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EDITED AND REVIEWED BY  
Ramona Maile Cutri,  
Brigham Young University, United States

\*CORRESPONDENCE  
Iben Maj Christiansen  
✉ [iben.christiansen@mdu.se](mailto:iben.christiansen@mdu.se)

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# Editorial: Theories and theorising in mathematics education and how they inform teacher education

Iben Maj Christiansen<sup>1\*</sup>, Gosia Marschall<sup>2</sup> and Claudia Corriveau<sup>3</sup>

<sup>1</sup>School of Education, Culture and Communication, Mälardalen University, Västerås, Sweden, <sup>2</sup>Faculty of Education, University of Cambridge, Cambridge, United Kingdom, <sup>3</sup>Studies in Teaching and Learning, Laval University, Québec City, QC, Canada

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## Editorial on the Research Topic

### Theories and theorising in mathematics education and how they inform teacher education

As the international comparison of mathematics teacher education, *the Teacher Education and Development Study: Learning to Teach Mathematics* (TEDS-M), shows, there are substantial variations in all aspects of teacher education content across the globe (e.g., [Blömeke and Kaiser, 2014](#)). It comes as no surprise to anyone working in education that all national, institutional and programme specifications of content, and to some extent pedagogy, reflect particular visions of what teachers are expected to know, do, believe, or even be. The same is true for teacher education. This may result from teacher education being largely a-theorized ([Mooney Simmie et al., 2017](#)), despite numerous calls for a more substantial theorization of teacher education (e.g., [Opfer and Pedder, 2011](#)). The main goal of this Research Topic is to address the problem of theory, focusing specifically on mathematics teacher education. We hope that the rich theoretical landscape of mathematics education might provide useful insights into how mathematics teacher education can be theorized and understood. We challenged the contributors of this Research Topic with the creative task of extending and reframing these theories.

The contributions to this Research Topic constitute three themes. Theme I focuses on theory as a tool for analyzing what goes on in teacher education. Theoretical perspectives on mathematics teaching and learning have been used to understand the complex connections between (i) explicit or implicit philosophies of mathematics, (ii) visions of schooling and (iii) the content and organization of teacher education. But these theories need to be extended to be applicable to teacher education. Theme II is about theory as a means of informing the selection of content or pedagogies for teacher education. Existing research encourages the search for teacher education pedagogies which generate better opportunities for student teachers to learn. For instance, it has been widely accepted that directing students to recognize tacit teacher competencies (e.g., [Nilssen, 2010](#)), to analyse teaching (e.g., [Ponte and Brunheira, 2001](#)), and to practice aspects of teaching (e.g., [Lampert et al., 2013](#)) provides better opportunities to learn. Theories can help bring together pedagogical repertoires into a more coherent whole with additional explanatory power, thereby enhancing an understanding of student teacher professional learning. Theme III is about theory as

content – theory as a part of what is taught in teacher education, while recognizing that the relationship between theory and practice generates its own opportunities and challenges to students and teacher educators alike. It will be of interest to the readers that the specific contributions to this Research Topic do not necessarily fall under one specific theme. We now provide short descriptions of the particular contributions.

Weingarden and Buchbinder use concepts from Sfard's commognition theory to identify discursive modifications in pre-service teachers' (PSTs) discourse in the lesson plans they designed, enacted and modified during a course, and then the changes to the opportunities for learners to engage in reasoning and proving as a result of the modifications (Theme I). Theory helps the authors distinguish discourse and meta-discourse about proof and thereby the opportunities for learners to engage in both discourses offered by the teaching. The results of this study show four types of discursive modifications: structural, mathematical, reasoning-based and logic-based. Although the authors do not elaborate on using these types of modifications as content in teacher education explicitly, we see the potential for doing so (Theme III).

