Pedagogical Perspective

2024, Vol 3, No 2, 358-384
ISSN: 2822-4841
https://doi.org/10.29329/pedper.2024.81

Teacher noticing skills in mathematics education: A meta-synthesis of recent studies[1]

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Article Info

Keywords

Noticing
Teacher noticing
Mathematics education
Meta-synthesis

Article History

Received 31.10.2024
Received in revised form 24.11.2024
Accepted 25.11.2024

Article Type

Research Article

Abstract

The present study examines articles published internationally from 2002 to 2023 that pertain to the skill of noticing in mathematics education. A thorough search was performed using the Web of Science and Scopus databases, focusing on journal article with this field. The purpose of the study was to systematically review and analyze research related to the noticing skill in mathematics education. Specifically, the study seeks to identify emerging trends, generate new research ideas, highlight underexplored areas within the field, and suggest potential research topics. The meta-synthesis method was employed to analyze various characteristics of the studies on noticing in mathematics education, including sample size, sample group, research methods, data collection tools, theoretical frameworks, content areas studied, objectives of the studies on noticing, components of noticing, and conceptualization of noticing. The analysis reveals that the majority of studies on teacher noticing have relied on small sample sizes and predominantly qualitative research designs, with a noticeable increase in the adoption of mixed-method approaches in recent years. The most commonly used data collection tools were video recordings and written notes, underscoring the importance of capturing real-time classroom interactions and reflective observations. The primary focus of these studies has been particularly on the domain of teaching numbers. Findings indicate that studies often integrate multiple components of noticing, reflecting a comprehensive approach to understanding how teachers observe, interpret, and respond to student behaviors. These findings indicated that researchers have diversified the field of noticing, resulting in a wide array of studies.

1 Introduction

The process of noticing encompasses the skills of attention, observation, and comprehension (Ball, 2011). This process is not random; rather, it is carried out intentionally and deliberately (Mason, 2011). Noticing involves the purposeful use of cognitive and perceptual abilities to identify and interpret significant elements within a specific context. Researchers have conducted various

[1] This study is based on the first author's master's thesis prepared under the supervision of the second author.

Cite: Öztürk, A., & Özgeldi, M. (2024). Teacher noticing skills in mathematics education: A meta-synthesis of recent studies. *Pedagogical Perspective, 3*(2), 358-384. https://doi.org/10.29329/pedper.2024.81

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studies to explore how individuals perceive and interpret their external worlds and surroundings. These studies particularly focus on individuals' noticing skills in specific domains, emphasizing how the process of noticing operates within contextual and domain-specific frameworks (Goodwin, 1994; Mason, 2002; Stewen & Hall, 1998). This line of research highlights the systematic and goal-oriented nature of noticing, shedding light on its critical role in understanding and responding to external stimuli.

Although the concept of noticing has been defined in various ways in the literature, it is frequently associated with expertise (Amador, 2022). Teacher noticing, in particular, is considered a critical aspect of professional expertise (Lin, 2023). A teacher who can notice within the classroom context is regarded as having developed profound expertise aligned with educational objectives and goals (Lee, 2021). In this regard, teachers' noticing abilities play a central role in guiding instructional processes effectively and achieving teaching goals.

Noticing skills fundamentally consist of a three-stage process (Jacobs et al., 2010; Sherin & van Es, 2005; van Es & Sherin, 2002). The first stage requires the teacher to direct their attention toward events occurring in the classroom, making crucial decisions about which events to focus on amid the numerous simultaneous occurrences. The second stage involves the teacher analyzing these noticed events in depth, connecting them to instructional principles and methods. The final stage is decision-making, where teachers adjust their instructional activities based on these analyses. This process is essential for teachers to effectively respond to classroom dynamics and optimize their teaching strategies.

Sherin et al. (2011) organized the teacher's noticing process into two core components: 'engaging with specific events in the educational setting' and 'making sense of classroom events.' Jacobs et al. (2010) introduced a third component, referred to as the decision-making phase, which emphasizes the responses teachers make based on their interpretations of student activities. While many studies focus on one or two components of noticing, Jacobs et al. (2010) conceptualized noticing as a professional noticing framework, which integrates three interrelated skills. This professional noticing particularly includes recognizing children's mathematical thinking, enhancing educators' capacity to gain a deeper understanding of student comprehension and implement appropriate pedagogical interventions (Jacobs et al., 2010). This framework centers on developing effective decision-making and the ability to interpret student interactions within instructional practice.

While the importance of noticing is emphasized, it is equally critical to acknowledge the necessity of applying this skill effectively. Teachers' utilization of this skill occurs within the framework of their knowledge and orientations. How teachers follow up on and implement what they notice is shaped by their existing knowledge and orientations (Scheiner, 2016). Therefore, teachers' perceptions are influenced not only by what they visually observe but also by their cognitive processes and prior knowledge (Scheiner, 2016). This underscores the growing importance of developing professional noticing skills within teacher education. Such skills enable teachers to manage classroom interactions more effectively and enrich students' learning experiences.

A review of the literature indicates that noticing has emerged as a prominent and extensively studied concept in recent years (Güner, 2017). Consequently, its importance has been highlighted and explored across numerous studies. In this context, König et al. (2022) conducted a comprehensive analysis of 182 articles, examining the conceptualization of noticing skills, research designs, and findings related to learning. This study emphasizes the importance of

developing teachers' noticing skills by thoroughly analyzing how noticing processes impact student learning. As a systematic review, it aims to contribute significant findings to teacher education and professional development, with the objective of enhancing educational quality and improving student outcomes.

Given the need to understand the direction of noticing research, identify commonalities and differences among studies, and conduct an in-depth exploration, this research employs a meta-synthesis approach. By analyzing articles published in the Web of Science and Scopus databases through meta-synthesis, this study aims to generate new insights for researchers and identify unexplored areas in noticing, thus highlighting new avenues for research. In this regard, it seeks to examine and analyze studies on teacher noticing in mathematics education, categorizing them by year, characteristics, variables, objectives, and components. The purpose of this study was to systematically review and analyze research conducted on noticing in mathematics education. Accordingly, the following research questions guide this investigation:

1. What are the characteristics of studies focused on noticing in mathematics education?
2. What are the objectives of research on noticing within the context of mathematics education?
3. What are the cognitive processes involved in teacher noticing in mathematics education?
4. How is the concept of 'noticing' conceptualized in the context of mathematics education?

2 Theoretical background

Since the 2000s, noticing has emerged as a key skill teachers need to support their professional development (Bastian et al., 2022; Birinci & Baki, 2019). Integrated into teaching and learning processes, this concept has evolved into what is known as the skill of noticing (Miller, 2011). Noticing skills relate to teachers' understanding of student learning through their focus areas, reasoning processes, and instructional decisions in teaching activities (Star & Strickland, 2008; van Es & Sherin, 2008). Consequently, noticing has become a new theoretical construct widely studied by researchers (Fernandez et al., 2012; Goldsmith & Seago, 2011; van Es & Sherin, 2002; van Es & Sherin, 2008).

A review of the literature reveals various definitions of noticing. Mason (2002) defines it as the ability to understand and interpret events occurring in a classroom, while van Es and Sherin (2002) describe it as the capacity to identify significant events in instructional processes, link these events to teaching and learning criteria, and explain their causes using existing knowledge. Jacobs et al. (2007) expand on this by defining noticing not only as recognizing certain events but also as the responses shown toward them. Despite differing perspectives on noticing, researchers share a common view: noticing encompasses teachers' attention to classroom actions, interactions, thought processes, and decisions (McDuffie et al., 2018). In other words, noticing involves not only how teachers observe and focus on classroom events but also how they interpret this information and take action based on their interpretations.

In recent years, there has been a growing interest in professional noticing within mathematics education. This interest has been fueled by researchers' efforts to understand both how the noticing process occurs and how it can be integrated into educational practices (Star & Strickland, 2008; van Es, 2011). It is recognized that the components of noticing are intertwined and overlapping, allowing mathematics teachers to move fluidly between them, continuously interpreting students' thinking and making responsive instructional decisions based on what they notice at the moment. Van Es and Sherin (2002) explored teachers' perceptions and responses to classroom events, introducing a three-stage framework to conceptualize the noticing process

during classroom interactions. This framework includes: recognizing and focusing on significant classroom events, linking these events to relevant teaching principles, and reasoning about these events while establishing meaningful connections. The first stage emphasizes the importance of teachers consistently observing classroom interactions during lessons and identifying events that hold pedagogical significance (Sherin & van Es, 2005). In the second stage, teachers analyze and interpret the relationship between these significant events and teaching principles, facilitating informed pedagogical decision-making (Sherin & van Es, 2005). The third stage focuses on teachers using their professional expertise to reason about these events and establish meaningful pedagogical connections (Sherin & van Es, 2005). This framework not only aids teachers in effectively managing classroom dynamics but also enables them to implement strategies that enhance student learning. Additionally, it fosters professional growth by encouraging continuous improvement in instructional practices.

The framework introduced by van Es and Sherin (2002) has been extensively applied in subsequent research by scholars such as Osmanoğlu et al. (2012), Dreher and Kuntze (2015), and Birinci and Baki (2019). These studies have focused on how teachers and preservice teachers identify, analyze, and inform their pedagogical decisions through classroom interactions. This framework has become a pivotal resource in teacher education, providing valuable insights into the development of noticing skills to improve teaching effectiveness. Professional noticing, as defined by van Es and Sherin (2002), aligns closely with their original conceptualization but shifts its emphasis from observing general classroom events to a more specific focus on professionally attending to children's mathematical thinking processes (Louie, 2018).

Jacobs et al. (2010) further elaborate that professional noticing encompasses three interconnected components: engaging with students' ideas, interpreting these ideas, and making instructional decisions based on informed pedagogical assessments. Jacobs et al. (2010) conducted a study with 131 preservice and inservice teachers, investigating their professional noticing of students' mathematical reasoning, with a particular emphasis on the aspects of *attending*, *interpreting*, and *decision-making*. In the attention phase, teachers should focus on the mathematical details within their students' thinking styles in the classroom. Teachers who attend to these details can better interpret students' ways of thinking and develop expertise in this area. During the interpretation phase, teachers need to analyze how these mathematical details shape students' mathematical thinking processes. In the decision-making phase, teachers should decide how to respond to students based on insights gained from their mathematical thinking and make appropriate pedagogical interventions accordingly. The findings revealed that preservice teachers struggled to focus on students' mathematical thoughts and that, over time, decision-making skills were more challenging to develop than attending and interpreting skills.

