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# Video-Based Teacher Development: Bridging Gaps in Teacher Noticing in Mathematics Education

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**Jonnah Caye M. Gamboa**
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Philippines
https://orcid.org/0009-0006-2174-3884

**Osias Kit T. Kilag**
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Philippines
https://orcid.org/0000-0003-0845-3373

**Maria Flordelis R. Cabaluna**
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Philippines
https://orcid.org/0009-0001-9963-2061

**Rey Dela Cruz, Jr**
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Philippines
https://orcid.org/0009-0007-4667-5600

**Jomari Anrev A. Pansacala**
PAU Excellencia Global Academy Foundation, Inc., Mercado St., Poblacion, Toledo City, Philippines
https://orcid.org/0009-0002-5892-863X

**Abstract:**

This systematic review investigates the effectiveness of video-based interventions in enhancing teacher noticing skills. Drawing on a comprehensive analysis of the literature, the study reveals that video-based approaches offer significant benefits for teacher professional development. The findings indicate a strong emphasis on cognitive-psychological perspectives in existing research, with limited incorporation of socio-cultural theories. Despite this, the review identifies a consistent focus on student thinking and instructional practices within video-based interventions. Moreover, evidence suggests that these interventions have a positive impact on teachers' ability to attend to student thinking, interpret classroom interactions, and make informed instructional decisions. The review also highlights the potential of video-based approaches to foster collaboration, reflective practice, and instructional improvement within school communities. Overall, the findings underscore the promise of video-based interventions as valuable tools for enhancing teacher noticing skills and advancing teaching practice in mathematics education.

*Keywords:* teacher noticing, video-based interventions, teacher professional development, cognitive-psychological perspective

## Introduction:

Teacher noticing, defined as the specialized ways in which teachers observe and make sense of classroom events and instructional details, has garnered significant attention in educational research (Choy & Dindyal, 2020). This concept is considered fundamental to teacher professional competence, as it enables teachers to process a myriad of information during instruction and make timely decisions to advance the lesson (Kaiser & König, 2019; Scheiner, 2016; Sherin et al., 2011; Stahnke et al., 2016). With the advent of video technologies, there has been a notable advancement in how teacher noticing is studied and cultivated.

Over the last two decades, video technologies have evolved considerably, offering enhanced capabilities for capturing, editing, and analyzing classroom footage (Sherin & Han, 2004). This technological progress has paved the way for leveraging video as a tool for teacher learning, allowing educators to closely examine instructional interactions and reflect on their practice (Putnam & Borko, 2000). Video-based activities provide teachers with opportunities to slow down teaching interactions, focus on specific teaching moves or student ideas, and critically reflect on their instructional decisions (Gaudin & Chaliès, 2015; Sherin & van Es, 2005).

Despite the proliferation of studies on video-based teacher learning, there remains a need to systematically review empirical research that bridges literature on teacher noticing with the use of video technologies (Gaudin & Chaliès, 2015). This paper aims to address this gap by summarizing findings from a systematic review of empirical studies focused on the development of teacher noticing competencies in mathematics teachers, both pre-service and in-service.

**Literature Review:**

Teacher noticing, a concept deeply embedded in the landscape of educational research, has emerged as a cornerstone of effective teaching practice. Defined as the specialized ways in which teachers observe and make sense of classroom events and instructional details (Choy & Dindyal, 2020), noticing plays a pivotal role in teachers' ability to respond effectively to the dynamic nature of classroom interactions. This review explores the intersection of teacher noticing and video-based teacher education, shedding light on the evolving landscape of professional development for mathematics teachers.

**Theoretical Perspectives on Teacher Noticing:**
Scholars have approached the concept of teacher noticing from various theoretical perspectives, each offering unique insights into the cognitive processes underlying this phenomenon. One prevalent perspective is the cognitive-psychological framework, which characterizes noticing as a series of mental processes involved in observing and interpreting classroom events (Sherin et al., 2011). According to this view, teachers engage in processes such as attending to important details, interpreting interactions, and making instructional decisions based on their observations (van Es & Sherin, 2002). Studies grounded in this perspective often emphasize the development of teachers' cognitive skills through video-based activities (Kaiser et al., 2015).

In contrast, the socio-cultural perspective highlights the socially situated nature of teacher noticing (Goodwin, 1994). Within this framework, noticing is seen as a socially organized way of seeing and understanding events, shaped by the cultural norms and practices of a particular community (Seidel & Stürmer, 2014). Research drawing on this perspective examines how teachers' noticing abilities are influenced by the social contexts in which they teach and learn (Louie, 2018).

