EXPLORING DEFICIT-BASED AND STRENGTHS-BASED FRAMINGS IN NOTICING STUDENT MATHEMATICAL THINKING

Thorsten Scheiner

Institute for Learning Sciences and Teacher Education,
Australian Catholic University, Australia

This study explores prospective teachers' framings in noticing students' mathematical thinking. A course was designed to engage prospective teachers in critical reflection of their framings and to encourage strengths-based framings when noticing students' mathematical thinking. Responses to noticing tasks during the first and last session of the course were analysed to identify what aspects prospective teachers pay attention to, what stances they adopt when interpreting, and what instructional moves they propose in responding to students' mathematical thinking. On this basis, prospective teachers' framings were characterised as deficit-based or strengths-based. The results show that prospective teachers shifted from deficit-based framings to strengths-based framings, and specific changes in prospective teachers' noticing are discussed.

INTRODUCTION

Research in teacher education over the last two decades has focused on an essential skill for teaching – the ability to pay attention to, interpret and respond to students' thinking – which has been termed 'teacher noticing' (for an overview, see Dindyal et al., 2021). One reason for this is that it captures teachers' moment-to-moment decision-making, which relies on teachers paying attention to what students are thinking and doing, and interpreting students' ideas to make informed decisions about how a lesson should proceed (Mason, 2002; Schoenfeld, 2011). This ability to notice students' thinking is central to the kind of instruction advocated, in particular by mathematics education reform initiatives that promote a student-centred, responsive approach to teaching (Franke et al., 2001).

Research shows that noticing matters for teaching and learning mathematics: when teachers pay close attention to the details of students' mathematical thinking, more opportunities for students' mathematical learning emerge (Santagata & Yeh, 2014). Research also shows that teachers can pay attention to the substance of students' mathematical thinking through targeted professional development (Santagata et al., 2021); however, the literature raises questions about what triggers changes in noticing. Some research suggests that changes in noticing are related to the specificity with which teachers see a phenomenon (van Es, 2011). Other research suggests that changes in noticing are related to how teachers frame or reframe the object of attention (Russ & Luna, 2013).

2022. In C. Fernández, S. Llinares, A. Gutiérrez, & N. Planas (Eds.). *Proceedings of the 45th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 395-402). PME.

The construct of framing is becoming increasingly important for understanding the nature of teachers' noticing and for designing teacher education and professional development programmes (Scheiner, 2021; Sherin & Russ, 2014). For example, research shows how framing can strongly influence teachers' noticing and actions in the classroom (Levin et al. 2009). Research also shows that teachers rely heavily on deficit-based framing, i.e. ways of thinking that portray students' mathematical thinking as deficits, inadequacies or failures (Louie et al., 2021). Teachers who use deficit-based framing often identify what students do not know or cannot do. However, deficit-based framing is a barrier to improving students' mathematical learning and can be detrimental to students' development of a positive mathematical identity (Aguirre et al., 2013). There are increasing calls for alternatives to deficit-based framing of students' mathematical thinking; one such alternative is strengths-based framing. Strengths-based framings are ways of viewing students' mathematical thinking as assets or resources rather than weaknesses or deficits (Crespo, 2000).

However, noticing students' mathematical strengths is a complex skill that needs to be learned in part because deficit-based framings are systematically embedded in mathematics education (Adiredja & Louie, 2020). Therefore, teachers need guided support to productively move away from deficit-based framings and embrace strengths-based framings to notice students' mathematical strengths. To this end, a teacher education course was designed to engage prospective mathematics teachers in critical reflection of their individual and collectively shared framings of students' mathematical thinking, and thus bring about a change in their orientations in noticing students' mathematical thinking.

The study presented here contributes to research on teacher noticing: it identifies teachers' framings and noticing practices in relation to students' mathematical thinking and investigates the nature and development of teachers' noticing of students' mathematical strengths. Specifically, the objectives of the study were: (a) the identification of a typology of deficit-based and strengths-based framings in noticing students' mathematical thinking, and (b) the characterization of how changes in framings promote changes in prospective teachers' attending, interpreting and responding to students' mathematical thinking.