Similarly, Amador (2016) conducted a study focusing on professionalization in mathematics education, employing the professional noticing framework developed by Jacobs et al. (2010). This study examined how preservice teachers applied professional noticing while conducting teaching experiments and analyzing students' mathematical thinking models. Results showed that, while preservice teachers could make some evaluative comments during professional noticing practices, they often struggled with in-depth analysis and rarely connected students' thinking with broader teaching and learning principles. These findings underscore the need for supporting preservice teachers in developing their professional noticing skills. Subsequent work on the conceptualization of noticing has been conducted by König et al. (2022). In their systematic review of teacher noticing, König and colleagues (2022) examine how the concept of teacher noticing is defined, the

characteristics of research designs in this field, and findings on enhancing teachers' noticing skills. The Perception, Interpretation, and Decision-Making (PID) model developed by Kaiser et al. (2015) divided teachers' skills into three core components. This model detailed how teachers perceive specific events in a teaching environment, interpret these events, and respond to students or offer alternative teaching strategies. In this context, the model defined 'teachers' context-specific skills as essential components that enhance and support knowledge-based learning' and included 'the teacher's processes of perceiving, interpreting, and making decisions' (Kaiser et al., 2015). The PID model was intentionally created to address the demand for examining teachers' skills within specific contexts, a domain that remains underexplored in current research (Kaiser et al., 2017). These context-specific skills enabled teachers to make more informed and effective decisions in the classroom.

The study by Yang et al. (2019) underscored the significance of situational approaches in assessing teachers' professional competencies. In this research, situational approaches were highlighted as a critical method for evaluating teachers' competencies, providing insights into their ability to devise solutions tailored to the challenges encountered in authentic classroom settings. This methodology also contributed to a global study in Germany that evaluates the efficacy of mathematics teacher education across diverse cultural contexts, encompassing participants from both Eastern and Western regions (Yang et al., 2019). Additionally, it enhances the assessment of teachers' classroom practices, serving as a foundation for the PID model (Kaiser et al., 2015). Moreover, the study by Bastian et al. (2022) examined the impact of varying levels of teaching experience on the development of expertise in teachers' noticing skills, specifically among three teacher groups: novice teachers, experienced teachers, and expert teachers. This research investigated how the length of teaching experience influences the growth of expertise in noticing skills and the distinctions among context-specific skills. Using a video-based tool to assess teachers' noticing abilities, the study categorized these differences and analyzed them using the PID model.

The teacher's noticing skill carries a distinctive quality compared to the everyday concept of noticing, and there is a broad consensus on this distinction (Dindyal et al., 2021). In the noticing process, the teacher takes on an active role (Yeşil, 2021). Researchers have conceptualized the components of noticing, in which the teacher actively participates, from various perspectives (Mason, 2002; Sherin et al., 2011). With the growing interest in studies on teachers' noticing skills, interest in these conceptualizations has also increased (Dindyal et al., 2021). The process of conceptualization in education is of great importance for enhancing the knowledge and skills of both teachers and students. When examined through various perspectives, this process provides a deeper understanding of educational practice and teacher development. Building on earlier work, König et al. (2022) conducted a comprehensive systematic review on the conceptualization of teacher noticing. Their study explored how teacher noticing has been defined, analyzed the characteristics of research designs in this field, and investigated findings related to enhancing teachers' noticing abilities. This work provides a detailed overview of the existing research landscape and contributes to a deeper understanding of the factors that influence the development of teacher noticing. They analyzed the theoretical conceptualization of the noticing process from four different perspectives: *cognitive-psychological, socio-cultural, discipline-specific,* and *expertise-based*. Each perspective addresses various aspects of teachers' noticing processes and their implications for teacher education and practice.

These four theoretical frameworks offer valuable insights into the multifaceted nature of teacher noticing, serving as a foundation for understanding and enhancing this critical process. Each perspective highlights unique aspects of noticing, providing distinct implications for the design and implementation of teacher education programs. Collectively, they contribute to the professional growth of educators by informing strategies and practices that support the development of effective noticing skills. The *cognitive-psychological perspective*, developed by van Es and Sherin (2002), defines teachers' noticing ability as a mental process that occurs within teaching and learning contexts. According to this perspective, teachers' ability to assess and interpret classroom observations is closely linked to individual cognitive processes. These processes shape teachers' capacity to understand student responses and develop appropriate pedagogical actions. The *socio-cultural perspective*, proposed by Goodwin (1994), advocates for understanding teacher noticing as a social and cultural phenomenon within a framework of professional vision. This perspective emphasizes that teachers' awareness is shaped by the norms and values of their professional communities and develops within these social structures. What and how teachers notice in the classroom are profoundly influenced by their social interactions and cultural practices. Moreover, Mason (2002) developed the *discipline-specific perspective*, defining teacher noticing as practices aimed at enhancing teachers' awareness within specific disciplines, such as mathematics. This approach focuses on helping teachers better understand discipline-specific events, concepts, and student thought processes, enabling them to respond accordingly. The *expertise-based perspective*, introduced by Berliner (2001), focuses on the differences between expert and novice teachers in teacher noticing. This perspective argues that experienced teachers have more advanced abilities to perceive, interpret, and respond to classroom events compared to novice teachers. Expert teachers, owing to their rich experiences and deep knowledge, can manage classroom dynamics more effectively and develop strategies that better support student learning.

In light of the evolving understanding of noticing as a crucial skill for teacher professional development, a meta-synthesis is necessary to consolidate and deepen our comprehension of this construct across various studies. The literature reveals a complex landscape of definitions and interpretations of noticing, emphasizing its multifaceted nature that encompasses attention, interpretation, and responsive decision-making in instructional contexts. However, the variability in definitions and findings—especially concerning the challenges faced by preservice teachers in developing these skills—highlights gaps in our current understanding. A meta-synthesis can integrate these diverse perspectives, allowing for a comprehensive analysis of the factors influencing the development of noticing skills in mathematics education. By synthesizing existing research, we can identify best practices, common challenges, and effective strategies for supporting teachers in cultivating their noticing abilities. Ultimately, this synthesis will contribute to a more nuanced theoretical framework, guiding future research and informing educational practices aimed at enhancing teacher effectiveness in recognizing and responding to student learning in the classroom.

3 Method

The analysis of internationally published articles focusing on noticing began with the application of *descriptive content analysis* to systematically present relevant information (Polat & Ay, 2016). Following this, a *meta-synthesis approach* was utilized to organize the studies around specific conceptual frameworks, facilitating deeper interpretation and synthesis (Çalık & Sözbilir, 2014).

One of the primary reasons for selecting the meta-synthesis approach in this study was that noticing research is often associated with *what* teachers focus on, *how* they reason, and the instructional decisions they make in their teaching practices to understand *how* students learn (Star & Strickland, 2008; van Es & Sherin, 2008). Due to the nature of such studies, they predominantly involved qualitative methodologies.

The meta-synthesis approach, a qualitative research model, is utilized as a method for systematically synthesizing data through the review of literature within a specific field (Tang, 2009). Unlike merely summarizing topics, it aims to synthesize existing studies to derive deeper insights (Chrastina, 2018). The primary goal of meta-synthesis is to analyze qualitative data through comparison, integrate findings with a critical perspective, and provide a comprehensive framework for the topic under investigation (Hodge et al., 2012). Notably, Bair (1999) expanded the scope of meta-synthesis to include studies employing qualitative, quantitative, and mixed methods approaches. Furthermore, research indicates that meta-synthesis studies often include not only qualitative but also quantitative and mixed-methods research (e.g., Aztekin & Taşpınar-Şener, 2015; Günday, 2023; Herdem & Ünal, 2018; Serbest, 2014). These studies primarily aim to guide future research by addressing specific objectives.

To synthesize and evaluate the topic of noticing from a holistic perspective, this study analyzed articles on mathematics teachers' noticing published in the Web of Science and Scopus databases between 2002 and 2023. To ensure the meta-synthesis was conducted systematically and scientifically, the application stages were guided by established frameworks (Noblit & Hare, 1988; Polat & Ay, 2016; Walsh & Downe, 2005). These stages were implemented in the study as follows:

1. *Identifying research problems*. As in any research, the research question and objective must be defined. These questions form critical points in the analysis, synthesis, and evaluation of the literature to be synthesized. For this study, the focus is on the field of noticing in mathematics education.
2. *Determining keywords and conducting a literature review*. Keywords relevant to the research topic, such as ‘noticing’ and ‘mathematics’, were selected to guide the literature review.
3. *Reviewing, identifying, and evaluating studies*. The studies included in the research were thoroughly read. Each article was labeled according to its publication year.
4. *Selecting studies based on inclusion criteria*. Studies included in this meta-synthesis were selected based on criteria such as time period, accessibility, research method, publication type, language, and keywords. The timeframe for this research spans from 2002, when van Es and Sherin conducted the first studies in the field, to 2023. Accessible studies in English and Turkish that employ qualitative, quantitative, or mixed methods and are published as articles were included. Of the 209 studies initially identified with the keywords, only those directly related to noticing in mathematics education were retained, resulting in a final sample of 83 studies.
5. *Analyzing selected studies to identify similarities and differences*. Themes and sub-themes based on similarities and differences among the studies were established and are presented in Table 1 in the data analysis section.
6. *Synthesizing findings and drawing conclusions*. Findings were synthesized according to the developed themes, and conclusions were drawn, presented in the findings section.
7. *Reporting the process and findings*. The study's findings were documented in the discussion section as a report of the meta-synthesis process.

3.1 Data collection and analysis

The search was conducted in the title fields of the Web of Science and Scopus databases using the keywords ‘noticing’ and ‘mathematics’. This search yielded 102 studies in Web of Science and 107 in Scopus. The studies were limited to articles published in English or Turkish between 2002 and 2023. After applying the inclusion criteria, 75 articles were identified from Web of Science

and 68 from Scopus, totaling 143 articles. Since 60 of these articles appeared in both databases, duplicates were removed, resulting in a final total of 83 unique articles. The data collection process began on June 1, 2023, and concluded on March 1, 2024. Accordingly, the distribution of the number of articles obtained by year is presented in Figure 1 below.

Figure 1 The distribution of studies included in the meta-synthesis research by year

Upon examining Figure 1, it was evident that there was an increasing number of studies focused on noticing in mathematics education over the years. This trend suggests a growing recognition of the importance of understanding and addressing the need for continued research into noticing in mathematics education.

Document analysis was conducted following the stages of the meta-synthesis process. In this meta-synthesis, the studies were organized by year, with works published in the same year ordered alphabetically. Themes and sub-themes aimed at identifying the objectives of studies on noticing were developed based on the similarities and differences among the studies, as displayed in Table 2. Open coding was then applied within these themes to the concept of 'noticing'.

According to Yıldırım and Şimşek (2016), there were three types of validity that can be used to maintain validity in meta-synthesis studies: *descriptive*, *interpretive*, and *theoretical validity*. *Descriptive validity* referred to the justification-based description of the accuracy of data obtained from the results of studies. Within this scope, in this study, data, theoretical frameworks, tables, and graphs were described based on justifications. The study was reviewed by three expert academics in the field, and feedback regarding the accuracy of the descriptions was obtained. *Interpretive validity* concerned the accurate, complete, and precise representation of the researchers' perspectives. The interpretations made by the researchers were reviewed by a field expert, and the tables and graphs were examined to evaluate these interpretations. *Theoretical validity* involved examining and compiling the theoretical framework and concepts of the study in light of scientific research. Within the scope of this study, the theoretical framework of the research was reviewed by a field expert, and its validity and reliability were analyzed.

