

Introduction to the papers of TWG23: implementation of research findings in mathematics education

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This introduction offers an overview of the eighteen contributions (15 papers and three posters) to the TWG23 at CERME12. The three thematic discussions that took place in this Thematic Working Group are addressed, namely: the role of change, matters of scaling, and the conception of stakeholders.

Keywords: Implementation research in mathematics education, change, scale, stakeholders.

Introduction

The 12th Congress of the European Society for Research in Mathematics Education (CERME12) was first postponed and then held virtually, in February 2-5 2022, due to the COVID-19 pandemic. Before the conference, a virtual pre-conference event was organized in February 2021. This event included two discussion sessions dedicated to Thematic Working Group activities, and particularly to planning the activity of the Thematic Working Group 23 (TWG23) “Implementation of research findings in mathematics education”. This introductory report gives an overview of the TWG23 at CERME12.

Contributions to the TWG23 at CERME12

The TWG23 at CERME12 was led by Mario Sánchez Aguilar, Boris Koichu and Morten Misfeldt, along with Rikke Maagaard Gregersen (until August 2021) and Linda Marie Ahl (from September 2021). The TWG23 received 18 contributions consisting of 15 papers and three posters. The authors of the contributions came from Austria, Denmark, Finland, Greece, Israel, Italy, Luxembourg, Mexico, Norway, Sweden, and the UK. The contributions were organized into thematic categories:

- Implementation of problem-solving and problem-posing approaches
- Implementation of teaching models and teachers’ perspectives on implementation
- Conditions for sustainable implementations
- Diagnostics tasks, instructional sequences, and curriculum design
- Implementation of programming, computational thinking, and other digital technologies

Due to the overarching nature of the poster by Konrad Krainer, it was selected to be the first contribution to be presented in the TWG23. This poster presentation served to set the scene in the group by means of providing the TWG23 participants with conceptual categories (technical rationality, reflective rationality, and societal rationality) that were then often referred to during the

conference for identifying and contrasting different approaches to the implementation of innovations and implementability of research.

The first thematic category “Implementation of problem-solving and problem-posing approaches” included contributions providing methodological and theoretical tools for the implementation of mathematical problem-solving and problem-posing approaches. The paper by Nafsika Patsiala and Ioannis Papadopoulos presented an instrument to record and examine whether students develop — through their experiences with problem-posing — the habit of mind named “seeking and using structure”. The paper by Jason Cooper and Boris Koichu introduced the notion of “problem-solving implementation chain” for analyzing the evolution of a problem-solving activity as it passes from the proponents to teachers and finally to students.

The second thematic category grouped two types of contributions. One type of contribution consisted of the studies that addressed the implementation of specific teaching approaches. This was the case of the research by Morten Blomhøj and collaborators, who introduced a three-phased didactical model to facilitate the implementation of an inquiry-based approach to mathematics teaching. Another research in this group of contributions was presented by Ola Helenius, who offered a theoretical discussion on large-scale implementation of a research-based teaching model for elementary school arithmetic. The other type of contributions within this category included studies focusing on teachers’ actions and perspectives on implementation processes. This focus was evident in the study by Maria Kirstine Østergaard and Uffe Thomas Jankvist, who used theoretical constructs from implementation research (IR) to identify elements of a mathematics teacher’s practice and thereby identified factors that seemed to influence the implementation of teaching units aimed at fostering students’ reflections on the nature of mathematics as a discipline. Other papers included in this category were by Åsmund Lillevik Gjære, who examined one Norwegian teacher’s enactment of an innovative system for mathematics teaching called developmental education in mathematics; and by Alessandra Boscolo, who reported the perspective of teachers about the implementation of active, bodily experienced mathematics learning activities.

The contributions grouped in the third thematic category brought to the fore the discussion of the sustainability of the implementation of innovations. The paper by Johan Prytz and colleagues paid particular attention to the issue of sustainability of an innovation in mathematics education, and the potential role of textbooks in sustaining the innovation. Another contribution within this category was the work presented by Mario Sánchez Aguilar and Apolo Castaneda, who pointed out the importance of distinguishing between politics of enactment and implementation as the first step in integrating the analysis of political sustainability into IR.