THEORETICAL FRAMEWORK

The study presented here draws on research on teacher noticing and teacher framing. An extensive body of research in teacher education has focused on understanding teacher noticing (for a critical discussion, see Scheiner, 2016; for a recent review, see König et al., 2021). There is broad consensus that noticing consists of the ability to pay attention to noteworthy aspects of teaching, interpret what is observed, and decide how to respond (Jacobs et al., 2010; Kaiser et al., 2015; van Es & Sherin, 2002). Conceptualisations of noticing that include attending, interpreting and responding have been used to examine teachers' noticing with different foci, with particular attention to noticing students' mathematical thinking (Sherin et al., 2011). However, common

approaches to teacher noticing focus on individual teachers and their internal mental processes, obscuring the fundamental ways in which noticing is shaped by historically and culturally constituted ways of structuring and organising experiences (Louie, 2018; Scheiner, 2021).

However, learning to recognise and interpret students' mathematical strengths requires acquiring tools and frameworks to figure out what to look for and how to characterise students' mathematical thinking. Such a perspective was articulated and applied in this study through the use of framing theory. Framings are understood here as culturally and historically constituted ways of organising and structuring experience (Goffman, 1974). They provide interpretive contexts that help participants in a given situation understand what tasks they are engaged in, what knowledge is relevant, and what behaviours are expected of them and others (Hammer et al., 2005).

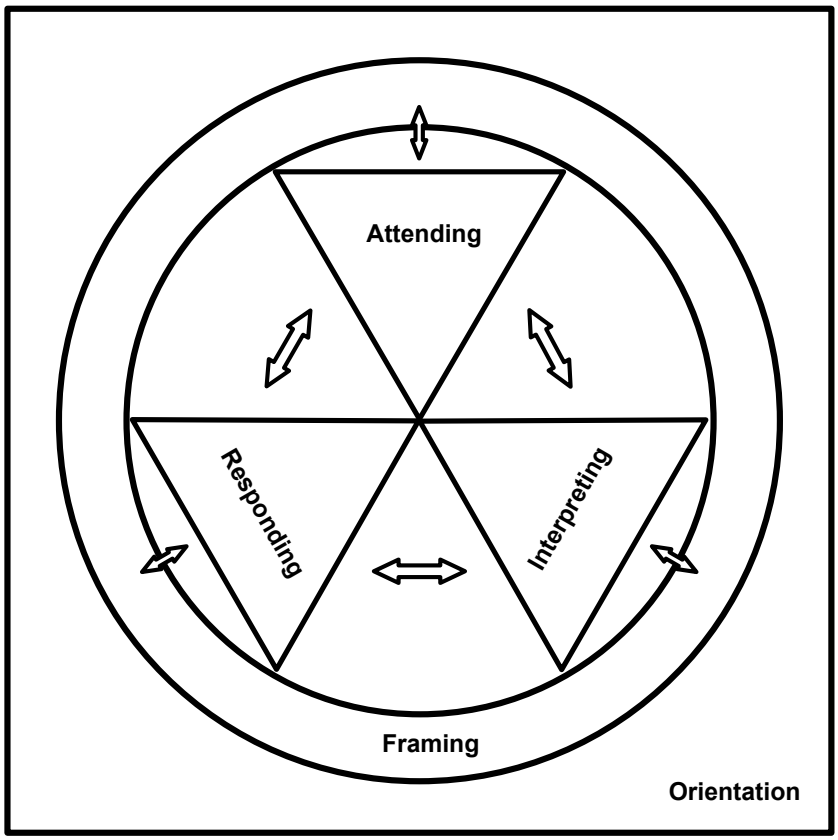


Figure 1: An integrated view of teacher noticing and teacher framing.

Following Levin et al. (2009) and Russ and Luna (2013), this study took an integrated view of framing and noticing (see Figure 1). That is, the three processes of attending, interpreting and responding are shaped by the ways teachers frame the object of attention, which in turn is constituted by broader orientations, such as orientations to deficits in students' mathematical understanding (see Scheiner, 2021). Accordingly, framing and noticing often reinforce each other. This makes it essential to critically reflect on framing and the ways in which it drives noticing.