To improve the study's reliability, both the researchers and a field expert conducted detailed coding of the data. The articles were analyzed by coding various elements, including the sample size, sample group, research methods, data collection tools, theoretical frameworks, content areas examined, study objectives related to noticing, and cognitive processes through open coding. Additionally, following König et al. (2022), the concept of noticing in mathematics education was classified into four perspectives: cognitive-psychological, socio-cultural, discipline-specific, and expertise-based. The coding process was conducted using the perspectives outlined in the theoretical frameworks of the studies. Perspectives mentioned in the introduction and literature review sections were excluded from the coding process, as these sections typically encompassed references to nearly all perspectives. Consistency between coders was assessed by examining the

level of agreement between the two sets of coding. For this purpose, the formula recommended by Miles and Huberman (2016) (Agreement count / (Agreement count + Disagreement count)) was employed. For internal consistency, a minimum inter-coder agreement of 80% is considered sufficient (Miles & Huberman, 2016), with this study achieving an agreement rate of 88%. The titles, codes, publication years, authors, and journal names of the articles included in the study are listed in Appendix 1.

4 Findings

The analysis of studies on noticing in mathematics education was structured under specific subheadings to highlight both the similarities and differences among the reviewed studies: sample size, sample group, research methods, data collection tools, theoretical frameworks, content areas studied, objectives of the studies on noticing, cognitive processes in noticing, and conceptualization of noticing.

4.1 Distribution of sample sizes

The distribution of sample sizes in studies examining noticing in mathematics education showed a wide range. Figure 2 showed that a considerable number of studies had relatively small sample sizes, with the largest group having sample sizes between 0-10 participants. A smaller number of studies included sample sizes ranging from 11-20, followed by those with 21-30 participants. Fewer studies focused on sample sizes between 31-40, and an even smaller group fell within the range of 41-50 participants. Studies with larger sample sizes, between 51-100 participants, were also represented, though they are fewer in number.

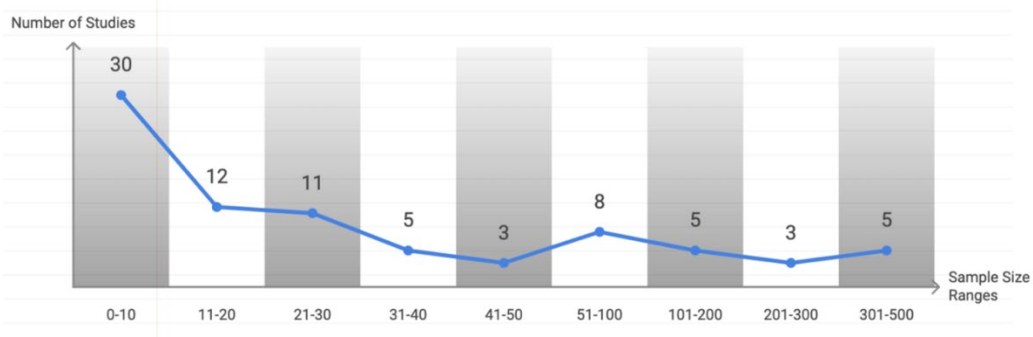

Figure 2 Distribution of sample sizes in mathematics education studies

4.2 Sample group and data sources

In research on noticing in mathematics education, the sample groups typically consisted of participants, such as preservice teachers, inservice teachers, faculty members, education coaches or mentors, and educational leaders. In some cases, curriculum materials or documents were also analyzed as part of the study, but these were not considered participants; rather, they were treated as artifacts or data sources to investigate noticing-related processes. Figure 3 indicated that while preservice and inservice teachers were the most frequently studied groups, faculty members, educational leaders, and documents were also included in some research. Additionally, certain studies incorporated two distinct sample groups, with some examining combinations of preservice and inservice teachers, inservice teachers alongside education coaches, or the inclusion of documents with different participant groups.

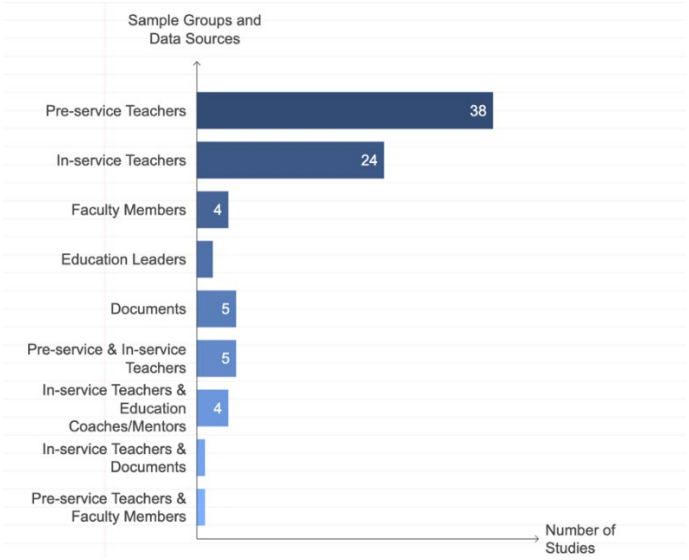

Figure 3 Sample groups and data sources in studies on noticing

4.3 Research methods

The distribution of research methods in studies investigating noticing in mathematics education revealed a clear preference for qualitative approaches. The majority of researchers utilized qualitative methods, accounting for 62.7% (n=52) of the studies, while a smaller proportion employed quantitative methods, representing 6% (n=5). Furthermore, a considerable number of studies (31.3%, n=26) adopted a mixed-methods approach, integrating both qualitative and quantitative methodologies. Qualitative methods were notably the most commonly used, indicating a strong preference for in-depth, exploratory analysis within this field of research.

Moreover, Figure 4 presented the distribution of research methods used in studies on noticing in mathematics education over the years, showing a steady increase in the volume of research in this area. Additionally, there was a notable rise in the use of both mixed methods and quantitative approaches, indicating a growing diversification in research methodologies within the field.

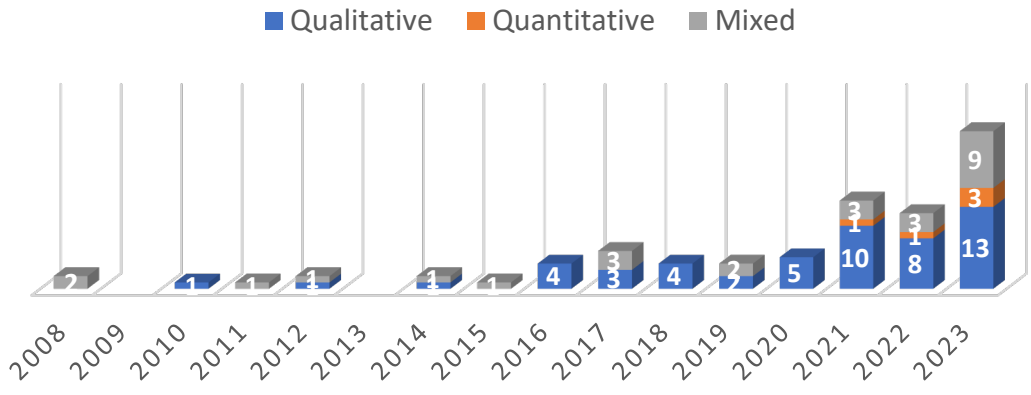

Figure 4 Distribution of research methods by year

4.4 Data collection tools

Figure 5 illustrated that the predominant data collection tools utilized in studies investigating noticing in mathematics education were videos and written notes. In contrast, the tools that received the least preference among researchers were documents (i.e., articles and book review),

report, and audio recording. This trend suggested a strong inclination towards visual and textual methods for capturing and analyzing educational phenomena, potentially due to their effectiveness in providing rich, detailed insights into the teaching and learning processes. The preference for videos might reflect a desire to capture dynamic interactions and contextual elements that enhance understanding, while written notes offer a straightforward means of documenting observations and reflections. Conversely, the lower utilization of documents and group work might indicate challenges in implementation or a lesser perceived value in these approaches for the specific aims of the studies examined.

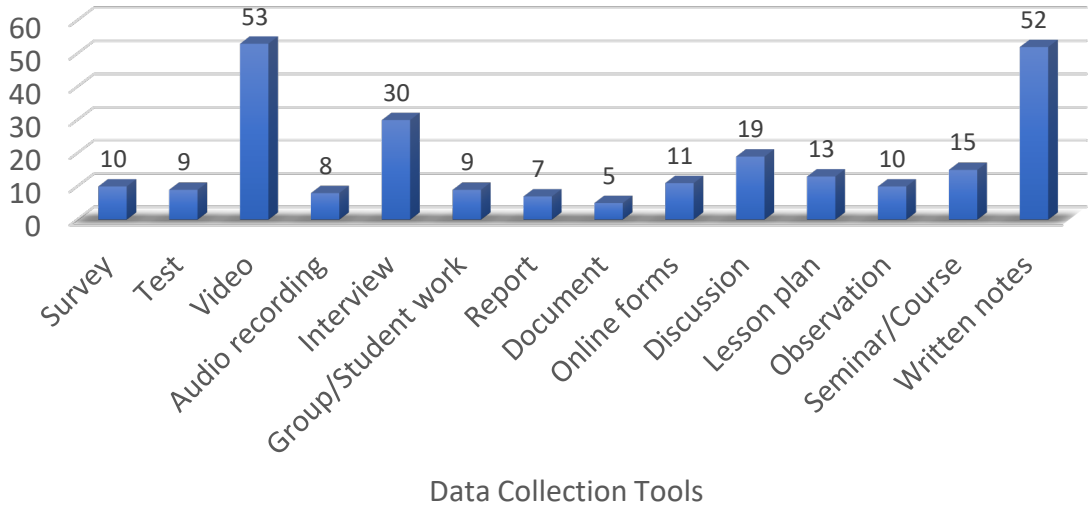

Figure 5 Data collection tools

Figure Note: Various data collection tools may be adopted in each study. Therefore, the total frequencies exceed the number of articles.

Moreover, upon examining Figure 6, the graph illustrated the frequency of data collection tools used in studies investigating noticing in mathematics education, categorized by research methods. This graph facilitated the identification of data collection tools that were utilized more frequently in conjunction with particular research methods. The combination of each tool and research method was represented visually through varying color intensities, with darker shades indicating a higher frequency of usage. Moreover, in qualitative research methods, the primary data collection tools favored were written notes, videos, and interviews. In contrast, quantitative research methods predominantly utilized videos, tests, and surveys as their main data collection instruments. Meanwhile, for mixed research methods, videos and written notes emerged as the most frequently employed tools.

