomo et al., 2016). Among them, some articles have examined the fundamental concepts related to multiple objects, such as mathematics teaching and the role of a teacher, and mathematics teaching and mathematics learning (24%, n = 6, respectively). A few studies have investigated mathematics teaching, mathematics learning and the role of a teacher (8%, n = 2), while the study by Purnomo et al. (2016) included the four objects all in one.

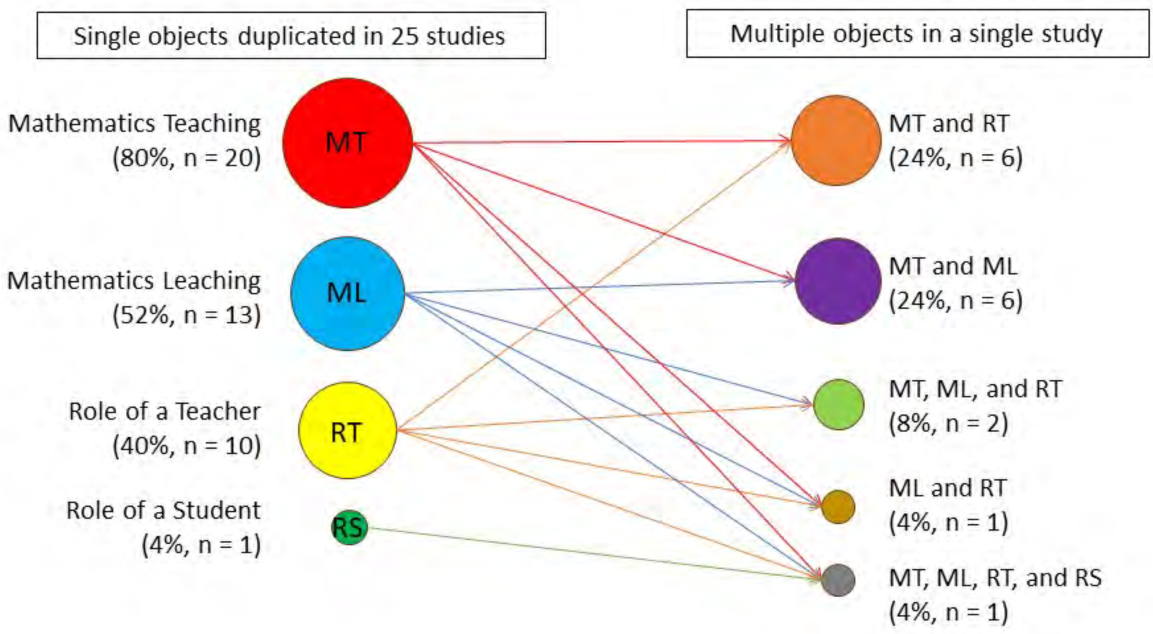

Figure 3. Network diagram for two types of objects studied in 25 articles

Note: The percentage represents the calculated value for the corresponding frequency compared to 25 studies.

Based on the comprehensive analysis of the object of view, we merged the data about mathematics teaching and the role of a teacher and mathematics learning and the role of a student. The factors linked to teaching and the teachers can be classified into four categories: organising process, teaching methods, handling students' struggles and learning and teachers' characteristics.

First, teachers' organising processes in the classroom reflected individual perspectives of mathematics teaching. Using a constructivist perspective, Bekdemir (2010) found that teachers tended to arrange their instructions from simple concrete concepts to complex abstract thinking for students, which the former can create as accessible mathematical ideas (Hourigan & Leavy, 2022). Therefore, teachers have daily duties to manage time and resources (Leavy et al., 2023), as well as flexible selections of instructions and activities (Nurlu, 2015), as facilitators responsible for discussing various ideas (Polly et al., 2013).

Second, there was a clear difference in teaching methods, depending on the point of view. For instance, student-centred pedagogies were used to discover and connect mathematical concepts with new teaching methods for teachers who have constructive views (Bekdemir, 2010; Polly et al., 2013), whereas teacher-centred practices (e.g. focusing on correct answers and preparing tests) were observed frequently in the transmissive viewers (Lo, 2021; Polly et al., 2013).