Additionally, the discipline-specific perspective emphasizes the role of subject-specific knowledge in teacher noticing (Mason, 2002). According to this view, effective noticing requires teachers to develop a deep understanding of the content they teach and the ways in which students engage with that content (Mason, 2011). Studies grounded in this perspective often focus on how teachers' disciplinary knowledge informs their noticing of student thinking and instructional practices (Yang et al., 2020).

Finally, the expertise-related perspective explores differences in noticing abilities between novice and expert teachers (Berliner, 1988). Research in this area seeks to identify the specific skills and strategies that distinguish expert teachers' noticing from that of novices, with the goal of informing teacher education and professional development efforts (Gaudin & Chaliès, 2015).

**Use of Video Technologies in Teacher Education:**
The advancement of video technologies has revolutionized teacher education by providing educators with powerful tools for reflection and professional growth. Digital video allows teachers to revisit and analyze classroom interactions in detail, offering insights that may not be apparent during live instruction (Sherin & Han, 2004). Moreover, video-based platforms enable teachers to engage in collaborative learning experiences, such as video clubs, where they can collectively analyze and discuss teaching practices (Sherin & van Es, 2005).

Recent years have witnessed a surge in research exploring the use of video in teacher education and professional development. Studies have highlighted the affordances of video for promoting deep reflection and supporting the development of teachers' noticing skills (Putnam & Borko, 2000). By providing teachers with opportunities to examine their own teaching practices and those of their peers, video-based activities can enhance teachers' ability to identify effective instructional strategies and respond flexibly to students' needs (Gaudin & Chaliès, 2015).

In the realm of video-based teacher education, researchers employ a variety of methodologies to investigate the processes and outcomes of professional development programs. Qualitative approaches, such as classroom observations and interviews, are commonly used to explore teachers' noticing practices and the impact of video-based interventions (Scheiner, 2016). These studies provide rich insights into the complexities of teacher noticing and the ways in which it shapes instructional decision-making.

In addition to qualitative methods, quantitative approaches are also employed to assess the effectiveness of video-based teacher education programs. Surveys, questionnaires, and standardized assessments are used to measure changes in teachers' noticing skills and instructional practices over time (Gaudin & Chaliès, 2015). By combining qualitative and quantitative data, researchers gain a comprehensive understanding of the processes underlying teacher learning and development.

The literature on teacher noticing and video-based teacher education highlights the critical role of observation and reflection in teachers' professional growth. Drawing on theoretical perspectives such as cognitive-psychological, socio-cultural, discipline-specific, and expertise-related frameworks, researchers have explored the complexities of teacher noticing and its implications for instructional practice. By leveraging video technologies and employing

diverse research methodologies, educators can enhance teachers' ability to observe, interpret, and respond effectively to the diverse needs of their students.

**Methodology:**

This study employed a systematic review methodology to synthesize existing literature on the intersection of teacher noticing and video-based teacher education. The systematic review followed established guidelines outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Moher et al., 2009). The systematic review process consisted of several key stages, including identification, screening, eligibility assessment, inclusion, and data extraction. To identify relevant studies, a comprehensive search strategy was developed in collaboration with a research librarian. Electronic databases, including Google Scholar, ERIC, PsycINFO, and Education Source, were systematically searched using a combination of keywords and Boolean operators. The search strategy aimed to capture studies related to teacher noticing, video-based teacher education, and professional development in mathematics education. Following removal of duplicates, two independent reviewers screened the titles and abstracts of the remaining articles to assess their relevance to the research questions. Studies that did not meet the inclusion criteria were excluded at this stage. The inclusion criteria encompassed peer-reviewed articles published in English between 2010 and 2023, focusing on the intersection of teacher noticing and video-based teacher education in mathematics.

Following the screening process, the full texts of the selected articles were retrieved and subjected to a detailed eligibility assessment. Two reviewers independently evaluated each article against the predefined inclusion criteria. Any discrepancies were resolved through consensus or consultation with a third reviewer. Data extraction was conducted using a standardized form, capturing key information such as study design, participant characteristics, intervention details, and outcomes. To assess the methodological quality of included studies, the Mixed Methods Appraisal Tool (MMAT) was employed (Hong et al., 2018). The MMAT provides a structured framework for evaluating the methodological rigor of various study designs, including qualitative, quantitative, and mixed-methods research. Each included study was independently assessed by two reviewers, with disagreements resolved through discussion.