In the fourth category, a group of contributions addressed issues of the implementation of diagnostics tasks, instructional sequences, and curriculum design. One contribution included in this category was the work presented by Morten Elkjær and Jeremy Hodgen. These scholars formulated an implementation process model for designing and implementing tasks for formative feedback in an online learning environment. Another contribution in this category was the literature review developed by Linda Marie Ahl and colleagues. This review dealt with the implementation of instructional sequences aimed to enhance students’ learning of mathematical concepts or

competencies. The review identified which competencies are targeted in the chosen sample of studies and what characterizes the implementation of the instructional sequences. Also included in this category was the contribution of Ellen Jameson and collaborators, who pointed out challenges to implementing mathematics education research through the processes and products of curriculum design. The work reported by Tuula Koljonen and colleagues examined the feasibility of using the Documentational Approach to Didactics to gauge the fidelity and characteristics of teachers' implementation of scripted teaching sequences for the teaching of arithmetic in primary school.

The fifth category included contributions focused on the implementation of digital technologies, mainly those related to computer programming. One case is the work by Raimundo Elicer and collaborators, who addressed the role of educational task design in implementation research. In collaboration with a 4th grade school teacher, the authors designed a geometric task from a hypothetical learning trajectory that required students to draw on their knowledge of mathematics and Programming and Computational Thinking (PCT). Another presentation was based on the paper by Andreas Lindenskov Tamborg and colleagues, who reported on the development of a survey tool to investigate how PCT is implemented in Denmark, Sweden, and England. Within this category was also the poster called "Comparing the implementation of programming and computational thinking in Denmark, Sweden and England" by Morten Misfeldt and collaborators (this poster was one of three winners of the first ever ERME Poster Award). Finally, another poster included in this category was by Ben Pierre Haas and collaborators, where they gave an overview of how technologies such as augmented reality, 3D printing, and tutoring systems could be employed by different users for teaching and learning STEAM-based educational ecosystems.

Thematic discussions

The TWG23 program included three thematic discussions. The themes were selected on the basis of previous discussions that had emerged as central for IR. Namely, they had been identified based on the papers published in the special issue on IR of ZDM – Mathematics Education (Koichu et al., 2021) as well as based on the papers published in the first two issues of Implementation and Replication Studies in Mathematics Education (IRME).

The role of change

The first theme was "intended change". The background for this theme was that it has proved difficult to measure the success of implementing innovations. For instance, are we reaching the intended change in a given implementation? And how can this question be addressed? The question for the first thematic discussion was:

How can we work with articulating and evaluating intended change? What are the pros and cons in relation to constructions such as program theory (theory of change) and realistic evaluation?

Matters of scaling

Large-scale implementations are complex endeavors, often intending to reach a large number of classrooms. If an idea is proven to work well in a certain setting, we are interested in disseminating it into other settings. As phrased by Artigue (2021, p. 22): "...implementation research, even if it can

take advantage of studies of limited scope, must be able to meet, as a genre, the scaling-up challenge”. The question guiding the second thematic discussion was:

What are the possible roles of small-scale vs. large-scale studies in implementation research? For example, in relation to different phases such as planning, testing, enacting, and evaluating.

The conception of stakeholders

No large-scale implementation can be successful without the scaffolding of stakeholders at different levels. Krainer (2021, p. 1175) asked: “Who are the relevant stakeholders whose voices should be heard when discussing implementation? What is the role of policymakers, administration experts, researchers, and practitioners with regard to defining and solving problems that occur in practice?” With insight into the absolute necessity of having a strategy for working with stakeholders, the theme for the third thematic discussion was:

How do we work with stakeholders? This includes conceptualizing their roles, designing/framing their participation, and evaluating the impact of their involvement in relation to three levels: administration/policymakers, researchers, and practitioners.

Concluding remarks

Concerning “change”, the TWG23 participants agreed that the tension between intended change and achieved change in an implementation project is a delicate question of interest for our research field. As for “scale” and scaling, the participants agreed on the need for both small-scale and large-scale studies in mathematics education IR. Moreover, it was clear that there is a need for further discussions on the conception and definition of “stakeholders”. The overall outcome of the TWG23 thematic discussions was that none of the three themes addressed can be fully explored in isolation from the others.

Future research directions emerging from the TWG23 discussions at CERME12 are the following: we need to discuss how a theory of change can be used to design, understand and evaluate implementations. It is necessary to further explore how small-scale and large-scale studies can provide the relevant information for different parts of an implementation process. There is a need for progressing our knowledge on how the concept of stakeholders can be used to refine different types of analysis of implementation projects. These discussions will continue at CERME13 in Budapest in 2023, and also on the pages of IRME.

References

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