Third, teachers spent time in different ways managing their students' struggles and learning requirements. On the one hand, more sensitive teachers immediately recognised the changes in students' learning (Leavy et al., 2023) and focused on preparing for teaching mathematics and coping with students' problems with plenty of time (Nurlu, 2015). On the other hand, in a traditional classroom with transmissive perspectives, teachers focused on practising skills and test preparation so that students could find the correct answers (Lo, 2021). In addition, teachers with low levels of self-efficacy spent less time on in-depth studying when faced with difficulties in mathematics (Marbán et al., 2021).

Fourth, teachers' characteristics were focused on creating a specific learning environment. Hourigan and Leavy (2022) emphasised teachers' enthusiasm towards mathematics, and Nurlu (2015) presented two factors, namely, tolerance and willingness, to create emotional safety and a good relationship between teachers and students.

Regarding teachers' views of mathematics learning, Purnomo et al. (2016) indicated that 'beliefs about teaching mathematics include beliefs about learning mathematics' (p. 636). Therefore, most studies attempted to understand participants' views of mathematics learning in relation to its teaching using scale-based questionnaires. However, they did not precisely describe the learning process of how to connect previous knowledge to new experiences or how to foster mathematical thinking and sharing. Hourigan and Leavy (2022) also proposed a similar problem regarding the 'artificial perception of the teacher's role in learning' among pre-service class teachers, including those with an ambiguous vision of learning and fixed mindsets in students' abilities. Only the study by Purnomo et al. (2016) expanded the importance of learning mathematics: connecting the subject with students' daily lives and encouraging them to become seekers of information or knowledge.

4.3 The interactive factors with the view

Regardless of the amount of knowledge and experience, personal perceptions of mathematics tend to be formed at an early stage. Thus, in this case, exploring influencers or expected outcomes related to one's view of mathematics teaching and learning is a reasonable starting point with which to understand the structure of the view. Hence, we grouped the interactive factors with views into two categories: influencers and expected outcomes.

4.3.1 Influencers

Nearly half of the studies (44%, n = 11) explained that teachers' past school experiences in learning mathematics influenced mostly the formation of their views of mathematics teaching and learning. With the grouping process of each statement, we established the following sub-categories: previous teachers' behaviours or teaching approaches, peer relationships, exams or competitive environments, personal characteristics and subject context.

First, teachers had negative or positive experiences with their past when learning mathematics. For instance, hostile actions, including physical (e.g. punishment and time-out) and verbal (e.g. discouraging comments) interactions, led to feelings of unsafety among students (e.g. Bekdemir, 2010). In addition, teachers' deficient knowledge of teaching mathematics and methods disturbed classroom interactions, and most of them were less interested in mathematics thinking, questions and concerns about students' struggles (e.g. Stoehr, 2017). Therefore, almost every participant experienced traditional learning mathematics, such as a teacher-led didactic approach to teaching mathematics, which sent a signal to students that 'mathematics is not for all' (e.g. Hourigan & Leavy, 2022). In contrast, teachers' efforts to cultivate positive learning environments with caring attitudes and to provide suitable support individually (e.g. preparing challenges for fast learners) enabled students to learn mathematics happily and gain confidence in the subject (Dove et al., 2021; Pair & Dinh, 2022). Second, peer relationships were mainly linked to peer pressure caused by comparing themselves with others, different learning patterns or unequal opportunities for engaging in learning with multiple learners (e.g. Bekdemir, 2010).

Third, exams or competitive environments (e.g. separated classroom groups based on the test and a fixed concept of elite or ordinary mathematics learners) caused frustration and anxiety among students (Bekdemir, 2010; Lo, 2021; Stoehr, 2017). Fourth, Gonzalez-DeHass et al. (2017) and Perry (2011) focused on learning goal preferences as personal characteristics. In particular, they found that unbalanced situations between personal learning goals and teachers' teaching styles in the classroom negatively influenced the participants' views. For example, if students seeking to master mathematics concepts, regardless of how much time they would take, were forced to obtain a high score in a performance-centred classroom, they may develop mastery- or performance-avoidance goals in learning mathematics, as described by the statement 'I just always seemed behind' (Leavy et al., 2023, p. 6).

