1st BICONE (Bhinneka Conference)
Empowering Society 5.0: Education, Technology, and Social Transformation
Vol 1 No 1 , 2025

Teacher Noticing As A Catalyst For Students' Mathematical Thinking: A Perspective From Educational Literature

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***Abstract*— Teacher noticing is a professional competence that encompasses the ability to attend to, interpret, and respond to students' thinking during the learning process. In the context of mathematics education, this study positions teacher noticing not merely as a passive observational tool, but as a catalyst that can drive the transformation of students' mathematical thinking. The purpose of this article is to systematically review the literature on the relationship between teacher noticing and students' mathematical thinking, in order to reveal the active role of noticing in enhancing the quality of learning. The methodology employed is a systematic literature review of 25 national and international scholarly articles published between 2008 and 2023. The findings indicate that teacher noticing contributes significantly to strengthening cognitive interactions in the classroom, developing instructional strategies based on students' thinking, and fostering higher-order thinking skills. Thus, teacher noticing has the potential to serve as a catalyst for pedagogical change in mathematics education, particularly in relation to students' mathematical thinking. This study recommends integrating teacher noticing into teacher education programs as well as expanding further research within the local Indonesian context.**

Keywords*— *Teacher Noticing, Mathematical Thinking, Higher-Order Thinking, Mathematics Education, Professional Competence

I. INTRODUCTION

Mathematics teaching often requires teachers not only to deliver content but also to understand how students think when solving problems. The concept of teacher noticing, the ability of teachers to attend to, interpret, and respond to students' mathematical thinking in a timely manner, has been recognized as an essential professional competence for enhancing instructional effectiveness [1] [2]. In recent years, however, research has shifted its perspective. Teacher noticing is no longer perceived as a passive act of observation, but rather as a catalyst that accelerates and deepens the development of students' mathematical thinking [3] [4] [5] [6].

A growing body of literature illustrates how noticing has been examined from diverse perspectives. [7], for example, showed that the use of video clips in mathematics teacher training programs redirected the focus of noticing from content to students' thinking, while simultaneously improving teachers' ability to analyze classroom mathematical interactions. Similarly, [8] provided a comprehensive review that revealed a wide range of conceptual approaches to noticing, highlighting the complex interrelationships between teachers' epistemologies, instructional quality, and the effectiveness of noticing practices. Building on this, [9] identified four major perspectives in teacher noticing research: expertise, sociocultural, discipline-specific, and cognitive-psychological. Within the cognitive-psychological perspective, [10] Learning to Notice framework emphasizes the teacher's role in recognizing, interpreting, and deciding how to respond to students' mathematical thinking.

More recently, scholars have also emphasized the sociopolitical and relational dimensions of noticing. [11] proposed that noticing extends beyond cognition, incorporating teachers' awareness of students' identities and cultural narratives. They argued that noticing is not a neutral act but has the potential to either support or hinder equitable and inclusive learning experiences. In a related line of inquiry, [12] introduced the concept of bidirectional framing, which suggests that the way teachers frame students' thinking not only influences but is also shaped by the noticing process itself. Importantly, shifting from a deficit-based framing to one that values students' strengths can fundamentally transform how teachers attend to, interpret, and respond during classroom interactions.

Despite these advances, research that explicitly positions teacher noticing as a catalyst for transforming students' mathematical thinking remains limited. Previous studies have focused primarily on theoretical structures, frameworks, and intervention strategies designed to cultivate noticing skills [13] [14] [15] [16]. However, few have explored the transformative potential of noticing in reshaping how students move from procedural to conceptual forms of mathematical understanding. This article seeks to fill that gap by positioning teacher noticing as a catalyst rather than merely an observational tool, by integrating cognitive-psychological, framing, and sociopolitical approaches to deepen the analysis of its dynamics, and by offering practical implications for mathematics teacher education. The study further aims to provide strategic recommendations for incorporating teacher

noticing into professional development programs, particularly within the Indonesian context, where empirical investigations remain scarce but urgently needed.

II. METHODOLOGY

A. Research Design

This study employed a Systematic Literature Review (SLR) approach, a structured and comprehensive method used to identify, analyze, and synthesize literature on a specific topic. The method was selected to explore in depth the contribution of teacher noticing as a catalyst in the development of students' mathematical thinking, without engaging in field data collection.