Figure 6 Graph showing the frequency of data collection tools by research methods

4.5 Theoretical frameworks used in the studies

The distribution of theoretical frameworks utilized in the studies was illustrated in Figure 7. Notably, several studies adopted the theoretical framework proposed by Jacobs et al. (2010), while others utilized frameworks by van Es (2011), van Es and Sherin (2002), Sherin and van Es (2009), and Kaiser et al. (2015). Other authors referenced additional theoretical frameworks, and some studies integrated multiple frameworks within their analyses. The pairing of Jacobs et al. (2010) and van Es (2011) was identified as the most commonly utilized combination in document analyses, although a limited number of studies did not specify the theoretical frameworks they employed.

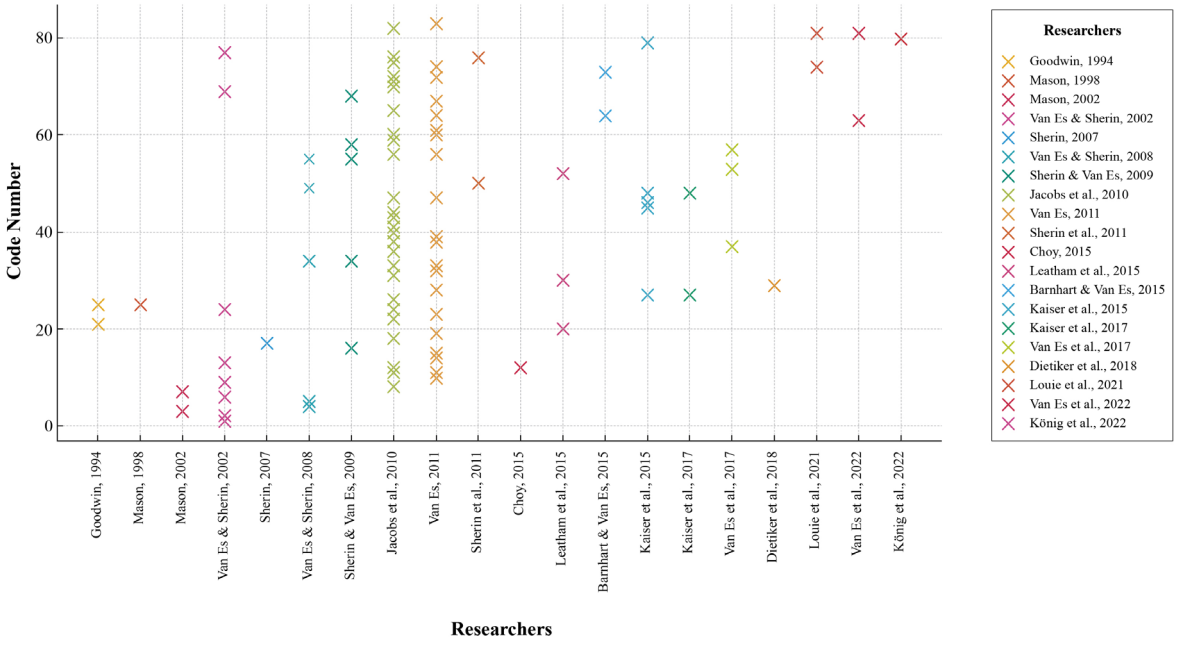

Figure 7 Distribution graph according to theoretical frameworks

4.6 Content areas studied

The content areas were classified into the following categories: teaching of numbers, teaching of geometry and/or measurement, teaching of algebra, and teaching of statistics and probability. Table 1 presented the distribution of studies on noticing in mathematics education according to the content areas studied.

Table 1 Distribution of studies according to content areas

Content Areas	f	%
Teaching of numbers	40	48.19
Teaching of geometry and/or measurement	31	37.35
Teaching of algebra	31	37.35
Teaching of statistics and probability	7	8.43
Not specified	5	6.02

Table note: Various subject areas may be adopted in each study. Therefore, the total frequency exceeds the number of articles.

Table 1 showed that the majority of studies focused on the teaching of numbers, geometry and/or measurement, algebra, and statistics and probability. A small portion of the studies did not specify a subject area. Additionally, several studies examined two or more content areas, while others were based on document analysis and did not involve any specific content area.

4.7 Objectives of the studies on noticing

The category focused on examining noticing comprises studies that specifically investigated the phenomenon itself. The development of noticing pertained to research that explores methods for enhancing noticing skills among teachers or students. The investigation of components included studies that analyzed the various elements and processes associated with noticing. The learning of noticing referred to studies that examined how the skill of noticing is acquired. The discovery of noticing encompassed research that revealed new dimensions of the noticing process, while the conceptualization category was concerned with the formulation of theoretical and conceptual frameworks surrounding noticing. Table 2 showed the distribution of studies on noticing according to their objectives.

Table 2 Distribution of studies on noticing according to their objectives

Noticing	f	%
Analysis of noticing	27	32.53
Enhancement of noticing	24	28.92
Exploration of noticing components	20	24.10
Comparison of noticing skills	8	9.64
Acquisition of noticing	5	6.02
Discovery of new dimensions of noticing	2	2.41
Theoretical conceptualization of noticing	8	9.64
Not specified	3	3.61

Table note: Various subject areas may be adopted in each study. Therefore, the total frequency exceeds the number of articles.

The findings reveal that most of the studies focused on examining noticing, enhancing noticing, and investigating the components of noticing. Additionally, some studies explored two categories. Among these, certain studies analyzed both the examination and development of noticing, while others investigated the examination and components of noticing, the examination and comparison of noticing, as well as the examination and conceptualization of noticing. A few studies also focused on the examination and learning of noticing, or the development and learning of noticing. Furthermore, three studies were classified as document analyses and thus did not fall into any

specific category.

4.8 Cognitive processes in noticing

Upon reviewing the studies focused on noticing in mathematics education, it becomes clear that researchers have employed a range of components: P (paying attention, perceiving, focusing), A (analyzing, interpreting, reasoning), and D (decision making, responding, reacting). The cognitive processes underpinning paying attention, analyzing, and decision-making are central to the act of noticing in mathematics education. Each component relies on distinct but interconnected cognitive functions that enable educators and learners to interpret and respond to mathematical content meaningfully. Table 3 illustrated the distribution of noticing in relation to cognitive processes.

Table 3 Distribution of studies on noticing according to cognitive processes

Cognitive processes	f	%
(Sole) Paying attention	7	8.43
(Sole) Analyzing	1	1.20
(Sole) Decision making	1	1.20
Perceiving and reasoning	14	16.87
Focusing and reacting	2	2.41
Paying attention, analyzing, and decision making	54	65.06
No component	4	4.82

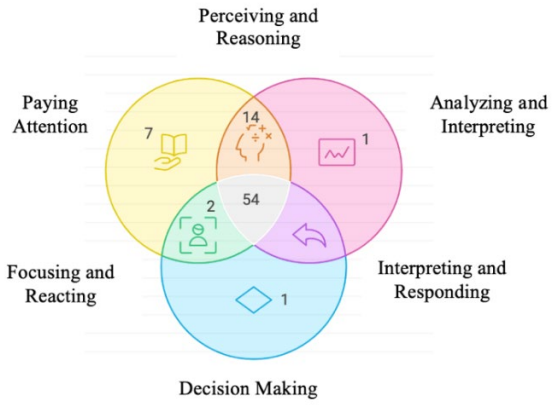

Figure 8 Cognitive processes in noticing in mathematics education

Figure 8 indicated that these components may be employed individually or in combination. A significant number of studies integrated multiple components, with several incorporating both P and A, or P and D. The majority of studies (i.e., 54 studies) employed all three components together (P, A, and D). It was also noted that a few studies (i.e., 4 studies), due to their nature as document analyses, did not include any of these components.

4.9 Conceptualization of noticing

According to König et al. (2022), the concept of noticing in mathematics education is categorized into four perspectives: cognitive-psychological, socio-cultural, discipline-specific, and expertise-based. The coding process was carried out in alignment with these categories. Based on the data obtained from the coding process, Table 4 presented below was created.

Table 4 Distribution of studies on noticing according to conceptualizations

Conceptualization	f	%
Cognitive-psychological perspective	76	91.56
Socio-cultural perspective	24	28.91
Discipline-specific perspective	22	26.50
Expertise-related perspective	14	16.87

Table Note: Various perspectives may be adopted in each study. Therefore, the total frequency exceeds the number of articles.

According to Table 4, the cognitive-psychological perspective was the most frequently referenced, while the expertise-related perspective was the least referenced. The number of references to the socio-cultural perspective and the discipline-specific perspective were approximately equal. Among these studies, there were 38 studies referencing one perspective, 38 studies referencing two perspectives, 6 studies referencing three perspectives, and 1 study referencing four perspectives.

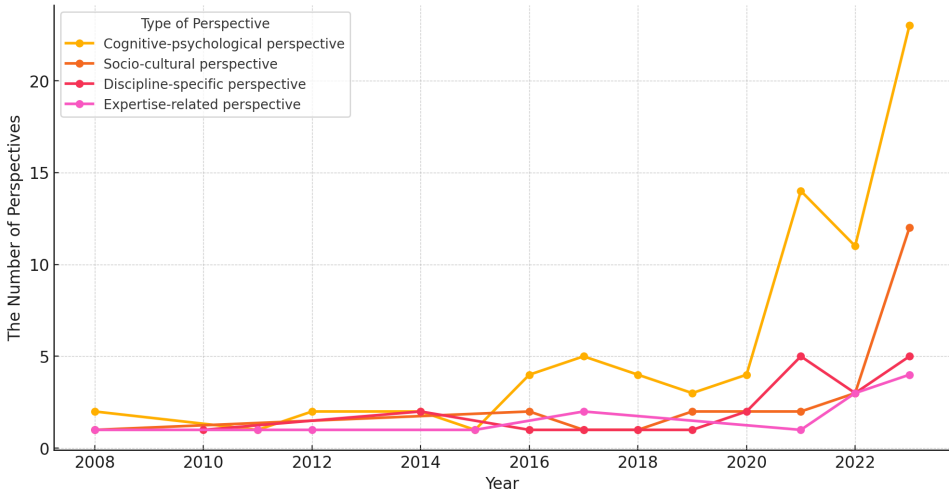

Figure 9 Distribution graph of perspectives over the years

Figure 9 illustrated a clear trend showing that the number of perspectives referenced in studies on noticing in mathematics education has grown alongside the increasing volume of research in the field. Notably, the socio-cultural perspective has experienced the most significant growth in recent years, reflecting a heightened interest in examining noticing through this lens. This suggested an evolving emphasis on the social and cultural dimensions of noticing within mathematics education research over time.