Finally, mathematics itself, as a subject context with scope and sequence-based contents, caused frustration for slow learners who may be unable to catch up to their proper levels (Leavy et al., 2023).

Regarding new experiences in the teacher education programme (17%, n = 6), including methods-related courses and teaching practice, they also greatly impacted the participants' views of mathematics teaching and learning. In particular, most of them were surprised at the innovative teaching methods (e.g. group discussions and student-centred pedagogies), and some of them had a chance to deepen their understanding of mathematics (e.g. Jong & Hodges, 2013). In addition, teaching practice supported pre-service class teachers' ability to implement constructive teaching methods (Giles et al., 2016; Jong & Hodges, 2013).

Other concepts of view (20%, n = 5) also influenced another view of mathematics teaching and learning. For example, Hourigan and Leavy (2022) emphasised the resultant beliefs about mathematics ability linked to attitude and self-efficacy, and Marbán et al. (2021) found a strong relationship between anxiety and enjoyment in teaching and learning mathematics. Further, the study by Russo et al. (2020) explored teachers' enjoyment of teaching mathematics and their corresponding attitudes.

The other factors presented in the studies were the school environment, such as appraisal and trust climate (Blömeke et al., 2015), and the parental factor (Dove et al., 2021). Lin (2022) and Russo et al. (2020) mentioned pre-service class teachers' mathematical knowledge, especially pedagogical content knowledge, as an influencer.

Interestingly, continual learning experiences and increased teaching experiences in mathematics were reported as slight differences in the two studies (Aljaberi & Gheith, 2018; Artemenko et al., 2021). Both studies indicated that the type of experience in teaching or learning mathematics had a more significant effect on the quality of mathematics teaching than the length of experience. Nevertheless, Artemenko et al. (2021) found that the experience of mastering and specialising in mathematics depended on the grade and complexity of the mathematics they were taught. In comparison, Aljaberi and Gheith (2018) reported that higher education and mastery of learning mathematics were inversely related to specialisation.

4.3.2 Expected outcomes

Research on outcomes requires considerable time and instruments, such as longitudinal or multiple sources. In addition, some participants with negative experiences in learning mathematics tend to conceal their negative emotions and attitudes to protect themselves from unsafe environments (e.g. shame and humiliation) during data collection (Stoehr, 2017). With this challenge, along with the hidden factors in scientific research, the outcomes were mostly in the theory or recommendation part rather than the results, except for the studies that included students' achievements with large samples (e.g. Polly et al., 2013).

Consequently, 19 articles (76%) anticipated that teachers' views of mathematics teaching and learning would influence teachers' actions in terms of instructional behaviours (e.g. Aljaberi & Gheith, 2018), decisions on teaching methods (e.g. Bekdemir, 2010) and classroom environment (e.g. Russo et al., 2020), among others. In addition, 11 (44%) and six studies (24%) indicated students' learning and students' views of mathematics as outcome factors, respectively. Among others, the study of Blömeke et al. (2015) estimated that those with constructive beliefs in mathematics teaching and learning could increase their job satisfaction.

4.4 Methodological approach

The ways in which various instruments are used and frequent experiments are conducted play a crucial role in predicting the accuracy of the results. In particular, over half of the studies (52%, n = 13) performed quantitative methods, about one-third of the studies (32%, n = 8) utilised qualitative methods, and four studies (16%, n = 4) merged data in a mixed manner. The frequency of data collection was mainly with one-time measurements (n = 17), followed by two rounds (n = 4) and more than three rounds of measurements (n = 4). In four mixed methods, 33–420 participants have participated in quantitative data collection. Then, about 5%–12% of those participants were selected for qualitative analysis, excluding single homogeneous and longitudinal studies in Germany (Blömeke et al., 2015).

The most frequently used instrument in quantitative methods was a revision of a previous rating scale for beliefs, anxiety, enjoyment, self-efficacy, attitudes and conceptions in 15 articles, followed by the self-developed tools for mathematics teaching practices (e.g. Aljaberi & Gheith, 2018) and mathematics learning experience (e.g. Jong & Hodges, 2013). For qualitative and mixed methods, semi-structured interviews and group interviews were used in 9 studies, whereas some studies used self-reported writing (e.g. Blömeke et al., 2015) and observations (e.g. Purnomo et al., 2016). Interestingly, Lin (2022) required 77 pre-service class teachers to complete drawing tasks to express themselves as mathematics teachers.