B. Sources and Search Strategy

The data for this review were obtained from scholarly articles published between 2008 and 2024. The databases consulted included Google Scholar, ERIC (Education Resources Information Center), SpringerLink, Sage Journals, as well as nationally accredited journals indexed in SINTA 1 and SINTA 2. The keywords used in the search process were "teacher noticing," "student thinking," "mathematical thinking," "mathematics education," "teacher noticing as catalyst," "higher-order thinking," and "professional noticing."

C. Inclusion and Exclusion Criteria

The inclusion criteria comprised peer-reviewed articles published between 2008 and 2024, written in English or Indonesian, focusing on teacher noticing in the context of mathematics education, addressing the impact of noticing on students, particularly in cognitive or thinking aspects, and consisting of empirical studies, theoretical papers, or systematic reviews. Conversely, the exclusion criteria involved studies outside the field of mathematics education, those that did not discuss the relationship between teacher noticing and students, and non-peer-reviewed publications such as blogs, opinion pieces, or unreviewed conference proceedings.

D. Literature Selection Procedure

The literature selection process was carried out in four stages. The initial identification yielded 85 articles across the five databases. Following title and abstract screening, 45 articles were retained as potentially relevant to the study's focus. A subsequent content evaluation resulted in the selection of 25 articles that met the inclusion criteria most consistently. Finally, these articles were subjected to thematic analysis and synthesis to identify emerging patterns, key findings, and contributions to the conceptual framework of teacher noticing as a catalyst. The literature selection procedur of this study is presented in Figure 1.

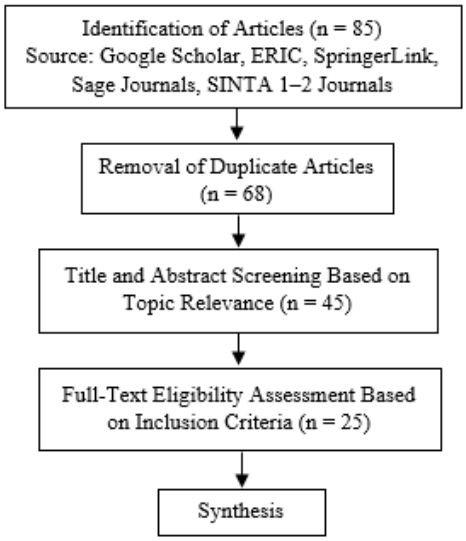

Fig. 1. Literature Selection Procedure

E. Data Analysis

The data were analyzed using thematic content analysis. Each article was examined according to its research focus, the type of teacher noticing investigated, the level of education addressed (elementary, secondary, or high school), the aspects of students' thinking associated with noticing (such as conceptual, critical, or reflective thinking), and the pedagogical implications for teachers. From this analysis, several key themes emerged, forming the foundation of this article's discussion: teacher noticing as a diagnostic tool, teacher noticing as a reflective-pedagogical tool, teacher noticing as a catalyst for mathematical thinking, and the challenges and opportunities of developing noticing in teacher training programs.

II. RESULT

Based on the inclusion criteria, a total of 25 articles were identified as the most relevant to the focus of this study. These selected works represent a combination of empirical studies, theoretical reviews, and conceptual analyses that collectively illustrate the development of teacher noticing research in the field of mathematics education. Table 1 presents a detailed overview of these articles, including the authors, year of publication, article title, journal or source, and primary focus.

TABLE 1. ARTICLES MEETING THE INCLUSION CRITERIA

No	Authors & Year	Title of the Article	Journal/Source	Main Focus
1	van Es & Sherin (2008)	Mathematics teachers' learning to notice: A framework for analyzing video cases	Journal of Mathematics Teacher Education	Initial framework of Learning to Notice
2	Jacobs, Lamb, & Philipp (2010)	Professional noticing of children's mathematical thinking	Journal for Research in Mathematics Education	Definition of professional noticing