Chazan and Herbst have previously used the construct of instructional exchanges to describe what is taken as evidence of learners' mathematics learning. In their paper, they extend this to describe what can be taken as evidence of student teachers' learning (Theme I). They consider exchanges where student teachers show that they can carry out certain teaching moves, plan lessons in desired ways, can notice aspects of teaching or can engage in reflective practice. Chazan and Herbst then make a move in an unusual direction, namely to suggest that if there are a range of common instructional exchanges in mathematics teacher education, perhaps additional exchanges could be considered in mathematics education, rather than using the common approach of letting learners work on mathematical tasks—with suggestions not unlike the explorative routines of the commognitive tradition (Lavie et al., 2019; Nachlieli and Tabach, 2019), engaging in exemplification (Watson and Mason, 2002), and so on. The authors go on to suggest that the use of a variety of work formats in teaching mathematics could also be applied in teaching teachers; in the latter, representation of teaching mostly happen through lesson plans written in templates. Examples of alternative work formats include annotated video clips or multimedia lesson scripting. In this way, the paper offers specific suggestions for expanding the pedagogical repertoire of mathematics teacher education (Theme II).

Pansell puts forward a strong argument for combining the framework of mathematical knowledge for teaching with the analytical distinction of *logos* and *praxis* from within the anthropological theory of the didactic. This results in an adjusted framework that indicates both what student teachers should know and be able to do in practice, and the substantiations for the practices. In the adjusted framework, Pansell provides examples of each category from the existing body of mathematics education research. The framework can thus be used both analytically, to interrogate what is covered in existing teacher education programmes (Theme I) or to inform the design, selection and sequencing of content for teacher education (Theme II). If

student teachers are to make professional decisions informed by existing knowledge and research, then it is relevant and important for teacher education to focus not just on their future practice but also on substantiations for the examples of this practice.

Bjerke and Nolan's study concerns what mathematics teacher educators see as challenges in the post-field-placement context of teacher education programmes, framing their study with the concept of disruptive pedagogy. The content of the interviews with the mathematics teacher educators addresses the division between what happens in the two contexts of teacher education (often closely overlapping with a division between theory and practice according to the literature) and gives voice to the mathematics teacher educators' feelings of resignation. In this sense, the paper contributes to an understanding of the difficulties of using theories in teacher education (Theme III). In addition, the paper confronts the reader as teacher-educator-researcher with issues to consider around using "theory" normatively in teacher education. As such, the paper in itself constitutes a disruptive pedagogy, albeit not for the student teachers but for the educators, who may want to consider better ways to include the voices of mentor teachers and PSTs in developing teacher education (Theme II).

Embodied cognition is gaining attention in the field of mathematics education, and Boonstra et al. take steps to explore how abstraction can be approached in teacher education from this perspective. They raise the question of how an embodied viewpoint on abstraction in geometry teaching can enhance both teaching practices and teacher education and professional development. From an embodied cognition perspective, they see abstraction in geometry as a process involving reflection, description, explanation and the organization of sensory-motor actions within the physical world, utilizing mathematical artifacts. Fostering abstraction from an embodied standpoint also requires insights from teachers' practical experiences. Boonstra et al. conducted semi-structured interviews with teachers to explore their views and needs related to abstraction that is compatible with embodied cognition. The analysis resulted in the identification of five central themes: (1) geometry, (2) acting and the use of materials and manipulatives, (3) abstraction, (4) teachers' views on students engaging in the process of abstraction and (5) teachers' needs. Boonstra et al. argue that promoting geometry abstraction through embodiment is essential for enabling future teachers to understand how to facilitate and appreciate students' individual bodily interactions, recognizing the significance of these interactions for future mathematical comprehension (Theme III).

The five very unique contributions to this Research Topic have offered a range of insights into the uses of theories in teacher education: how to work with theory with students, how to use theoretical perspectives to consider selection of content, how to draw on theoretical extension of theory to inform pedagogical repertoires in teacher education, how to assess student teacher learning in more theoretically informed ways, and how to obtain deeper insight into existing teacher education practices. As such, although they represent just a beginning to addressing the gap in

theorization in teacher education, they provide important and insightful contributions.

## Author contributions

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