RESEARCH DESIGN AND METHOD

Mathematics teacher education course

In this study, a teacher education course consisting of fourteen three-hour face-to-face meetings was designed to support prospective teachers notice students' mathematical strengths by encouraging more systematic reflection on their own and others' framings using methods of critical reflection (Brookfield, 1995; Liu, 2015). Specifically, carefully designed case studies of students' mathematical work were used (e.g., Scheiner & Pinto, 2019), and prospective teachers were asked to respond in writing to what they noticed about students' mathematical thinking. These written noticing responses were intended to help the prospective teachers reflect critically on their own and others' noticing as they thought about, talked about and looked at students' mathematical thinking. These reflections went far beyond reflecting on personal framings by encouraging the prospective teachers to consider framings of students' mathematical thinking represented in the literature and in critical writings that counter deficit-based framings of students' mathematical thinking, such as Smith et al. (1994). The prospective teachers then explored how they might use these new perspectives and ideas in their own framing of students' mathematical thinking.

Data collection

The study data were collected from nine prospective secondary mathematics teachers who participated in the mathematics teacher education course. The study data consisted of the prospective teachers' written responses to noticing tasks collected during the first and last sessions of the course. The noticing tasks were specifically designed to gain insight into the nature and development of prospective teachers' noticing of students' mathematical understanding of limits.

Similar to Jacobs et al. (2010), each of the tasks involved a series of noticing activities that focused the prospective teachers' attention on the particular student's reasoning ('What do you find noteworthy about the student's mathematical reasoning?'), their interpretation of the student's understanding ('What did you learn about the student's mathematical thinking and how can you interpret the student's understanding?'), and their response to the student's thinking ('Suppose you were the student's teacher, what and how would you respond to the student's mathematical thinking?'). The purpose of these noticing activities was to find out which aspects the prospective teachers highlighted as noteworthy, what their stances were in interpreting students' mathematical thinking, and what instructional moves they suggested in their responses to the students' thinking under consideration.