3	Qi et al. (2022)	Using video-based professional development to enhance teacher noticing	Teaching and Teacher Education	Video-based intervention
4	König et al. (2023)	Conceptual frameworks of teacher noticing: A systematic review	ZDM Mathematics Education	Conceptual review of noticing
5	Louie et al. (2023)	Framing and teacher noticing in mathematics classrooms	Educational Studies in Mathematics	Bidirectional framing
6	Chen et al. (2025)	Perspectives on teacher noticing in mathematics education	Mathematics Education Research Journal	Four main perspectives
7	Jacobs & Spangler (2017)	Research on mathematics teacher noticing	ZDM Mathematics Education	Early literature review
8	Chan et al. (2019)	Teacher noticing and mathematical practices	Mathematics Teacher Educator	Teacher practices and noticing
9	Schack et al. (2013)	Teacher noticing of students' algebraic thinking	Journal of Mathematics Teacher Education	Noticing in algebra
10	Sun & van Es (2015)	Analyzing teachers' noticing in classroom video clubs	Journal of Teacher Education	Video clubs as a medium for noticing
11	Kersting et al. (2012)	Measuring teacher noticing using video-based tasks	Journal of Teacher Education	Assessment instruments
12	Stockero (2014)	Characterizing pivotal teaching moments	Journal for Research in Mathematics Education	Critical moments and noticing
13	Simpson & Haltiwanger (2017)	Developing teachers' noticing through task-based interviews	Mathematics Teacher Educator	Task-based interviews
14	Amador et al. (2021)	Teacher noticing in online mathematics environments	Journal of Digital Learning in Teacher Education	Online contexts
15	González et al. (2020)	Sociopolitical dimensions of teacher noticing	Educational Studies in Mathematics	Noticing and social justice
16	Herbst et al. (2019)	Mathematics teacher noticing in practice	ZDM Mathematics Education	Practical classroom studies
17	Gurl (2018)	Designing professional development for noticing	Teaching and Teacher Education	Professional development
18	Carlson et al. (2019)	Teacher noticing of students' problem-solving strategies	Mathematics Education Research Journal	Problem-solving strategies
19	Krupa et al. (2017)	Teacher noticing and discourse in secondary mathematics	Journal of Mathematics Teacher Education	Noticing and classroom discourse
20	Choy (2016)	Teachers' professional noticing and mathematical reasoning	Asia Pacific Journal of Education	Mathematical reasoning
21	Miller (2021)	Equity-focused teacher noticing	Mathematics Teacher Educator	Equity-based noticing
22	Li et al. (2022)	Cultural perspectives in teacher noticing	International Journal of Science and Mathematics Education	Cross-cultural perspectives
23	Santagata et al. (2020)	Developing noticing through lesson study	Teaching and Teacher Education	Lesson study
24	Kazemi & Franke (2004)	Teacher learning in mathematics reform	American Educational Research Journal	Reform and noticing
25	ZDM Review (2023)	Advances in teacher noticing research	ZDM Mathematics Education	Recent review

The analysis of the 25 selected articles reveals recurring patterns and thematic focuses that shed light on the multifaceted role of teacher noticing in mathematics education. While Table 1 provides an overview of the individual contributions of each study, a deeper synthesis highlights four overarching themes that capture the ways in which teacher noticing influences students' mathematical thinking. These thematic categories, along with their key research foci, main contributions, and representative references, are summarized in Table 2.

TABLE 2. SUMMARY OF KEY FINDINGS

Main Theme	Research Focus	Main Contribution	Key References
Teacher noticing as a diagnostic tool	Teachers identify students' difficulties, misconceptions, and reasoning strategies	Helps teachers detect specific learning needs and design appropriate interventions	Jacobs et al. (2010); Qi et al. (2022)
Teacher noticing as a reflective-pedagogical tool	Teachers use noticing to evaluate instructional effectiveness	Encourages teachers to develop adaptive teaching strategies based on student thinking	van Es & Sherin (2008); König et al. (2023)
Teacher noticing as a catalyst for mathematical thinking	Noticing positioned as a driver for higher-order thinking	Stimulates students' conceptual, analytical, and reflective abilities through teacher responses	Louie et al. (2023); Chen et al. (2025)

Challenges and opportunities in developing noticing	Teacher training limitations, sociocultural context, and equity issues	Highlights the need for integrating noticing into teacher education, video-based training, and multicultural approaches	ZDM Review (2023); Louie et al. (2023)

The synthesis presented in Table 2 demonstrates that teacher noticing serves not only as a diagnostic and reflective tool but also as a catalyst for fostering students' higher-order mathematical thinking. At the same time, it reveals the challenges and opportunities associated with implementing noticing practices, particularly within diverse educational and cultural contexts. Building on these findings, the following discussion elaborates on each of the four identified themes, highlighting their theoretical significance, practical implications, and relevance to mathematics education in Indonesia.

