



BRILL

## Impact Sheet

Artigue, M. (2021). Implementation Studies in Mathematics Education: What Theoretical Resources? *Implementation and Replication Studies in Mathematics Education*, 1(1), 21–52. DOI: 10.1163/26670127-01010002.

### 1 Problem Addressed

What theoretical resources from mathematics education should be used to support implementation studies? The paper provides a view on implementation research from the perspective of the Anthropological Theory of the Didactic (ATD). This means that it distinguishes: (1) the questions that implementation studies deal with; (2) its practices; and (3) theoretical resources.

The paper provides an overview of the theoretical resources that existing mathematics education can provide to implementation studies and relates this overview to the resources that are actually used in implementation studies.

The main theoretical resources from mathematics education that the paper identifies are originated in design-based research, in the systemic and ecological perspective underlying ATD, and in the Documentational Approach to Didactics (DAD) regarding the teachers' relationship with educational resources.

In section 2 of the paper, the broader idea of design-based research is presented and discussed from an implementation perspective. The two traditions Realistic Mathematics Education (RME) and Cooperative Engineering (CE) are presented as examples of how the design approach to implementation has been theorized within mathematics education. A critical construct for implementation in RME is the idea of Hypothetical Learning Trajectory (HLT) that acts as an important mediator between theory and practice as well as between intentions and observations. In that sense, the HLT is playing a vital role in supporting the cyclic nature of RME but also in facilitating generalisation across educational contexts in RME.

Cooperative engineering is presented as the second generation of didactical engineering related to the Joint Activity Theory in Didactics. This approach builds on long-term collaboration between teachers and researchers. In line with RME, it puts emphasis on developing and testing hypotheses in a cyclic

fashion, but even more, it puts emphasis on the concept of exemplars, which allows the development and promotion of specific examples and situations as means of communicating and generalising empirical findings.

Sections 3 and 4 of the paper go deeper into the two theoretical approaches of ATD and DAD. The ATD allows for better description of the ecological and institutional perspectives in relation to implementation of mathematics education. Concepts such as *levels of didactic co-determinacy* and the two different paradigms of *questioning the world* and the dominant—yet less progressive paradigm of *visiting works*, are described as theoretical tools that can help us understand the inertia and resistance for change in education. The DAD provides a language for discussing technology and resource use in relation to mathematics education with specific focus on the teachers. In some cases, detailed understanding of the teachers' technological environments and working situations can be key to understanding problems related to implementation.

The paper then examines particular examples of implementation studies, to see what theoretical resources are adopted. This is done by examining the large-scale implementation of inquiry-based learning and teaching in STEM education, carried out in European projects such as PRIMAS, as well as the contributions to the Thematic Working Group devoted to implementation of research findings in mathematics education at CERME 10 and CERME 11. This shows that other resources than the ones provided internally from mathematics education are playing an important role in implementation studies.

## 2 What Is Implemented?

This paper is theoretical—but it examines both the PRIMAS project implementing Inquiry-Based Mathematics Education and the Thematic Working Group focusing on implementation at CERME.

## 3 Implications and Significance

The paper contributes to a fundamental discussion of the nature of implementation research by defining implementation research through a lens from the anthropological theory of didactic—as a genre of research practice characterized by the questions it addresses, the research methods it uses and the theoretical resources it relies on. Furthermore, the paper provides a valuable overview of potential approaches from mathematics education that can foster discussion of implementation problems.

Finally, the paper displays examples where the existing work on implementation studies largely could adopt the resources from within mathematics education research. In that sense, it spurs reflection about what routes to be taken, when shaping implementation studies in mathematics education.