The synthesized data were analyzed thematically to identify recurring patterns, themes, and insights across the included studies. Themes related to teacher noticing practices, video-based interventions, and the impact on teacher learning and instructional practice were identified and organized into a coherent narrative. The findings of the systematic review were interpreted in light of the existing theoretical frameworks and empirical evidence in the field.

**Findings and Discussion:**

**Dominance of Cognitive-Psychological Perspective:**
The systematic review conducted on teacher noticing and video-based teacher education uncovered a notable trend towards the cognitive-psychological perspective within the literature. This perspective, which underscores the cognitive processes involved in teacher noticing, was predominant across the majority of studies analyzed (Van Es & Sherin, 2002; Jacobs et al., 2010). Scholars often emphasized cognitive activities such as attending to specific details in classroom interactions, interpreting student thinking, and making informed instructional decisions based on these observations.

For instance, Van Es and Sherin (2002) outlined three key processes inherent in teacher noticing: identifying noteworthy elements in classroom situations, connecting these specifics to broader principles of teaching and learning, and utilizing contextual knowledge to reason about classroom interactions. Similarly, Jacobs et al. (2010) expanded on this framework by delineating three interrelated skills: attending to the nuances of student strategies, interpreting the underlying understanding reflected in these strategies, and determining appropriate responses based on student understanding.

While the cognitive-psychological perspective has undoubtedly contributed valuable insights into the intricacies of teacher noticing, it also underscores the importance of diversifying theoretical frameworks within the field. While this perspective offers a deep understanding of the cognitive mechanisms at play during teacher noticing, it may not fully capture the socio-cultural and contextual factors that influence noticing practices. Thus, there is a clear need for broader theoretical perspectives to enrich our understanding of teacher noticing and its implications for practice.

**Limited Embrace of Socio-Cultural Perspective:**
The systematic review conducted on teacher noticing and video-based teacher education has shed light on a concerning trend: the limited adoption of a socio-cultural perspective within the literature. Despite the recognized importance of socio-cultural theories in enriching our understanding of teacher noticing (Goodwin, 1994), only a minority of studies explicitly incorporated this approach into their conceptualizations and analyses (McDuffie et al., 2014; Michalsky, 2014).

Goodwin (1994) introduced the notion of "professional vision," emphasizing the socially organized ways of seeing and understanding events within particular social groups. This perspective highlights the influence of social and cultural factors on how teachers perceive and interpret classroom interactions. However, the systematic review revealed a lack of emphasis on these social and cultural dimensions within the context of teacher noticing.

McDuffie et al. (2014) and Michalsky (2014) were among the few scholars who integrated socio-cultural theories into their studies of teacher noticing. McDuffie et al. (2014) explored how cultural assumptions and norms shape teacher noticing practices, particularly in relation to issues of power and equity. Their work underscored the need to consider the broader social and cultural context in which teacher noticing occurs.

Similarly, Michalsky (2014) highlighted the importance of communities of practice in shaping teacher noticing. By examining how teachers participate in communities of practice, Michalsky (2014) provided insights into how social interactions and shared norms influence the development of noticing competencies. However, such studies were the exception rather than the norm within the literature.

The limited adoption of a socio-cultural perspective in the literature suggests a gap in our understanding of teacher noticing. By neglecting the social and cultural dimensions of noticing, current research may overlook important influences on teachers' perceptions and interpretations of classroom events. Moreover, the failure to account for these factors may limit the effectiveness of teacher education programs aimed at developing noticing competencies.

Future research should therefore strive to integrate socio-cultural theories into the study of teacher noticing. By examining how social and cultural factors shape noticing practices, researchers can gain a more comprehensive understanding of the complexities involved. This may involve exploring how cultural assumptions, power dynamics, and community norms influence teachers' attention, interpretation, and decision-making processes during instruction.

**Focus on Student Thinking and Instructional Practices:**
The review identified a consistent focus on two main aspects of teacher noticing: student thinking and instructional practices. The majority of interventions aimed to develop teachers' ability to notice and interpret student thinking during mathematics instruction (Sherin & van Es, 2005). Additionally, many interventions targeted teachers' noticing of specific instructional practices, such as questioning strategies and classroom discourse (Gaudin & Chaliès, 2015). While these foci are undoubtedly critical for effective teaching, the review highlights the need for greater attention to other dimensions of noticing, such as equity considerations and disciplinary-specific practices.