Although each method or instrument has its strengths and limitations, the expanded scope of participants with various data collection methods can enhance research triangulation. Thus, numerous studies have proposed longitudinal designs, including mixed examination for view change (e.g. Chang, 2015), multiple data collection for stronger comparisons (e.g. Jong & Hodges, 2013) and large-scale research including male teachers for outcome generalisation (Hourigan & Leavy, 2022; Stoehr, 2017). Furthermore, some studies pointed to the limitations of self-reporting materials and convenience samples (e.g. Giles et al., 2016).

At the same time, many studies recommended that cross-regional, institutional and cultural backgrounds should be reflected in future research to support their evidence and understanding of phenomena in primary mathematics education (e.g. Artemenko et al., 2021). The majority of primary school teachers are women, and they are reported to suffer from mathematics-induced anxiety more than men worldwide (e.g. Schaeffer et al., 2021). However, gender effects have not yet been confirmed. Hence, each study preferentially considered social, cultural, economic and educational characteristics regardless of the gender imbalance of primary school teachers. For example, pre-service class teachers in Germany experience long practical teaching training with mentoring for a smooth transition (Blömeke et al., 2015), whereas Ireland has one national curriculum that requires mandatory mathematics for all students to graduate from secondary school (Leavy et al., 2023). Moreover, Hong Kong, with its Confucian heritage classroom, frequently experiences teacher-centeredness (Lo, 2021), whereas, in the cultural context of Cyprus, resilience has been regarded as the most important social value of teachers' professionalism (Xenofontos & Andrews, 2020).

4.5 Types of teachers based on view profiles

Generally speaking, primary school teachers with negative mathematics learning experiences are assumed to possess high levels of anxiety, low self-efficacy or fixed beliefs towards the subject. In turn, those views of mathematics would have a negative impact on their teaching behaviours. However, in the study by Lo (2021), pre-service class teacher groups with positive and negative learning experiences in mathematics appeared to be enthusiastic teachers who endeavour to create better learning classrooms by reflecting on their strengths and weaknesses. Xenofontos and Andrews (2020) described such motivational willingness as resilience in the face of challenging mathematical situations and found that most in-service class teachers desired never to give up teaching mathematics. Therefore, it is worth noting which types of teachers have been highlighted in the follow-up research, along with recommendations to support pre- and in-service class teachers according to the view profiles. We categorised them into three groups, namely, (A) mutual consistency, (B) weak consistency and (C) inconsistency (contradictory), based on the relationship between their views of mathematics and their expected outcomes (Figure 4).

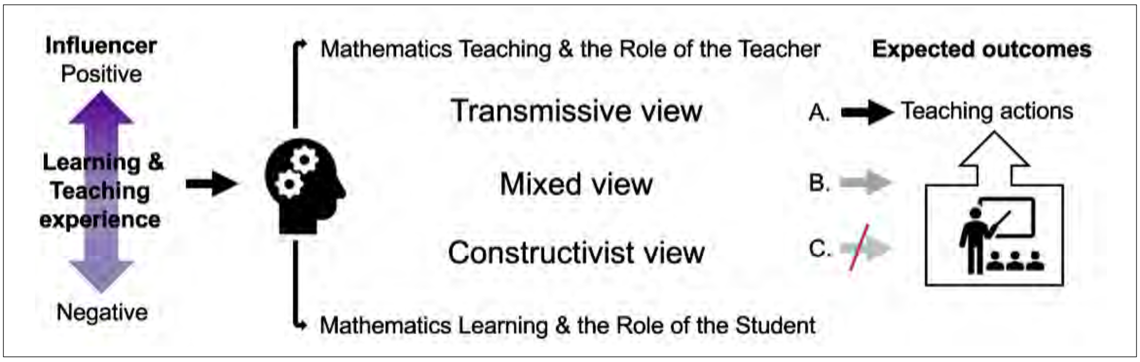

Figure 4. Illustration of the three types of teachers needing different kinds of attention based on the relationships: (A) Mutual consistency, (B) Weak consistency and (C) Inconsistency (contradictory)