5 Discussion

This research utilized the meta-synthesis method to explore international studies on the concept of noticing published between 2002 and 2023. Firstly, the analysis, particularly with respect to *sample sizes*, indicated a prevalence of small sample groups. This trend may be linked to the dominance of qualitative research, as qualitative methods often prioritize smaller samples for the purpose of conducting in-depth analysis (Creswell, 2003). In terms of the sample groups studied in noticing-related research, preservice teachers and inservice teachers were identified as the most frequently examined populations. Similar conclusions were reached in a systematic review by König et al. (2022), likely because preservice and inservice teachers constitute some of the most actively researched groups in education. Focusing on these groups underscores a larger objective of exploring the connection between teacher quality and student achievement (Darling-Hammond, 2000). This points to the ongoing need for continuous advancements in teacher

education, explaining why these groups are often the focal point of research. Nevertheless, it is crucial to ensure that less represented groups—such as lecturers, instructional coaches, and educational leaders—are not neglected, and that their unique professional needs are sufficiently addressed.

Secondly, in the analysis of studies on the concept of noticing based on *research methods*, qualitative methods were the most frequently employed. This reflects the nature of noticing as a cognitive and reflective process, which is often explored through in-depth, context-specific investigations that qualitative methods afford. However, when examining the distribution of qualitative, quantitative, and mixed methods over time, there has been a clear rise in the adoption of quantitative and mixed methods in studies related to noticing over the past decade. This shift could be attributed to several factors. First, studies on teacher education (Yang et al., 2019) and professional development (van Es & Sherin, 2008) have become increasingly complex, requiring more comprehensive methodologies to capture the multi-dimensional nature of teacher learning and practice. Moreover, the broadening scope of noticing research, incorporating more interdisciplinary approaches (Dreher & Kuntze, 2015), has likely contributed to this methodological diversification. As noticing research increasingly intersects with fields like cognitive psychology, educational technology, and subject-specific pedagogies, researchers have found it necessary to employ methods that capture both the depth and breadth of these interactions. Mixed-methods approaches, which combine the strengths of both qualitative and quantitative research, allow for a more holistic understanding of the complex phenomena being studied, such as the relationship between teacher noticing and student outcomes. Additionally, advancements in research tools and analytical techniques have enabled scholars to integrate various types of data (e.g., video analysis, surveys, and student assessments) and adopt more sophisticated analytical frameworks (Lin, 2023). This has opened up new possibilities for exploring the multifaceted aspects of noticing in diverse educational settings, and for understanding how noticing evolves over time or across different professional learning contexts.

Moreover, in the analysis of studies on the concept of noticing based on *data collection tools*, the most frequently used instruments were videos and written notes. This result is consistent with the findings of König et al.'s (2022) systematic review. Research indicated that video analyses were designed to help preservice teachers identify and interpret classroom situations as they naturally unfold (Sherin, 2007; Sherin & van Es, 2005; van Es & Sherin, 2008). These analyses served as a powerful tool to enhance teachers' ability to recognize, understand, and make sense of complex classroom interactions, which could often be difficult to fully grasp in real-time. Through the video-based scenarios, preservice teachers developed a deeper pedagogical awareness and sharper interpretive skills. These skills were essential not only for understanding the dynamics of classroom interactions but also for informing their instructional decision-making. Moreover, the frequent use of video analyses in teacher education programs is not merely a trend but a pedagogically sound approach. It allows for the practical application of theoretical knowledge while fostering the development of critical, reflective, and adaptive teaching practices. As a result, video analysis has become a cornerstone in teacher education, playing a vital role in shaping more effective, responsive, and reflective educators.

The analysis of studies on the concept of noticing reveals a variety of *theoretical frameworks*. Research by Dietiker et al. (2018), König et al. (2022), and Sherin (2007) has been among the least utilized frameworks. These underused theoretical approaches may offer opportunities for researchers seeking to explore novel and underexplored areas. Conversely, the frameworks

developed by Jacobs et al. (2010) and van Es (2011) have been the most commonly used. This aligns with the findings of Amador et al.'s (2021) systematic review. While these frameworks are frequently used individually, they are also often applied together. The popularity of Jacobs et al.'s (2010) framework may be attributed to its focus on how mathematics teachers perceive, interpret, and respond to student answers and understanding, while van Es (2011) emphasizes how teachers observe and reflect on mathematics lessons through video recordings. An examination of the evolution of these frameworks over time highlights the ways in which educational research has diversified and deepened. Initially, the focus was primarily on improving individual teaching practices, but over time, it has shifted to more complex topics such as classroom interactions and teacher interventions. The methodologies and theoretical frameworks have also become more comprehensive. Between 2011 and 2017, various frameworks gained broader recognition, with works like those by Kaiser et al. (2017) offering different approaches to mathematics education. Since 2018, theoretical frameworks have become increasingly diverse and sophisticated, as seen in the work of Louie et al. (2021).

The evolution of these frameworks also parallels shifts in the *objectives of educational research*. In the earlier stages, particularly during the late 2000s, research was more concerned with improving the instructional techniques of individual teachers. Frameworks during this period, such as those by Star and Strickland (2008) and Liljedahl (2010), focused on teachers' immediate actions and decisions within the classroom. These early models were primarily concerned with the teacher's perspective and aimed to identify ways to enhance individual performance through better noticing and response to student needs. However, as educational research progressed into the 2010s, there was a growing recognition of the importance of broader, more systemic factors influencing classroom dynamics. Frameworks developed during this period, particularly those by Kaiser et al. (2017), began incorporating more complex variables such as social interaction, teacher-student dynamics, and the influence of external factors like curriculum standards and policy on teacher noticing. This shift reflected a deeper understanding that teaching and learning are not isolated processes but are embedded within larger social and institutional contexts.

Since 2018, the continued development of theoretical frameworks, as illustrated by Louie et al. (2021), indicated that the field has become increasingly nuanced. Recent frameworks were characterized by a more holistic approach that integrates cognitive, social, and cultural dimensions of noticing. These more recent frameworks also demonstrated an increased recognition of the diversity in classroom settings, addressing the distinct needs of students from various socio-economic, linguistic, and cultural backgrounds. This increasing complexity not only expands the definition of effective noticing but also compels researchers to create more advanced methodologies that can adequately reflect the intricate nature of teaching and learning in contemporary classrooms. In conclusion, the contrast between underutilized and dominant frameworks presents opportunities for further investigation and suggests that the field is ripe for innovation. As the research community continues to expand its understanding of what it means for teachers to notice, future studies may build upon both well-established and emerging frameworks to offer deeper insights into the ways teachers engage with student thinking and learning in diverse educational settings.

The analysis of studies on the concept of noticing, based on the *content areas* examined, revealed that the most commonly preferred area of study was the teaching of numbers. Duncan et al. (2007) emphasized the critical importance of teaching numbers for developing students' foundational mathematical skills, which has also been reflected in noticing research. The least studied subject

area was the teaching of statistics and probability. Franklin et al. (2007) noted that this area has not been adequately emphasized in curricula, which may have contributed to its lower prevalence in noticing studies. It was also observed that the teaching of algebra and the teaching of geometry and/or measurement have similar and high percentages. This suggested that these two areas of mathematics education were popular for studies focused on developing students' abstract thinking abilities. Furthermore, the findings indicated that several studies investigated multiple content areas, highlighting an interdisciplinary perspective that acknowledges the interconnectedness of mathematical concepts. This approach might facilitate a more holistic understanding of how various topics relate to one another within mathematics education. Additionally, some studies were classified as document analyses and, as such, did not directly engage with any specific content area. This distinction underscored the methodological diversity in the research, where some studies focused on theoretical or archival examination rather than practical application within defined mathematical domains. Overall, the findings illustrated the varied landscape of research in mathematics education, emphasizing both focused and broad approaches to content exploration.

The analysis of studies on the concept of noticing, based on their *objectives*, revealed that the most commonly focused areas were the analysis of noticing, the enhancement of noticing, and the exploration of its components. The high frequency of these categories highlighted the significance of preservice and inservice teachers' ability to observe and interpret student responses and understanding in education. Mason (2002) underscored the importance of teachers' noticing skills in helping them better understand students' thought processes. Enhancing these skills could enable teachers to make more appropriate interventions in students' learning processes, ultimately improving the quality of learning. The category of exploring noticing had the lowest frequency, indicating that research in this area was relatively new. The categories of comparing noticing and learning noticing showed both low and similar frequencies, suggesting a need for more studies comparing teachers' noticing skills and examining how these skills could be learned. Van Es and Sherin (2008) discussed the importance of learning observation skills in education, providing models for how such skills could be developed. Some studies explored multiple categories, suggesting that these categories may influence one another.

Most researchers agreed that professional noticing involves the ability to attend to specific aspects of students' mathematical thinking, interpret these aspects, and make educational decisions accordingly (Jacobs et al., 2010; Kaiser et al., 2015; Mason, 2002; van Es & Sherin, 2008). Studies on the components of noticing most commonly integrated three core elements: attending, analyzing, and decision-making, reflecting researchers' conceptualizations of noticing. However, some researchers have focused on individual components depending on their study's objectives: attending only (Star & Strickland, 2008), analyzing only (Amador, 2022), decision-making only (Kosko, 2022), attending and analyzing (Lin, 2023), or attending and decision-making (Jazby, 2023). Notably, no studies have used only analyzing and decision-making. Thus, studies in the field of noticing have consistently incorporated the attending component, supporting Ball's (2011) definition of noticing as involving attending, observing, and understanding activities.

The analysis of the conceptualization of noticing revealed that the cognitive-psychological perspective was the most frequently referenced, consistent with the findings of the systematic review by Weyers et al. (2024). This suggested that the cognitive-psychological perspective has retained its prominence over the years and remains a widely explored area of research. The socio-

cultural and discipline-specific perspectives were referenced at approximately the same frequency in the studies reviewed. However, an examination of their distribution over time showed differing trends. The discipline-specific perspective was consistently employed across all years but has seen a relative decline in recent years as the volume of studies has increased. In contrast, the socio-cultural perspective has demonstrated a growing trend in recent years, reflecting evolving academic interests in this dimension. The origins of the concept of noticing can be traced back to Goodwin's (1994) concept of professional vision, which laid the foundation for the socio-cultural perspective. Early conceptualizations were heavily influenced by Goodwin's work, but his influence diminished over time. Interestingly, the renewed focus on the socio-cultural perspective in recent years suggested a return to the foundational ideas of noticing, indicating how the field was reconnecting with its roots while adapting to contemporary research trends.

5.1 Limitations and future directions

A key limitation of this study is its exclusive focus on teacher noticing within the context of mathematics education. While this narrow scope provides valuable insights specific to this field, it may limit the generalizability of the findings to other subject areas, where the nature, role, and purposes of noticing could vary significantly. Expanding the scope to include other disciplines could offer a more comprehensive understanding of noticing across diverse educational contexts. Future research should not only expand into other subjects but also consider longitudinal approaches to capture how teacher noticing evolves over time and how it impacts instructional practices and student outcomes in the long term. In the studies, qualitative methods have been predominantly used, while the application of quantitative methods has remained limited. Diversifying research methods can enable data collection from different perspectives and result in more comprehensive findings. At the same time, studies with larger sample groups have predominantly employed quantitative or mixed methods, with less emphasis on qualitative methods. Research could be conducted using qualitative methods with large sample groups. In studies conducted with sample groups, most research has focused on middle school student groups, while more emphasis could be placed on studies involving preschool student groups. Additionally, research could be conducted using both qualitative and quantitative methods to explore how the components of noticing influence one another. The most commonly used data collection tools have been video recordings and written notes. In addition to these tools, the use of modern technologies such as interactive applications and virtual reality could provide more effective data collection methods, especially in remote education. Existing studies have focused on specific theoretical frameworks. However, exploring different theoretical frameworks could facilitate a deeper understanding of the field.