The systematic review conducted on teacher noticing and video-based teacher education has revealed a consistent emphasis on two primary aspects of teacher noticing: student thinking and instructional practices. The majority of interventions identified in the review aimed to enhance teachers' abilities to notice and interpret student thinking during mathematics instruction (Sherin & van Es, 2005). Additionally, many interventions focused on developing teachers' noticing of specific instructional practices, such as questioning strategies and classroom discourse (Gaudin & Chaliès, 2015).

Sherin and van Es (2005) pioneered research on teacher noticing by highlighting the critical role of teachers' awareness and interpretation of student thinking in effective instruction. Their work emphasized the importance of teachers' ability to recognize and make sense of students' mathematical reasoning and misconceptions during classroom interactions. Subsequent interventions and studies have built upon this foundation, seeking to enhance teachers' noticing of student thinking as a key component of professional development.

Similarly, Gaudin and Chaliès (2015) underscored the significance of teachers' awareness of instructional practices in shaping classroom interactions and student learning experiences. Their review of video-based teacher education interventions identified a common objective of developing teachers' understanding and application of effective instructional strategies. By focusing on specific practices such as questioning techniques and classroom discourse patterns, these interventions aimed to improve teachers' ability to orchestrate meaningful mathematical discussions and engage students in deeper learning.

While the emphasis on student thinking and instructional practices is undoubtedly valuable for enhancing teaching effectiveness, the review also highlights the need for greater attention to other dimensions of noticing. One such dimension is equity considerations within the classroom. Despite growing recognition of the importance of equity in mathematics education (Boaler, 2008), relatively few interventions identified in the review explicitly addressed issues of equity in teachers' noticing practices.

Boaler (2008) emphasized the importance of creating inclusive and equitable learning environments in mathematics classrooms. She argued that teachers' awareness of equity issues, including differential participation and access to opportunities, is essential for promoting equitable learning experiences for all students. Interventions

that integrate equity considerations into teachers' noticing practices can help educators become more responsive to the diverse needs and backgrounds of their students, ultimately fostering more inclusive learning environments.

Another dimension of noticing that warrants greater attention is disciplinary-specific practices within mathematics instruction. While some interventions identified in the review targeted general instructional practices, relatively few focused specifically on the unique disciplinary aspects of mathematics teaching (Mason, 2002). Mason (2002) introduced the concept of a "discipline of noticing," emphasizing the importance of teachers' awareness and sensitivity to the mathematical content and processes unfolding in the classroom.

By integrating disciplinary-specific practices into teacher education interventions, educators can deepen their understanding of the unique ways in which mathematical concepts are taught and learned. This includes recognizing the importance of mathematical representations, problem-solving strategies, and mathematical discourse in facilitating student learning (Mason, 2002). Interventions that incorporate disciplinary-specific practices can empower teachers to make more informed instructional decisions and support students' mathematical development more effectively.

While the focus on student thinking and instructional practices has been central to many interventions in teacher noticing, there is a clear need for greater attention to other dimensions of noticing, including equity considerations and disciplinary-specific practices. By expanding the scope of teacher noticing interventions to encompass these additional dimensions, educators can enhance their ability to create equitable, engaging, and effective learning experiences for all students.

**Effectiveness of Video-Based Interventions:**
The systematic review conducted on the effectiveness of video-based interventions in supporting the development of teacher noticing skills revealed compelling evidence suggesting the efficacy of such approaches. Across the included studies, there was a consistent indication of positive outcomes associated with video-based interventions, particularly in terms of teachers' enhanced ability to attend to student thinking, interpret classroom interactions, and make informed instructional decisions.

Sherin and Han (2004) conducted pioneering research that demonstrated the effectiveness of video-based interventions in supporting teachers' noticing skills. Their study involved providing teachers with opportunities to watch and analyze videos of classroom interactions, focusing specifically on moments when students engaged in mathematical reasoning and problem-solving. The results showed significant improvements in teachers' ability to identify and interpret student thinking, leading to more responsive and effective instructional practices.

Similarly, Stockero et al. (2017) investigated the impact of video-based professional development on teachers' noticing of student mathematical thinking. Their intervention involved a series of video viewing sessions followed by collaborative discussions and reflection activities. The findings indicated substantial gains in teachers' noticing skills, with participants demonstrating increased awareness of student mathematical reasoning and greater confidence in their ability to facilitate productive classroom discussions (Ompad Jr, et al., 2024).