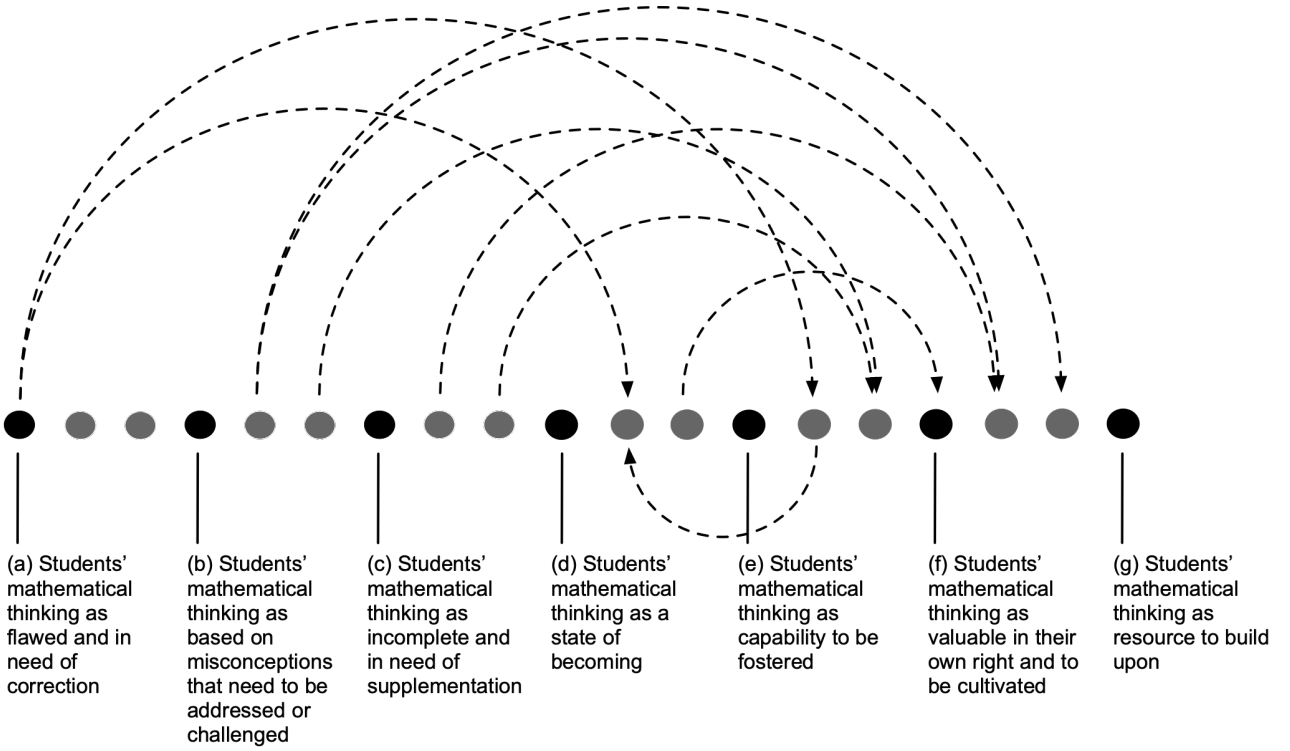
Data analysis

The analysis of the prospective teachers' written noticing responses was conducted in four phases. First, the written noticing responses were divided into three units: attending, interpreting and responding. Second, fine-grained analyses (see diSessa et al., 2016) were conducted at the level of each written noticing response unit to identify

the aspects that the prospective teachers highlighted as noteworthy in their attention to students' mathematical reasoning, the stances they used in interpreting students' understanding, and the instructional moves they suggested in responding to students' thinking. Third, the identified aspects, stances and instructional moves were used to code the response units (attending, interpreting and responding units) of the prospective teachers at the beginning and end of the course. This process involved double coding of all attending, interpreting or responding units for the presence or absence of each of the aspects, stances or instructional moves. Inter-rater reliability was above 80% for all categories (aspects, stances and instructional moves) for all response units (attending, interpreting and responding). Disagreements were resolved by consensus. Fourth, the framings that the prospective teachers used in noticing students' mathematical thinking were derived based on the aspects, stances and instructional moves that the prospective teachers identified in their written noticing responses.

RESULTS AND DISCUSSION

In total, seven different framings of students' mathematical thinking were identified; three of these were deficit-based (a-c), one was uncommitted, i.e., neither deficit-based nor strengths-based (d), and three were strengths-based (e-g) (see Figure 2).



Note. Black coloured circles refer to different framings, the grey coloured circles in between refer to tendencies towards the respective framings. Each of the dashed lines refers to one of the prospective teachers' shifts in framing, the direction of which is indicated by the arrow.

Figure 2: Prospective teachers' shifts from deficit-based to strengths-based framings of students' mathematical thinking.

Analyses of the written noticing responses indicated that the prospective teachers purposefully shifted from deficit-based framings to strengths-based framings. Seven of the nine prospective teachers initially showed a strong tendency towards deficit-based framings in their written noticing responses, while the other two prospective teachers tended towards strengths-based framings at the beginning of the course. By the end of the course, all prospective teachers tended towards strengths-based framings in noticing students' mathematical thinking.

The shifts in the prospective teachers' framing (see Figure 2) promoted a mode of attention, interpretation and response that differed substantially from the way the prospective teachers had previously noticed students' mathematical thinking. First, the prospective teachers' attention shifted in terms of the aspects they highlighted in students' mathematical thinking. Not only did the prospective teachers shift from a general tendency to identify students' weaknesses to identifying students' strengths; they also paid less attention to students' weaknesses while their attention to students' strengths increased. Second, the stances that prospective teachers adopted when interpreting students' mathematical understanding changed. Prospective teachers moved from a general tendency to use deficit-based stances to strengths-based stances; but they also moved beyond simply evaluating or judging students' mathematical understanding to interpreting it as a phenomenon in its own right. Third, the instructional moves that the prospective teachers proposed in response to students' mathematical work also changed. In the beginning, the prospective teachers tended to propose instructional moves aimed at addressing or overcoming deficits and weaknesses that the prospective teachers had discovered in the students' mathematical thinking. In the end, however, the prospective teachers tended to propose instructional activities aimed at enriching, extending or building upon students' understanding.