The reliance on articles from only the Web of Science and Scopus databases presents a potential limitation for this study, as these databases, though extensive, do not encompass the entire spectrum of academic literature on teacher noticing. Research in education is often dispersed across various platforms, including ERIC, JSTOR, and even open-access repositories such as Google Scholar, which may house relevant studies that are not indexed in Scopus or Web of Science. By not incorporating these additional sources, the study risks missing important insights or alternative perspectives on teacher noticing, especially those emerging from less frequently indexed journals or from diverse educational contexts. Future studies could address this limitation by expanding the range of databases consulted, providing a more holistic understanding of the topic and potentially uncovering trends, methodologies, or findings that are currently overlooked.

Additionally, this study includes articles published in English and Turkish. Incorporating articles published in other languages could further broaden the scope of the research.

In addition to the database limitations, the meta-synthesis approach, while powerful for drawing overarching conclusions, comes with inherent challenges. Synthesizing studies that employ diverse methodologies can dilute specific insights, as different research designs and analytical frameworks may not align neatly with one another. Combining the findings in a meta-synthesis can reduce the granularity of the perspectives, potentially oversimplifying complex educational phenomena. This challenge suggests that future studies could benefit from stratifying analyses by study type or even adopting alternative methodologies, such as systematic reviews that retain more methodological specificity. Furthermore, exploring teacher noticing in varied educational disciplines beyond mathematics, such as science or language arts, would enable researchers to observe how noticing operates differently across subjects. Such comparative insights could reveal whether the skills and cognitive processes associated with teacher noticing are universally applicable or uniquely tailored to the demands of different subject areas.

References

Amador, J. (2016). Professional noticing practices of novice mathematics teacher educators. *International Journal of Science and Mathematics Education, 14*(1), 217-241. https://doi.org/10.1007/s10763-014-9570-9

Amador, J. M. (2022). Mathematics teacher educator noticing: Examining interpretations and evidence of students' thinking. *Journal of Mathematics Teacher Education, 25*(2), 163-189. https://doi.org/10.1007/s10857-020-09483-z

Amador, J., Bragelman, J., Castro, S., & Superfine, A. (2021). Prospective teachers' noticing: A systematic literature review. *Teaching and Teacher Education,* 99, 103256. https://doi.org/10.1016/j.tate.2020.103256

Aztekin, S., & Taşpınar Şener, Z. (2015). Türkiye'de matematik eğitimi alanındaki matematiksel modelleme araştırmalarının içerik analizi: Bir meta-sentez çalışması [The Content Analysis of Mathematical Modelling Studies in Turkey: A Meta-synthesis Study]. *Eğitim ve Bilim, 40*(178), 1-20. https://doi.org/10.15390/EB.2015.4125

Bair, C. R. (1999). *Meta-synthesis*. ASHE Annual Meeting Paper. https://eric.ed.gov/?id=ED437866

Ball, D. L. (2011). Foreword. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. xx-xxiv). Routledge. https://doi.org/10.4324/9780203832714

Bastian, A., Kaiser, G., Meyer, D., Schwarz, B., & König, J. (2022). Teacher noticing and its growth toward expertise: An expert-novice comparison with pre-service and in-service secondary mathematics teachers. *Educational Studies in Mathematics, 110*, 205-232. https://doi.org/10.1007/s10649-021-10128-y

Berliner, D. C. (2001). Learning about and learning from expert teachers. *International Journal of Educational Research, 35*(5), 463–482. https://doi.org/10.1016/S0883- 0355(02)00004-6

Birinci, M., & Baki, M. (2019). Bir ortaokul matematik öğretmeninin mesleki gelişiminden yansımalar: Kesir öğretiminde fark etme becerisinin işe koşulması [Reflections from a secondary school mathematics teacher's professional development: Implementation of the skill of noticing in teaching fractions]. *Elementary Education Online, 18*(3), 1141–1156. https://doi.org/10.17051/ilkonline.2019.610853

Chrastina, J. (2018). Meta-synthesis of qualitative studies: Background, methodology and applications. *Nordsci Conference Proceedings Book 1 Volume 1*. https://doi.org/10.32008/nordsci2018/b1/v1/13

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Sage Publications.

Çalık, M., & Sözbilir, M. (2014). İçerik analizinin parametreleri [Parameters of content analysis]. *Eğitim ve Bilim, 39*(174), 33–38. https://doi.org/10.15390/EB.2014.3412

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8*(1). https://doi.org/10.14507/epaa.v8n1.2000

Dietiker, L., Males, M., Amador, J., & Earnest, D. (2018). Curricular noticing: A comprehensive framework to describe teachers' interactions with curriculum materials. *Journal for Research in Mathematics Education, 49*(5), 521–532. https://doi.org/10.5951/jresematheduc.49.5.0521

Dindyal, J., Schack, E. O., Choy, B. H., & Sherin, M. G. (2021). Exploring the terrains of mathematics teacher noticing. *ZDM Mathematics Education, 53*(1), 1-16. https://doi.org/10.1007/s11858-021-01249-y

Dreher, A., & Kuntze, S. (2015). Teachers' professional knowledge and noticing: The case of multiple representations in the mathematics classroom. *Educational Studies in Mathematics, 88*(1), 89-114. https://doi.org/10.1007/s10649-014-9577-8

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428- 1446. https://doi.org/10.1037/0012-1649.43.6.1428

Fernandez, C., Llinares, S., & Valls, J. (2012). Learning to notice students' mathematical thinking through on-line discussions. *ZDM Mathematics Education, 44*, 747-759. https://doi.org/10.1007/s11858-012-0425-y

Franklin, C., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Scheaffer, R. (2007). *Guidelines for assessment and instruction in statistics education (GAISE) report: A pre-K-12 curriculum framework*. American Statistical Association.

Goldsmith, L. T., & Seago, N. (2011). Using classroom artifacts to focus teachers' noticing: Affordances and opportunities. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 169-187). Routledge. https://doi.org/10.4324/9780203832714

Goodwin, C. (1994). Professional vision. *American Anthropologist, 96(3)*, 606–633. https://doi.org/10.1525/aa.1994.96.3.02a00100

Günday, S. (2023). *Matematik eğitiminde soyutlama konusunda yapılan lisansüstü tezlerin meta-sentezi* [*Meta-synthesis of postgraduate theses on abstraction in mathematics education*]. [Unpublished master's thesis]. Erzincan Binali Yıldırım Üniversitesi.

Güner, P. (2017). *Ortaokul matematik öğretmeni adaylarının fark etme becerilerinin ders imecesi kapsamında incelenmesi* [*Investigating preservice middle school mathematics teachers' noticing of students' mathematical thinking in the context of lesson study*]. [Unpublished master's thesis]. Orta Doğu Teknik Üniversitesi.

Herdem, K., & Ünal, İ. (2018). STEM eğitimi üzerine yapılan çalışmaların analizi: Bir meta-sentez çalışması [Analysis of studies about STEM education: A meta-synthesis study]. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi, 48*(48), 72–89. https://doi.org/10.15285/maruaebd.345486

Hodge, D. R., Horvath, V. E. T., Larkin, H., & Curl, A. L. (2012). Older adults' spiritual needs in health care settings: A qualitative meta-synthesis. *Research on Aging*, *34*(2), 131- 155. https://doi.org/10.1177/0164027511411308

Jacobs, V. R., Lamb, L. L., & Philipp, R. A. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education, 41*(2), 169-202. https://doi.org/10.5951/jresematheduc.41.2.0169

Jacobs, V., Lamb, L., Philipp, R., Schappelle, B., & Burke, A. (2007). *Professional noticing by elementary school teachers of mathematics*. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL.

Jazby, D. (2023). Conceptualising mathematics teacher noticing as a perception/action cycle. *Mathematics Education Research Journal, 35*(1), 133–155. https://doi.org/10.1007/s13394-021-00392-9

Kaiser, G., Blömeke, S., König, J., Busse, A., Döhrmann, M., & Hoth, J. (2017). Professional competencies of (prospective) mathematics teachers—Cognitive versus situated approaches. *Educational Studies in Mathematics*, 94(2), 161-182. https://doi.org/10.1007/s10649-016-9713-8

Kaiser, G., Busse, A., Hoth, J., König, J., & Blömeke, S. (2015). About the complexities of video-based assessments: Theoretical and methodological approaches to overcoming shortcomings of research on teachers' competence. *International Journal of Science and Mathematics Education, 13*(2), 369-387. https://doi.org/10.1007/s10763-015-9616-7

Kosko, K. W. (2022). Pre-service teachers' professional noticing when viewing standard and holographic recordings of children's mathematics. *International Electronic Journal of Mathematics Education, 17*(4), Article em0706. https://doi.org/10.29333/iejme/12310

König, J., Santagata, R., Scheiner, T., Adleff, A.-K., Yang, X., & Kaiser, G. (2022). Teacher noticing: A systematic literature review of conceptualizations, research designs, and findings on learning to notice. *Educational Research Review, 36(3)*, 100453. https://doi.org/10.1016/j.edurev.2022.100453

Lee, M. Y. (2021). Improving preservice teachers' noticing skills through technology-aided interventions in mathematics pedagogy courses. *Teaching and Teacher Education, 101(2)*, 103301. https://doi.org/10.1016/j.tate.2021.103301

Liljedahl, P. (2010). Noticing rapid and profound mathematics teacher change. *Journal of Mathematics Teacher Education, 13*(5), 411-423. https://doi.org/10.1007/s10857-010-9151-y

Lin, Y. C. (2023). Using virtual classroom simulations in a mathematics methods course to develop pre-service primary mathematics teachers' noticing skills. *British Journal of Educational Technology, 54*(3), 734-753. https://doi.org/10.1111/bjet.13291

Louie, N. L. (2018). Culture and ideology in mathematics teacher noticing. *Educational Studies in Mathematics, 97*(1), 55-69. https://doi.org/10.1007/s10649-017-9775-2

Louie, N., Adiredja, A. P., & Jessup, N. (2021). Teacher noticing from a sociopolitical perspective: The FAIR framework for anti-deficit noticing. *ZDM Mathematics Education*, *53*(1), 95–107. https://doi.org/10.1007/s11858-021-01229-2

Mason, J. (2002). *Researching your own practice: The discipline of noticing*. Routledge Falmer. https://doi.org/10.4324/9780203471876

Mason, J. (2011). Noticing: Roots and branches. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 65-80). Routledge. https://doi.org/10.4324/9780203832714

McDuffie, A. R., Choppin, J., Drake, C., & Davis, J. (2018). Middle school mathematics teachers' orientations and noticing of features of mathematics curriculum materials. *International Journal of Educational Research, 92*, 173-187. https://doi.org/10.1016/j.ijer.2018.09.019

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* [*Nitel veri analizi*] (S. Akbaba Altun & A. Ersoy, Çev. Ed., 2021). Pegem Akademi.