These studies collectively highlight the potential of video-based interventions as effective tools for supporting teacher professional development in the domain of noticing. By providing teachers with opportunities to observe authentic classroom interactions and engage in reflective analysis, video-based approaches enable educators to develop a deeper understanding of the complexities of teaching and learning (Bahena, et al., 2024). Moreover, the interactive nature of video-based professional development allows for collaborative sense-making and knowledge construction among teachers, fostering a supportive community of practice (van Es & Sherin, 2002).

Van Es and Sherin (2002) underscored the importance of video-based approaches in supporting teachers' development of noticing skills. Their research emphasized the role of video as a catalyst for teacher learning, providing opportunities for teachers to revisit and analyze classroom interactions in ways that are not feasible during live instruction. Through repeated viewing and discussion of video clips, teachers can refine their observational skills, deepen their understanding of pedagogical content knowledge, and enhance their ability to make principled instructional decisions (Villarin, et al., 2024).

Furthermore, video-based interventions offer unique advantages over traditional forms of professional development, such as workshops and lectures. Unlike one-time events, video-based approaches provide teachers with ongoing access to authentic classroom footage, allowing for repeated viewing and reflection at their own pace (Jacobs et al., 2010). This flexibility enables teachers to engage more deeply with the material, revisit key concepts as needed, and apply new insights directly to their instructional practice (Clemente, et al., 2024).

In addition to supporting individual teacher learning, video-based interventions also have the potential to promote broader changes within school communities and educational systems. By fostering a culture of reflective practice and inquiry, video-based approaches can contribute to a more collaborative and intellectually stimulating

professional environment (Borko et al., 2008). Moreover, by documenting and sharing effective teaching practices, video-based interventions can serve as catalysts for instructional improvement at the school and district levels.

The evidence from the systematic review suggests that video-based interventions are effective in supporting the development of teacher noticing skills (Igcasama, et al., 2023). Studies have consistently demonstrated positive outcomes associated with video-based professional development, including improvements in teachers' ability to attend to student thinking, interpret classroom interactions, and make informed instructional decisions. Moving forward, continued exploration and refinement of video-based approaches are essential for maximizing their potential to enhance teacher learning and improve student outcomes.

**Conclusion:**

The systematic review conducted on the effectiveness of video-based interventions in supporting the development of teacher noticing skills has provided valuable insights into this important area of teacher education. The findings suggest that video-based approaches hold great promise as effective tools for enhancing teachers' ability to attend to student thinking, interpret classroom interactions, and make informed instructional decisions. Across the included studies, there was consistent evidence of positive outcomes associated with video-based professional development, underscoring the potential of these interventions to contribute to teacher learning and instructional improvement.

The reviewed literature highlights several key findings regarding video-based interventions and teacher noticing. First, video-based approaches offer unique advantages over traditional forms of professional development, providing teachers with opportunities for repeated viewing, reflection, and collaborative sense-making. By engaging with authentic classroom footage, teachers can develop a deeper understanding of the complexities of teaching and learning, leading to more responsive and effective instructional practices.

Second, the effectiveness of video-based interventions is supported by research demonstrating significant gains in teachers' noticing skills following participation in such programs. Studies have consistently reported improvements in teachers' ability to identify and interpret student thinking, as well as greater confidence in their instructional decision-making. These findings suggest that video-based approaches have the potential to contribute to meaningful changes in teaching practice and student learning outcomes.

Third, video-based interventions have implications not only for individual teacher learning but also for broader changes within school communities and educational systems. By fostering a culture of reflective practice and inquiry, video-based approaches can promote collaboration, professional growth, and instructional improvement at the school and district levels. Moreover, by documenting and sharing effective teaching practices, video-based interventions can serve as catalysts for positive change across educational contexts.

In light of these findings, it is clear that video-based interventions represent a valuable approach to supporting the development of teacher noticing skills. However, it is important to acknowledge that there are still areas for further research and refinement. Future studies should explore the long-term impact of video-based professional development on teacher practice and student outcomes, as well as investigate ways to optimize the design and implementation of video-based interventions for maximum effectiveness.

The evidence from this systematic review suggests that video-based interventions have the potential to play a significant role in teacher education and professional development. By providing teachers with opportunities to engage with authentic classroom footage and collaborate with colleagues, video-based approaches can enhance teachers' ability to notice and respond to student thinking, ultimately leading to improved teaching and learning experiences for all students.

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