III. DISCUSSION

A. Teacher Noticing as a Diagnostic Tool

The findings reveal that teacher noticing plays an important role in helping teachers diagnose students' thinking processes in real time. The ability to observe students' problem-solving strategies enables teachers to identify misconceptions and provide timely feedback. This aligns with Jacobs et al. (2010), who emphasize that professional noticing forms the foundation for detecting students' conceptual difficulties.

B. Teacher Noticing as a Reflective-Pedagogical Tool

Noticing benefits not only students but also serves as a reflective tool for teachers' pedagogical practices. Teachers who carefully observe and interpret student interactions are better positioned to evaluate the effectiveness of their instructional approaches. As highlighted by Luna and Selmer, (2021), and Weyers et al. (2023), the reflective dimension of noticing strengthens instructional quality that is grounded in student thinking.

C. Teacher Noticing as a Catalyst for Mathematical Thinking

A central finding of this review is the positioning of noticing as a catalyst rather than a passive observation tool. Teachers who actively respond to students' thinking strategies can stimulate the development of higher-order cognitive skills, including deductive reasoning, generalization, and reflection. Lusiana et al. (2024) demonstrate that shifting teachers' framing from a deficit perspective to a strengths-based perspective transforms the quality of their responses, thereby enriching students' learning experiences.

D. Challenges and Opportunities in the Indonesian Context

Although teacher noticing has emerged as a central research theme in international mathematics education, its implementation in Indonesia remains limited. Challenges include insufficient teacher training, the dominance of traditional instructional approaches, and a lack of awareness regarding the sociopolitical dimensions of noticing. Nevertheless, significant opportunities exist through teacher professional education programs (PPG), video-based professional development, and the "Merdeka Curriculum," which emphasizes student-centered learning.

IV. CONCLUSION AND IMPLICATIONS

A. Conclusion

This systematic review of 25 selected articles demonstrates that teacher noticing is not merely a passive observational tool but rather serves as a catalyst for advancing students' mathematical thinking. Four major themes were identified: (1) teacher noticing as a diagnostic tool for identifying students' difficulties and reasoning strategies, (2) teacher noticing as a reflective-pedagogical tool that strengthens student-centered instruction, (3) teacher noticing as a catalyst for stimulating higher-order thinking, and (4) challenges and opportunities in local implementation, particularly in teacher education programs in Indonesia. The novelty of this article lies in emphasizing teacher noticing as a transformative pedagogical element capable of fostering deeper mathematical thinking skills among students.

B. Theoretical Implications

Theoretically, this study broadens perspectives on teacher noticing by integrating cognitive-psychological frameworks with framing and sociopolitical dimensions. This contributes to a richer understanding of noticing as not only an individual teacher skill but also a relational and contextual process that shapes teaching and learning interactions.

C. Practical Implications

The findings provide several practical implications for mathematics education, especially in Indonesia:

1. Teacher Professional Development: Teacher education programs and continuous professional training should incorporate teacher noticing, particularly through video-based training or lesson study.
2. Merdeka Curriculum: The implementation of the student-centered Merdeka Curriculum can be strengthened by positioning noticing as a core teacher competence.
3. Inclusive and Equitable Classroom Practices: Teachers should be trained to attend to students' identities and cultural backgrounds in noticing, thereby fostering more equitable and meaningful learning experiences.

D. Recommendations for Future Research

Future research is encouraged to:

1. Explore teacher noticing practices in Indonesian mathematics classrooms through empirical studies.
2. Develop culturally contextualized assessment instruments for teacher noticing.
3. Examine the effectiveness of noticing-based interventions in enhancing students' higher-order thinking skills across educational levels.

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