Of course, it is very likely that the framings identified here and the ways in which they promoted changes in teachers' noticing are specific to the context of this study. Thus, the framings shown in Figure 2 are not necessarily representative but illustrate the many ways in which prospective teachers attend, interpret and respond to students' mathematical thinking.

References

Adiredja, A.P., & Louie, N. (2020). Understanding the web of deficit discourse in mathematics education. *For the Learning of Mathematics*, *40*(1), 42–46.

Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). *The impact of identity in K-8 mathematics: Rethinking equity-based practices*. National Council of Teachers of Mathematics.

Brookfield, S. D. (1995). *Becoming a critically reflective teacher*. Jossey-Bass.

Crespo, S. (2000). Seeing more than right and wrong answers: Prospective teachers' interpretations of students' mathematical work. *Journal of Mathematics Teacher Education*, *3*(2), 155–181.

diSessa, A.A., Sherin, B., & Levin, M. (2016). Knowledge analysis: an introduction. In A.A. diSessa, M. Levin, & N.J.S. Brown (Eds.), *Knowledge and interaction: A synthetic agenda for the learning sciences* (pp. 30–71). Routledge.

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.

Franke, M.L., Carpenter, T.P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal*, *38*(3), 653–689.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Northeaster University Press.

Hammer, D., Elby, A., Scherr, R.E., & Redish, E.F. (2005). Resources, framing, and transfer. In J.P. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (pp. 89–120). Information Age Publishing.

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.

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*(3), 369–387.

König, J., Santagata, R., Scheiner, T., Adleff, A.-K., Yang, X., & Kaiser, G. (2021). Teacher noticing: A systematic literature review on conceptualizations, research designs, and findings on learning to notice. (Manuscript submitted).

Levin, D. M., Hammer, D., & Coffey, J.E. (2009). Novice teachers' attention to student thinking. *Journal of Teacher Education*, *60*(2), 142–154.

Liu, K. (2015). Critical reflection as a framework for transformative learning in teacher education. *Educational Review*, *67*(2), 135–157.

Louie, N. (2018). Culture and ideology in mathematics teacher noticing. *Educational Studies in Mathematics*, *97*(1), 55–69.

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.

Mason, J. (2002). *Researching your own practice: The discipline of noticing*. Routledge.

Russ, R., & Luna, M.J. (2013). Inferring teacher epistemological framing from local patterns in teacher noticing. *Journal of Research in Science Teaching*, *50*(3), 284–314.

Santagata, R., König, J., Scheiner, T., Nguyen, H., Adleff, A.-K., Yang, X., & Kaiser, G. (2021). Mathematics teacher learning to notice: A systematic review of studies of video-based programs. *ZDM Mathematics Education*, *53*(1), 119–134.

Santagata, R., & Yeh, C. (2014). Learning to teach mathematics and to analyze teaching effectiveness: Evidence from a video-and practice-based approach. *Journal of Mathematics Teacher Education*, *17*(6), 491–514.

Scheiner, T. (2016). Teacher noticing: Enlightening or blinding? *ZDM – Mathematics Education*, *48*(1), 227–238.

Scheiner, T. (2021). Towards a more comprehensive model of teacher noticing. *ZDM – Mathematics Education*, *53*(1), 85–94.

Scheiner, T., & Pinto, M.M.F. (2019). Emerging perspectives in mathematical cognition: Contextualizing, complementizing, and complexifying. *Educational Studies in Mathematics*, *101*(3), 357–372.

Schoenfeld, A.H. (2011). Noticing matters. A lot. Now what? In M.G. Sherin, V.R. Jacobs, & R.A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 223–238). Routledge.

Sherin, M.G., Jacobs, V.R., & Philipp, R.A. (2011). Situating the study of teacher noticing. In M.G. Sherin, V.R. Jacobs, & R.A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 1–13). Routledge.

Sherin, M.G., & Russ, R. (2014). Teacher noticing via video: The role of interpretive frames. In B. Calandra & P. Rich (Eds.), *Digital video for teacher education: Research and practice*. Routledge.

Smith, J.P., diSessa, A.A., & Roschelle, J. (1994). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *The Journal of the Learning Sciences*, *3*(2), 115–163.

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' eye*s (pp. 134–151). Routledge.

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.