Above all, many studies highlighted intensive support for the A-type (mutual consistency), negatively demonstrating the similarity between participants' perspectives, beliefs, attitudes, emotions or self-efficacy and the expected outcomes. For example, highly anxious teachers with negative mathematics learning experiences relied on more traditional teaching methods (e.g. teacher-centred instructions, worksheets or memorising patterns and algorithms) while undermining students' learning habits (e.g. Artemenko et al., 2021). Moreover, as the most worrisome types of teachers, groups of early-stage in-service class teachers with static beliefs and insufficient knowledge (Blömeke et al., 2015) and pre-service class teachers with relatively low levels of efficacy and knowledge were proposed (Chang, 2015). In summary, teachers with low knowledge and self-efficacy, or those with fixed beliefs in teaching and learning, were revealed as major concerns in numerous studies (e.g. Hourigan & Leavy, 2022).

Meanwhile, Type B (weak consistency between perspective and outputs) had mixed views of mathematics teaching and learning. In the study by Hourigan and Leavy (2022), there were mixed perceptions between mathematics efficacy in solving the problem and mathematics teaching in Type B, such as 'I'm doing good at math but I'm not sure [of teaching] effectively" (p. 25). Hourigan and Leavy (2022) noted that the confused perception between individual mathematics efficacy and teaching efficacy would make pre-service class teachers weakly aware of their role in students' learning. Instead, they are likely to focus on fixed external factors (e.g. disposition and parents' support) related to students' competence. According to Stoehr (2017), some teachers with high levels of mathematics anxiety but constructive learning perspectives have been shown to avoid self-development in precisely understanding mathematics concepts. In addition, Lin (2022) expressed concerns about the actual teaching behaviours of pre-service class teachers with mixed concepts about teaching and learning mathematics, as shown in their drawings.

Regarding Type C (inconsistency or contradiction between perspectives and expected behaviours), we obtained some interesting results. For example, Leavy et al. (2023) pointed out that some pre-service class teachers with successful experiences and high self-efficacy in traditional past learning environments are likely to use the equivalent method in teaching mathematics. The authors were concerned that teachers with high confidence in mathematics would be excluded from subsequent studies, mainly due to the belief that they would implement effective mathematics teaching methods. Meanwhile, Perry (2011) recommended that future research should deeply explore teachers with high mastery goals for learning mathematics while teaching traditional mathematics (e.g. performance-oriented goals). This mismatch can cause greater confusion for students; for example, students with performance-approach goals are eager to make judgments of their ability, whereas those with performance-avoidance goals try to prevent any negative judgments about their work. These groups of students face the risk of either performance- or achievement-avoidance tendencies with high levels of anxiety.

Furthermore, according to Perry (2011), previous studies do not recommend changes in one's learning-oriented goals; however, supporting pre-service class teachers in a mastery-oriented learning environment can help them acquire positive attitudes towards teaching mathematics. In the same vein, Xenofontos and Andrews (2020) found that the two groups showed a strong vision for mathematics teaching but managed classrooms in different ways. The first group with strong mathematics backgrounds (e.g. positive experience and high confidence in mathematics) focused on learning conceptual understanding in a challenging atmosphere, whereas the second group with less advanced backgrounds (e.g. negative experience and low confidence in mathematics) focused on emotional security, such as enjoyment and preventing negative experiences for students. The authors were concerned that the second group would be less interested in undergoing in-depth learning.

Accordingly, many studies recommended follow-up research on long-term, individual and strategic support for pre-and in-service class teachers. For example, Jong and Hodge (2013) claimed that providing regular learning and implementation opportunities might affect pre-service class teachers' attitudes towards mathematics. In another study (Jong & Hodge, 2015), they confirmed that mathematics-related pedagogical methods are helpful for pre-service class teachers with negative attitudes, although environments and materials are also considered significant factors influencing teachers with positive attitudes. Similarly, Pair and Dinh (2022) highlighted the importance of teacher education programs and educators, particularly the need for deliberate group formation experiences that take personal learning habits and dispositions into account for successful group discussions. Finally, Xenofontos and Andrews (2020) proposed different kinds of support for pre-service and in-service class teachers, namely, subject knowledge with self-abilities to teach mathematics meaningfully for the former and pedagogical content knowledge with skills to teach mathematics effectively in facilitating students' learning for the latter.