Miller, K. F. (2011). Situation awareness in teaching. In M. G. Sherin, R. A. Philipp, & V. R. Jacobs (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 51-65). Routledge. https://doi.org/10.4324/9780203832714

Noblit, G. W., & Hare, R. D. (1988). *Meta-ethnography: Synthesizing qualitative studies*. Sage Publications. https://doi.org/10.4135/9781412985000

Osmanoğlu, A., Işıksal, M., & Koç, Y. (2012). Öğretmen adaylarının ilköğretim matematik programında vurgulanan öğrenci rolleri üzerine fark ettikleri noktalar: Video örnek olay kullanımı [Prospective teachers' noticing with respect to the student roles underlined in the elementary mathematics program: Use of video-cases]. *Eğitim ve Bilim, 37*(165), 336–347.

Polat, S., & Ay, O. (2016). Meta-sentez: Kavramsal bir çözümleme [Meta-synthesis: A Conceptual analysis]. *Eğitimde Nitel Araştırmalar Dergisi, 4*(2), 52-64. https://doi.org/10.14689/issn.2148-2624.1.4c2s3m

Scheiner, T. (2016). Teacher noticing: Enlightening or blinding? *ZDM Mathematics Education, 48*(1), 227–238. https://doi.org/10.1007/s11858-016-0771-2

Serbest, A. (2014). *Ders imecesi yönteminin etki alanları üzerine bir meta-sentez çalışması* [*The examination of lesson study's impacts with meta-synthesis*]. [Unpublished master's thesis]. Karadeniz Teknik Üniversitesi.

Sherin, M. G. (2007). The development of teachers' professional vision in video clubs. In R. Goldman, R. Pea, B. Barron, & S. Derry (Eds.), *Video research in the learning sciences* (pp. 383-395). Lawrence Erlbaum.

Sherin, M. G., & van Es, E. A. (2005). Using video to support teachers' ability to notice classroom interactions. *Journal of Technology and Teacher Education, 13*(3), 475-491.

Sherin, M. G., & van Es, E. A. (2009). Effects of video club participation on teachers' professional vision. *Journal of Teacher Education, 60*(1), 20–37. https://doi.org/10.1177/0022487108328155

Sherin, M. G., Jacobs, V. R., & Philipp, R. A. (Eds.). (2011). *Mathematics teacher noticing: Seeing through teachers' eyes*. Routledge. https://doi.org/10.4324/9780203832714

Star, J. R., & Strickland, S. K. (2008). Learning to observe: Using video to improve preservice mathematics teachers' ability to notice. *Journal of Mathematics Teacher Education, 11*(2), 107- 125. https://doi.org/10.1007/s10857-007-9063-7

Stevens, R., & Hall, R. (1998). Disciplined perception: Learning to see in technoscience. In M. Lampert & M. L. Blunk (Eds.), *Talking mathematics in school: Studies of teaching and learning* (pp. 107–150). Cambridge University Press.

Tang, X. (2009). Qualitative meta-synthesis techniques for analysis of public opinions for in- depth study. In J. Zhou (Ed.), *Complex sciences. Complex 2009. Lecture notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering* (Vol. 5, pp. 111). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-02469-6_111

Van Es, E. A. (2011). A framework for learning to notice student thinking. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 134-151). Routledge. https://doi.org/10.4324/9780203832714

Van Es, E. A., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education, 10*(4), 571-596.

Van Es, E. A., & Sherin, M. G. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education*, 24, 244–276. https://doi.org/10.1016/J.TATE.2006.11.005

Walsh, D., & Downe, S. (2005). Meta synthesis method for qualitative research: A literature review. *Journal of Advanced Nursing*, *50*(2), 204-211. https://doi.org/10.1111/j.1365- 2648.2005.03380.x

Weyers, J., König, J., Scheiner, T., Santagata, R., & Kaiser, G. (2024). Teacher noticing in mathematics education: a review of recent developments. *ZDM Mathematics Education*, *56*(2), 249–264. https://doi.org/10.1007/s11858-023-01527-x.

Yang, X. R., Kaiser, G., König, J., & Blömeke, S. (2019). Professional noticing of mathematics teachers: A comparative study between Germany and China. *International Journal of Science and Mathematics Education,* 17(5), 943-963. https://doi.org/10.1007/s10763-018-9907-x

Yeşil, D. (2021). *Bir ortaokul matematik öğretmeninin fark etme becerisi bağlamında mesleki gelişimi* [*Professional development of a secondary school mathematics teacher in the context of noticing*]. [Unpublished doctoral thesis]. Anadolu Üniversitesi.

Yıldırım, A., & Şimşek, H. (2016). *Sosyal bilimlerde nitel araştırma yöntemleri* (10. baskı) [*Qualitative research methods in social sciences* (10th ed.)]. Seçkin Yayıncılık.

Appendix 1

Table A. Articles Used in the Meta-Synthesis Research.

No	Researchers	Article	Journal	Year
M1	Star, JR; Strickland, SK	Learning to Observe: Using Video to İmprove Preservice Mathematics Teachers' Ability to Notice	Journal of Mathematics Teacher Education	2008
M2	van Es, EA; Sherin, MG	Mathematics Teachers' Learning to Notice in The Context of a Video Club	Teaching and Teacher Education	2008
M3	Liljedahl, P	Noticing Rapid and Profound Mathematics Teacher Change	Journal of Mathematics Teacher Education	2010
M4	Chieu, VM; Herbst, P; Weiss, M	Effect of an Animated Classroom Story Embedded in Online Discussion on Helping Mathematics Teachers Learn to Notice	Journal of the Learning Sciences	2011
M5	Huang, R; Li, YP	What Matters Most: A Comparison of Expert and Novice Teachers' Noticing of Mathematics Classroom Events	School Science and Mathematics	2012
M6	Osmanoglu, A; Isiksal, M; Koç, Y	Prospective Teachers' Noticing with Respect to The Student Roles Underlined in The Elementary Mathematics Program: Use of Video-cases	Eğitim ve Bilim-Education and Science	2012
M7	Breen, S; McCluskey, A; Meehan, M; O'Donovan, J; O'Shea, A	A Year of Engaging with The Discipline of Noticing: Five Mathematics Lecturers' Reflections	Teaching in Higher Education	2014
M8	Wager, AA	Noticing Children's Participation: Insights into Teacher Positionality Toward Equitable Mathematics Pedagogy	Journal for Research in Mathematics Education	2014
M9	Dreher, A; Kuntze, S	Teachers' Professional Knowledge and Noticing: The Case of Multiple Representations in The Mathematics Classroom	Educational Studies in Mathematics	2015
M10	Amador, J	Professional Noticing Practices of Novice Mathematics Teacher Educators	International Journal of Science and Mathematics Education	2016
M11	Amador, J.M., Carter, I., Hudson, R.A.	Analyzing Preservice Mathematics Teachers' Professional Noticing	Action in Teacher Education	2016
M12	Choy, BH	Snapshots of Mathematics Teacher Noticing During Task Design	Mathematics Education Research Journal	2016
M13	Roller, SA	What They Notice in Video: A Study of Prospective Secondary Mathematics Teachers Learning to Teach	Journal of Mathematics Teacher Education	2016
M14	Amador, JM	Preservice Teachers' Video Simulations and Subsequent Noticing: A Practice-Based Method to Prepare Mathematics Teachers	Research in Mathematics Education	2017
M15	Güner, P., Akyüz, D.	Lesson Study Professional Development Model: Investigating Noticing Skills of Prospective Mathematics Teachers	Elementary Education Online	2017
M16	Lesseig, K; Elliott, R; Kazemi, E; Kelley-Petersen, M; Campbell, M; Mumme, J; Carroll, C	Leader Noticing of Facilitation in Video cases of Mathematics Professional Development	Journal of Mathematics Teacher Education	2017

M17	Schnell, S; Prediger, S	Mathematics Enrichment for All - Noticing and Enhancing Mathematical Potentials of Underprivileged Students as an Issue of Equity	Eurasia Journal of Mathematics Science and Technology Education	2017
M18	Simpson, A; Haltiwanger, L	This is the First Time I've Done This: Exploring Secondary Prospective Mathematics Teachers' Noticing of Students' Mathematical Thinking	Journal of Mathematics Teacher Education	2017
M19	van Es, EA; Cashen, M; Barnhart, T; Auger, A	Learning to Notice Mathematics Instruction: Using Video to Develop Preservice Teachers' Vision of Ambitious Pedagogy	Cognition and Instruction	2017
M20	Kilic, H	Pre-Service Mathematics Teachers' Noticing Skills and Scaffolding Practices	International Journal of Science and Mathematics Education	2018
M21	Louie, NL	Culture And Ideology in Mathematics Teacher Noticing	Educational Studies in Mathematics	2018
M22	McDuffie, AR; Choppin, J; Drake, C; Davis, J	Middle School Mathematics Teachers' Orientations and Noticing of Features of Mathematics Curriculum Materials	International Journal of Educational Research	2018
M23	Ulusoy, F., Çakiroğlu, E.	Using Video Cases and Small-Scale Research Projects to Explore Prospective Mathematics Teachers' Noticing of Student Thinking	Eurasia Journal of Mathematics, Science and Technology Education	2018
M24	Birinci, M., Baki, M.	Reflections From a Secondary School Mathematics Teacher's Professional Development: Implementation the Skill of Noticing in Teaching Fractions	Elementary Education Online	2019
M25	Dominguez, H	Theorizing Reciprocal Noticing with Non-Dominant Students in Mathematics	Educational Studies in Mathematics	2019
M26	Fisher, MH; Thomas, J; Jong, C; Schack, EO; Dueber, D	Comparing Preservice Teachers' Professional Noticing Skills in Elementary Mathematics Classrooms	School Science and Mathematics	2019
M27	Yang, XR; Kaiser, G; König, J; Blömeke, S	Professional Noticing of Mathematics Teachers: A Comparative Study Between Germany and China	International Journal of Science and Mathematics Education	2019
M28	Biccard, P	The Development of Noticing in Primary School Mathematics Teachers	Independent Journal of Teaching and Learning	2020
M29	de Guzman, AB; Adamos, JL	Like The Layers of An Onion: Curricular Noticing as A Lens to Understand the Epistemological Features of The Philippine K To 12 Secondary Mathematics Curriculum Materials	Educational Research for Policy and Practice	2020
M30	Fernández, C; Llinares, S; Rojas, Y	Prospective Mathematics Teachers' Development of Noticing in An Online Teacher Education Program	ZDM-Mathematics Education	2020
M31	Shin, D	Prospective Mathematics Teachers' Professional Noticing of Students' Reasoning About Mean and Variability	Canadian Journal of Science Mathematics and Technology Education	2020
M32	Uygun, T	Pre-Service Middle Level Mathematics Teachers' Noticing of Student Mathematical Thinking and Teacher Identity in The Context of Virtual Experimentation	International Journal of Mathematical Education in Science and Technology	2020
M33	Amador, JM	School Leaders' Noticing Based on Video of Mathematics Instruction	International Journal of Leadership in Education	2021
M34	Copur-Gencturk, Y; Rodrigues, J	Content-Specific Noticing: A Large-Scale Survey of Mathematics Teachers Noticing	Teaching and Teacher Education	2021
M35	Dindyal, J; Schack, EO; Choy, BH; Sherin, MG	Exploring The Terrains of Mathematics Teacher Noticing	ZDM-Mathematics Education	2021
M36	Hine, G; Lesseig, K	Supporting Preservice Secondary Mathematics Teachers' Professional Noticing of Student Thinking	Australian Journal of Teacher Education	2021
M37	Jakopovic, PM	Coaching to Develop Teacher Professional	International Journal of	2021

