



# Multidimensionality as a feature of the research in mathematics teacher education: different targets to be noticed and different lenses to describe and explain

Salvador Llinares<sup>1</sup>

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The research focuses in the articles of his issue display the multidimensionality of the research in mathematics teacher education. The papers explore different aspects of the mathematics teacher education field to describe and explain them using different theoretical frameworks. Therefore, we can understand multidimensionality as a quality of research in mathematics teacher education rooted in the different research objects and theoretical and methodological approaches researchers adopted. This perspective complements conversations that acknowledge commonalities in some studies as a way to handle the diversity of research on mathematics teacher education (Miyakawa, 2022) and emphasizes different aspects of the diversity: “A diversity of problems that our research addresses, which should lead to a diversity of theoretical perspectives and methodologies ... [and] a diversity of the geographical locations from where authors come and the locations in which studies are done” (Brodie, 2022, p. 503). The articles in this issue can be seen as steps into the conversations about two dimensions of research on and with mathematics teachers, currently relevant and that reflect on this multidimensionality: the individual and/or social emphases and the theory–practice relationships (Skott, Van Zoest, & Geller, 2013). These papers can be considered evidence of steps taken in these conversations and in how we use theories in practice (Lerman, 2013).

In this issue, the subject targets are five different objects of investigation: teachers’ beliefs as mediators for the implementation of an innovation in teaching; novice facilitators’ practice in professional development (PD) for mathematics teachers; the facilitators’ deficit talk depicting students based on their perceived deficits in an equity-oriented professional development; prospective teachers’ learning in a hybrid space between a method course and field experiences; and the impact of professional development on teachers’ self-efficacy and their tendency to choose student-centered practices.

The article by Livy, Muir, Trakulphadetkrai, and Larkin from Australia and UK (current issue) focuses on primary teachers’ beliefs as mediators in mathematics teaching. They describe and explain how teachers’ beliefs can filter some approaches to innovation in mathematics teaching. In particular, primary school teachers’ perceptions (as beliefs) about integrating children’s literature in mathematics teaching and identifying perceived barriers

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✉ Salvador Llinares  
sllinares@ua.es

<sup>1</sup> Universidad de Alicante, Alicante, Spain

or enablers. Children's literature as a tool in mathematics teaching is a recognition of the connections between mathematics and other subjects and the close connection between children's mathematical and language abilities.

Karsenty, Pöhler, Schwarts, Prediger, and Arcavi from Israel and Germany (current issue) scrutinize novice facilitators' practices and the underlying decision to explain their practice (facilitators in professional development, who are called mathematics teacher educators in others contexts). The specific focus is the facilitator's practice of attempting to manage teacher discussion within PD sessions. The authors attempt to distill common aspects from two different PD projects in terms of cultural context, content, aims, and framing of organizations. They depict the facilitators' decision-making processes underlying their observed practices when they steer the discussion in PD sessions.

Byun, from the USA (current issue), offers an alternative perspective to analyze the moment-by-moment interactions in the sessions in a PD to understand the pervasive use of deficit talk (utterances that depict students and families based on their perceived deficits). The purpose is to examine what actions participants in an equity-oriented PD achieve with a range of discursive practices. This examination allows understanding when and how deficit talk emerge while facilitators are collaborating with mathematics teachers to improve mathematics teaching.

Gonzalez, Villafañe-Cepeda, and Hernández-Rodríguez, from Puerto Rico (current issue), identify learning opportunities for the prospective teacher during discussions in sessions linked to an approach to lesson study which has as goal to connect academic and practitioner knowledge. This experience bridges prospective teachers' experiences in a methods course and their field experiences, creating a hybrid space for prospective teachers' learning. Gonzalez and her colleagues describe and explain how the language about teaching, the mathematical proficiency framework, and a lesson plan template introduced in the methods course are transformed into tools to create learning opportunities during the lesson plan activity and revision in field experiences. The adaptation of the lesson study is the means used to create the hybrid space for prospective teachers' learning with a focus on discussions during the planning step showing the connection between the Methods course and the field experiences.

Saadati, Chandia, Cerda, and Felmer, from Chile (current issue), evaluate the impact of professional development on teachers' self-efficacy belief and the nature of their classroom activities in a context of curricular change that advocates changes in teacher practices. Self-efficacy is defined considering the focus on self as a problem solver (self-efficacy in performing solving problems) and on self as a teacher of problem solving (self-efficacy in teaching problem solving).