5 Discussion and conclusions

To collect empirical evidence regarding the structure of the view of mathematics and explore view profiles in primary school class teachers, we systematically analysed peer-reviewed articles published between January 2010 and December 2022, and intensively identified 25 papers among them. Guided by this purpose, we extracted and analysed data concerning the most studied topics (i.e. the main concept of view and the object of view), interacting factors with views (i.e. influencers and expected outcomes), the types of teachers for follow-up research and methodological approaches, including limitations and recommendations.

In summary, the concepts of the views of mathematics teaching and learning have been frequently studied with other concepts, similar to the cross-sectional characteristics of concepts raised in previous studies (e.g. Hannula et al., 2005; Shilling-Traina & Stylianides, 2013). In addition, the objects of the views mainly focused on mathematics teaching and the role of a teacher, whereas there was relatively little interest in mathematics learning and the role of a student. However, as proposed in the structure of the view of mathematics (Hannula et al., 2005; Rösken et al., 2007), such a view of the self as a learner and a teacher should be explored (Joutsenlahti, 2005).

Then, we categorised the factors of teaching and the role of a teacher into organisations, teaching methods, handling students' struggles and learning and teachers' characteristics. The findings indicate that these factors represent the self-regulation of one's view of mathematics, as mentioned by Pehkonen (1998), from a transmissive to a constructivist view (Chamberlin, 2013). For instance, as facilitators are eager to discuss ideas, those with a constructivist perspective endeavour to create instructions and activities as accessible mathematical ideas. They are likely to spend sufficient time solving students' problems, such as their struggles and learning paths. Meanwhile, those with transmissive perspectives relied on teacher-centred methods to practice skills and prepare for tests. Some teachers with low levels of self-efficacy might avoid facing any difficulties in mathematics and focus more on creating emotional safety. However, some studies illustrated the complex relationships between teachers' views and their expected actions, thereby echoing the findings of Kayan Fadlelmula (2022) and Thompson (1992). Thus, some mixed concepts of teachers' views, such as negative attitudes towards mathematics but constructive views regarding teaching mathematics, may cause artificial perceptions about teachers' role in students' learning.

Although each study explored the object of the view of mathematics separately, the spectrum of the view of mathematics was similarly shown from positive to negative (Hannula et al., 2005). Based on the results, we confirmed that dynamic and complicated factors regarding one's view of mathematics teaching and learning should be explored in relation to their outcomes, which we categorised into three groups (i.e. mutual consistency, weak consistency and inconsistency or contradictor). These groups show the typical needs of different kinds of support and view profiles. However, following an ontological approach to affect, some studies did not consider the view in terms of a state or a trait characteristic, which might cause inappropriate method selection in exploring the relevant concepts. For example, some emotions, such as feelings or goal-related concepts, were solely examined through interviews or questionnaires, which are better suited for exploring attitudes, values, or belief concepts (Hannula, 2007).

Thus, we propose several suggestions for future research. First, research methods should be sufficiently considered in one of the ontological approaches to affect.

Second, the object of view must be expanded from mathematics teaching to mathematics learning, including the roles of a teacher and a student. Third, the view profiles must be identified in dynamic ways so that they can be linked to the mechanisms between individual teachers' views and teaching behaviours. Fourth, in agreement with Hannula (2007), a relatively sufficient research period with multiple methods and instruments is recommended. Finally, expanding the study target group into pre-service and in-service class teachers, as well as teacher educators with a large sample and heterogeneous settings (e.g. distinct backgrounds at the national, regional and institutional levels), could provide more practical and specialised insights into the topic.

There are several limitations to the study. First, we screened only the articles written in English in four databases. Thus, a broad search language and dataset would provide a deeper understanding of the topic (e.g. Lehtonen et al., 2019). Second, to explore the nature of influencers in relation to the view of mathematics, we excluded any intended designed courses or programmes to enhance the view. For future research, specifically designed resources (e.g. teaching methods courses and teaching practice) could increase the accuracy of the research results, such as for analysing the relationship between new experiences and their view change. Third, we excluded mathematical knowledge in the second stage of the screening to explore other influencers. Although our review regarded the knowledge factor as a minor variable, mathematical knowledge has the potential to link teachers' views to their effective instructional behaviours. Finally, in accordance with the statement made by Hannula (2007), the physiological and sociological approaches that affect the view of mathematics are worthy of further exploration.