		Noticing: Planning with Students and Mathematics in Mind	Mentoring and Coaching in Education	
M38	Lee, MY	Improving Preservice Teachers' Noticing Skills Through Technology-Aided Interventions in Mathematics Pedagogy Courses	Teaching and Teacher Education	2021
M39	Lee, MY	The Potential Relationship Between Clinical Interview Skills and Mathematics Teacher Noticing: An Exploratory Study	International Journal of Science and Mathematics Education	2021
M40	Lee, MY	Using A Technology Tool to Help Pre-Service Teachers Notice Students' Reasoning and Errors on A Mathematics Problem	ZDM-Mathematics Education	2021
M41	Ng, OL; Chan, T	In-Service Mathematics Teachers' Video-Based Noticing of 3D Printing Pens in Action	British Journal of Educational Technology	2021
M42	Suh, J; Gallagher, MA; Capen, L; Birkhead, S	Enhancing Teachers' Noticing Around Mathematics Teaching Practices Through Video-Based Lesson Study with Peer Coaching	International Journal for Lesson and Learning Studies	2021
M43	Tyminski, AM; Simpson, AJ; Land, TJ; Drake, C; Dede, E	Prospective Elementary Mathematics Teachers' Noticing of Childrens' Mathematics: A Focus on Extending Moves	Journal of Mathematics Teacher Education	2021
M44	Warshauer, HK; Starkey, C; Herrera, CA; Smith, S	Developing Prospective Teachers' Noticing and Notions of Productive Struggle with Video Analysis in a Mathematics Content Course	Journal of Mathematics Teacher Education	2021
M45	Yang, XR; Kaiser, G; König, J; Blömeke, S	Relationship Between Chinese Mathematics Teachers' Knowledge and Their Professional Noticing	International Journal of Science and Mathematics Education	2021
M46	Yang, XR; König, J; Kaiser, G	Growth of Professional Noticing of Mathematics Teachers: A Comparative Study of Chinese Teachers Noticing with Different Teaching Experiences	ZDM-Mathematics Education	2021
M47	Amador, JM	Mathematics Teacher Educator Noticing: Examining İnterpretations And Evidence of Students' Thinking	Journal of Mathematics Teacher Education	2022
M48	Bastian, A; Kaiser, G; Meyer, D; Schwarz, B; König, J	Teacher Noticing and Its Growth Toward Expertise: An Expert-Novice Comparison with Pre-Service and In-Service Secondary Mathematics Teachers	Educational Studies in Mathematics	2022
M49	Brown, RE	Using Written Teaching Replays to Learn What Early Career Secondary Mathematics Teachers Notice	International Journal of Science and Mathematics Education	2022
M50	Copur-Gencturk, Y; Tolar, T	Mathematics Teaching Expertise: A Study of The Dimensionality of Content Knowledge, Pedagogical Content Knowledge, And Content- Specific Noticing Skills	Teaching and Teacher Education	2022
M51	Ergene, B.C., Bostan, M.I.	Supporting Pre-Service Mathematics Teachers' Professional Noticing of Students' Reasoning About Length	European Journal of Science and Mathematics Education	2022
M52	Kilic, H; Dogan, O	Preservice Mathematics Teachers' Noticing in Action and In Reflection	International Journal of Science and Mathematics Education	2022
M53	Kosko, K.W., Zolfaghari, M., Heisler, J.L.	Professional Noticing as Student-Centered: Pre-Service Teachers' Attending to Students' Mathematics In 360 Video	Eurasia Journal of Mathematics, Science and Technology Education	2022
M54	Kosko, KW	Pre-Service Teachers' Professional Noticing When Viewing Standard and Holographic Recordings of Children's Mathematics	International Electronic Journal of Mathematics Education	2022
M55	Lee, HJ; Kim, HJ	Learning From Noticing: Elementary	Educational Studies	2022

		Mathematics Preservice Teachers' Noticing and Responsiveness on Lesson Modification		
M56	Tasdan, BT; Dede, AT; Koyunkaya, MY	Examining Pre-Service Mathematics Teachers' Argumentation-Supported Lesson Plans and Their Noticing During Planning	International Journal of Mathematical Education in Science and Technology	2022
M57	van Es, EA; Hand, V; Agarwal, P; Sandoval, C	Multidimensional Noticing for Equity: Theorizing Mathematics Teachers' Systems of Noticing to Disrupt Inequities	Journal For Research in Mathematics Education	2022
M58	Xenofontos, C; Alkan, SH	Prospective Primary Teachers' Professional Noticing in Non-Formal Learning Environments: The Case of a Mathematics Fair	Education Sciences	2022
M59	Amador, JM; Wallin, A; Keehr, J; Chilton, C	Collective Noticing: Teachers' Experiences and Reflection on A Mathematics Video Club	Mathematics Education Research Journal	2023
M60	Bas-Ader, S; Erbas, AK; Cetinkaya, B; Alacaci, C; Cakiroglu, E	Secondary Mathematics Teachers' Noticing of Students' Mathematical Thinking Through Modeling-Based Teacher Investigations	Mathematics Education Research Journal	2023
M61	Ding, MX; Li, XB; Manfredonia, ML; Luo, WD	US And Chinese Elementary Teachers' Noticing of Cross-Cultural Mathematics Videos	Journal of Mathematics Teacher Education	2023
M62	Estapa, A; Amador, JM	A Qualitative Metasynthesis of Video-Based Prompts and Noticing in Mathematics Education	Mathematics Education Research Journal	2023
M63	Graham, M; McDuffie, AR	Supporting Mathematics Preservice Teachers in Noticing for Equity	School Science and Mathematics	2023
M64	Guler, M; Taylan, RD; Baki, M; Demirel, D; Celik, D; Guzel, EB; Aslan-Tutak, F; Celik, AO	Supporting Novice Mathematics Teachers: The Impact of an E- Mentoring and Video-Based Professional Development Program on Teachers Noticing Skills	International Electronic Journal of Mathematics Education	2023
M65	Han, C; Kim, HJ; Kwon, ON; Lim, W	Exploring Changes of Mathematics Teachers' Noticing in A Video Club: Identifying Turning Points	International Journal of Science and Mathematics Education	2023
M66	Jazby, D	Conceptualising Mathematics Teacher Noticing as A Perception/Action Cycle	Mathematics Education Research Journal	2023
M67	Lee, MY; Lee, JE	An Analysis of Elementary Prospective Teachers' Noticing of Student Pattern Generalization Strategies in Mathematics	Journal of Mathematics Teacher Education	2023
M68	Lin, YC	Using Virtual Classroom Simulations in A Mathematics Methods Course to Develop Pre-Service Primary Mathematics Teachers' Noticing Skills	British Journal of Educational Technology	2023
M69	Mirzaei, AM; Jansen, A; Headrick, L; Middleton, J	Using Teacher and Student Noticing to Understand Engagement in Secondary Mathematics Lessons	School Science and Mathematics	2023
M70	Nama, S; Ayalon, M	Exploring Change in Secondary Mathematics Teachers' Noticing of Argumentation Through Experiencing Peer-Assessment Strategies	Journal of Mathematics Teacher Education	2023
M71	Nama, S; Hayeen-Halloun, M; Ayalon, M	Noticing Of Argumentation: A Comparison Between Pre-Service and In-Service Secondary-School Mathematics Teachers	Journal of Mathematical Behavior	2023
M72	Rotem, SH; Ayalon, M	Changes In Noticing Multiple Dimensions in Classroom Situations Among Pre-Service Mathematics Teachers	Teaching and Teacher Education	2023
M73	Rotem, SH; Ayalon, M	Constructing Coherency Levels to Understand Connections Among the Noticing Skills of Pre-Service Mathematics Teachers	Journal of Mathematics Teacher Education	2023

M74	Rubin, E; van Es, EA	My Noticing Lens Disrupts This Narrative: Preservice Mathematics Teachers' Awareness of The Self as Noticer	School Science and Mathematics	2023
M75	Spitzer, SM; Phelps-Gregory, CM	The Relationship Between Prospective Teachers' Mathematics Knowledge for Teaching and Their Ability to Notice Student Thinking	Mathematics Education Research Journal	2023
M76	Stovall, JL; Pimentel, DR; Carlson, J; Levine, SR	High School Mathematics Teachers' Noticing of Inequitable Talk	Journal of Mathematics Teacher Education	2023
M77	Teuscher, D; Cannon, T; Christensen, S	Secondary Prospective Mathematics Teachers Learning to Notice: The Need for a Dual Perspective of Teaching	School Science and Mathematics	2023
M78	Wei, Y., Zhang, Q., Guo, J., Chen, M.	Learning To Teach Through Noticing: A Bibliometric Review of Teacher Noticing Research in Mathematics Education During 2006–2021	Humanities and Social Sciences Communications	2023
M79	Weyers, J; König, J; Rott, B; Greefrath, G; Vorhölter, K; Kaiser, G	Mathematics Teachers' Professional Noticing: Transfer of A Video-Based Competence Assessment Instrument into Teacher Education for Evaluation Purposes	Zeitschrıit Fur Erziehungswıssenschaft	2023
M80	Weyers, J., König, J., Scheiner, T., Santagata, R., Kaiser, G.	Teacher Noticing in Mathematics Education: A Review of Recent Developments	ZDM-Mathematics Education	2023
M81	Yeh, CTY	Discrete Noticing: Theorizing at The Intersections of Race and Ability in Mathematics Education	School Science and Mathematics	2023
M82	Yildiz, DG; Osmanoglu, A; Alayli, FG	Providing A Video-Case-Based Professional Development Environment for Prospective Mathematics Teachers to Notice Students' Misconceptions in Measurement	Journal of Mathematics Teacher Education	2023
M83	Yilmaz, N; Ozdemir, IEY	Pre-Service Mathematics Teachers' Learning to Notice Student Statistical Thinking in The Context of Lesson Study	International Electronic Journal of Mathematics Education	2023