The second feature of the multidimensionality applied to mathematics teacher education research is the variation in how the authors describe and explain the phenomenon to be studied. The myriad of theoretical frameworks adopted to describe and explain the mathematics teaching practice and the learning of prospective teachers and novice facilitators can also be considered evidence of the multidimensionality of the research in mathematics teacher education. The different theoretical frameworks adopted to describe and explain what needs to be studied are critical and reflect the complexity of mathematics teacher education. Sometimes, the researchers have adapted theoretical frameworks from abroad (Livy and colleagues; Byun; Gonzalez and colleagues, and Saadati and colleagues), and other ones make adaptations from frameworks linked to mathematics education (Karsenty and colleagues).

Livy and colleagues use the theory of planned behavior (TPB) (Ajzen, 1991) to try to predict and understand the teachers' behavior (through their beliefs) regarding the

integration of children's literature in mathematics teaching. They make it by identifying perceived barriers and enablers. This specific theoretical approach allows the authors to frame the identified themes (perceived enablers and barriers) from the different components of the theory of planned behavior, for instance, the *perceived behavioral control* component as a factor that could hinder a particular behavior; the *subjective norms* component, regarding how the teachers think about the way the key stakeholders in their schools perceive the use of children's literature; and *attitudes toward the behavior* component, related with teachers' evaluation of the behavior.

Karsenty and colleagues propose a conceptual framework to explain facilitators' practice and underlying decisions as a lift of Schoenfeld's ROG framework (Resources, Orientations and Goals) (Schoenfeld, 2010) from the teacher level to the facilitator level. They use this extended framework to understand how the facilitators think and act in the classroom to identify what makes their behavior effective or ineffective. Karsenty and colleagues add to the three components of the ROG framework a fourth component, the facilitator's identity (to develop the ROGI framework), to describe and explain the facilitators' decision-making when they sensed that ROG components were helpful and necessary but not sufficient. This extended framework (ROGI) reveals conflicting forces with which novice facilitators are faced with, considering their resources, goals, orientations, and identity. The extended framework allows explaining the novice facilitator practice while managing the discussion in PD sessions. The authors look at how the resources available, orientations, goals and identity affect the facilitator's decisions. From this perspective, the management of discussion in PD sessions is a form of problem solving (in this case, professional problem solving) to the novice facilitators when they are learning a new practice.

Byun's study adopts interactional approaches—conversation analysis and discursive psychology—to examine underlying discursive functions of deficit talk in PD interactions. The framework adopted allows attending to participants' orientations using analytic constructs from conversation analysis and discursive psychology (adjacency pairs, repair, epistemic asymmetry, rhetorical description, and emotional discourse).

Gonzalez and colleagues use the apprenticeship learning from situated learning theory as a theoretical framework, considering that learning is connected to the context where it happens (Lave & Wenger, 1991). This framework draws on how prospective teachers negotiate meanings using the resources of teaching practice, a language shared, and a mutual engagement to create a hybrid space for learning to connect the method course and the field experience.

Saadati and colleagues adopt a socio-cognitive view of learning that explains a bi-directional influence among behavior, personal characteristics, and environment. This theoretical perspective underlines the relevance of self-beliefs about the skills one has to achieve the proposed goals (Bandura, 1989). From the authors' point of view, the focus on teachers' self-efficacy beliefs can help us understand the enablers and barriers that mathematics teacher face when they implement a new curriculum demanding a new teaching practice (e.g., the shift for teacher-centered practices toward student-centered practice). For that, this theoretical framework is considered useful to understand the impact of participation in a specific professional development program focused on teachers' self-efficacy beliefs about performing and teaching problem solving.

The five articles in this issue can be considered a reflection of the multidimensionality of mathematics teacher education as a research field and how mathematics teacher educators manage the theory–practice and individual-social relationships in a diversity of geographical locations (Australia/UK; Israel/Germany, USA, Puerto Rico, and Chile). The diversity in research focuses and theoretical frameworks can provide insights into new perspectives

(Miyakawa, 2022) as a way of understanding the multidimensionality of our research field. To some extent, these articles contribute to the dialogs on these relationships to understand mathematics teachers' role in mathematics teaching and contribute to their further development in different parts of the world. Furthermore, the articles are instances of how the phenomenon studied (the objects of investigation) can be understood in light of the theoretical/conceptual framework adopted. We should underline *in light of*, since “theories [about practice] both constrain and afford what one sees and how one interprets what one sees” (Lerman, 2013, p. 629). In this sense, the articles in this issue offer multiple stories of what happens in the practice of mathematics teacher education (mathematics classrooms and professional development) in different geographical locations. Therefore, even if only locally, these studies take the field forward.

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