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Note: Studies included in the systematic review are indicated by an asterisk (*).

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Appendix

#	Authors	Year	Study place	Participants (scope)	Concept	Object	Methods	Influencer	Expected outcomes
1	Aljaberi, N. M., & Gheith, E.	2018	Jordan	2 (101)	2	1, 2, 3	1	6	1, 4
2	Artemenko, C., Masson, N., Georges, C., Nuerk, H.-C., & Cipora, K.	2021	Germany, Belgium	3 (1106)	3, 5	1, 2	1	6, other	3, 4, 5
3	Bekdemir, M.	2010	Turkey	1 (167)	5	1, 3	3	2	1, 5
4	Blömeke, S., Hoth, J., Döhrmann, M., Busse, A., Kaiser, G., & König, J.	2015	Germany	4 (231)	2	1, 2	3	1, other	1, 6
5	Chang, Y.-L.	2015	Taiwan	2 (1302)	6	1	1	–	1, 4, 5
6	Dove, J., Montague, J., & Hunt, T. E.	2021	UK	2 (4)	5	2, 3	2	2, other	3
7	Giles, R. M., Byrd, K. O., & Bendolph, A.	2016	USA	1 (41)	6	1	1	3	4, 5
8	Gonzalez-DeHass, A. R., Furner, J. M., Vásquez-Colina, M. D., & Morris, J. D.	2017	USA	1 (182)	5, 6	2	1	Other	4
9	Hourigan, M., & Leavy, A. M.	2022	Ireland	1 (450)	2, 6	1, 3	3	2, 5	3, 4, 5
10	Jong, C., & Hodges, T.	2013	USA	1 (75)	3	1, 2	1	2, 3	1
11	Jong, C., & Hodges, T. E.	2015	USA	1 (146)	1, 3	1	1	2, 3	1, 3, 4
12	Leavy, A., Bjerke, A. H., & Hourigan, M.	2023	Ireland	1 (402)	2, 6	1, 3	3	2	1, 4, other
13	Lin, Y.-C.	2022	Taiwan	1 (77)	2,4	1, 2	2	1, 5	–
14	Lo, W. Y.	2021	Hong Kong	1 (19)	2	1, 3	2	2	1, 3
15	Marbán, J. M., Palacios, A., & Maroto, A.	2021	Spain	1 (1473)	3, 4,5,7	1	1	5	1, 3
16	Nurlu, Ö.	2015	Turkey	2 (4)	6	1, 3	2	–	1, 4
17	Pair, J., & Dinh, K.	2022	USA	1 (20)	4	2	2	2, 3, other	1
18	Perry, C. A.	2011	USA	1(384)	3	1	1	Other	1, 3, other
19	Polly, D., McGee, J. R., Wang, C., Lam bert, R. G., Pugalee, D. K., & Johnson, S.	2013	USA	2 (471)	2	1, 2	1	–	1, 4
20	Purnomo, Y. W., Suryadi, D., & Darwis, S.	2016	Indonesia	1 (1)	2	1, 2, 3, 4	2	1, 2, 5, other	1
21	Russo, J., Bobis, J., Sullivan, P., Down -ton, A., Livy, S., McCormick, M., & Hughes, S.	2020	Australia	2 (98)	3, 4	1, 2, 3	1	5	1
22	Schaeffer, M. W., Rozek, C. S., Maloney, E. A., Berkowitz, T., Levine, S. C., & Beilock, S. L.	2021	USA	2 (591)	5	–	1	–	1, 4
23	Stoehr, K. J.	2017	USA	1 (1)	5	1, 2	2	2, 3	1, 2
24	Wilson, S.	2013	Australia	1 (219)	5	2	1	Other	1, 5
25	Xenofontos, C., & Andrews, P.	2020	Cyprus	2 (22)	6	1, 3	2	2, 3	1