

A methodological proposal for a teaching experiment to develop teachers' conceptual systems

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Problem addressed

Teacher learning has been a subject of study due to its complexity. It is recognized as a process involving conceptual transformations related to mathematical knowledge, the planning and implementation of lessons, and the retrospective analysis of that implementation, factors that can lead to the self-regulation of teaching practice (Goldsmith et al., 2013). Teachers not only expand their own knowledge but also facilitate learning and take responsibility for designing experiences that foster the active construction of mathematical knowledge among their students (Avishai et al., 2025).

Research reveals that teacher learning is non-linear and follows recurring cycles of inquiry outside the classroom and experimentation within it (Goldsmith et al., 2013). Furthermore, this process is situated and emerges from participation in communities of practice, interaction with colleagues, reflection on personal experiences, and the negotiation of meaning within professional development settings (Goldsmith et al., 2013). This highlights the multidirectional nature of teacher professional development and the need for professional development projects to comprehensively support teachers' conceptual development.

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Loucks-Horsley et al. (2010) note that, during the learning process, teachers expand and revise their prior knowledge. So, the process should have opportunities for experimentation, anticipation, artifact creation, implementation, and reflection. That is why Lee and Vongkulluksn (2023) propose a professional development project in which teachers learn to teach and learn through teaching. The researchers' findings suggest a need to translate this knowledge from research into practice (Jankvist et al., 2021). This project will conduct research on implementation aimed at improving the design, use, and support of innovations within the context of teaching practice (Koichu et al., 2021) to propose a methodology for a teacher training program. This leads to the question: What methodological elements should a teaching experiment incorporate to promote and investigate the evolution of teachers' conceptual systems?

How is it addressed?

Models and Modeling Perspective (MMP) provides a framework for describing and analyzing the development of conceptual systems. MMP considers a model to be a cognitive construct developed by individuals, expressed through external notational systems, and employed to describe, interpret, or predict mathematical phenomena (Lesh & Doerr, 2003). Such models can be understood as Conceptual Systems (CS), characterized by their internal structure, elements, interrelations, and governing rules. CS are dynamic rather than static; they evolve through continuous interaction with external systems that support their refinement (Sriraman & Lesh, 2007). Modeling may therefore be interpreted as the dynamic process by which individuals generate, elaborate, and modify CS.

The MMP emphasizes a multitiered framework for understanding the co-evolution of conceptual systems across three interdependent levels: students, teachers, and researchers. This approach allows teachers to extend, modify, and refine their CS while they focus their cognitive attention on interpreting student behaviors during the tasks (Sevinc & Lesh, 2018). Through this reciprocal process, teachers refine their own models of student learning, while their pedagogical actions influence students' conceptual development. In addition, when teachers design instructional artifacts or materials, they externalize aspects of their interpretive systems. These artifacts thus serve as external representations of internal cognitive frameworks, providing opportunities for reflection and generating insights into both professional practice and research.

Furthermore, professional development initiatives are particularly effective when they invite teachers to actively engage in modeling activities, designing and adapting tasks and developing pedagogical practices for classroom modeling. This suggests that teacher training programs should

be intentionally structured to create conditions for the articulation, testing, and refinement of teachers' CS. Drawing upon these theoretical considerations, we propose a teaching experiment organized as a professional development course aimed at fostering teachers' CS.

What is implemented?

This implementation in progress is a methodological proposal aimed at improving the design and implementation of an innovative teacher professional development course designed to foster the progression of teachers' CS through modeling experience. As the theory emphasizes, the course should: 1) strengthen mathematical knowledge, 2) facilitate productive classroom discussions, 3) support the articulation of mathematical arguments, 4) promote collaborative peer learning, and 5) foster the creation of practical instructional instruments.

The methodological design proposed is structured into six phases: i) preparation; ii) experimentation; iii) collaborative analysis; iv) implementation; v) reflection and discussion; and vi) artifact creation (modeling task, anticipated solution inventory, observation and implementation guides). This design positions teachers simultaneously as mathematics learners and reflective practitioners, thereby aligning professional development with the dynamic processes central to the MMP.

What is the potential importance?

This methodological proposal is expected to contribute to both research and practice in mathematics teacher education. From a research perspective, it offers a framework for documenting and analyzing the development of teachers' conceptual systems within authentic professional learning contexts. From a practical perspective, it provides a replicable structure for designing teacher education courses that explicitly integrate mathematical modeling as a catalyst for conceptual growth.

By foregrounding artifact creation and collaborative reflection as central components of the professional learning process, the proposed teaching experiment seeks to strengthen the conceptual foundations that enable teachers to support modeling in their classrooms. Ultimately, this initiative aspires to advance a deeper integration of modeling into mathematics education, consistent with the demands of contemporary curricular reforms.

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