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An introduction to TWG17: Navigating ways forward amidst diversity

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At CERME13, the TWG17 worked to navigate ways forward amidst a diversity of theories in mathematics education research (MER). The TWG17 made explicit efforts to negotiate shared meaning for terms being used, emphasizing those that did not translate well from (or into) English. Interrogating the question of the scientificity of MER led to reflection on the value-ladenness of MER. Theoretical approaches (e.g., networking, adapting), rather than individual theories, organized discussion. Implications included continued attention to ontological, epistemological, axiological, and ethical dimensions of theorising, to explain affordances of theoretical and methodical choices.

Keywords: Theory, diversity of theories, networking of theories, method, theoretical approaches.

Navigating a diversity of theoretical perspectives and approaches

As mathematics education researchers, it is necessary to reflect on and further work with theories, to thereby advance mathematics education research (MER) as a scientific discipline. The question of how to work with theories, including those specific to and extending beyond mathematics education, has been central to the Thematic Working Group 17 (TWG17) since the group's inception at CERME4 in 2005 (Kidron et al., 2018). The diversity of theories in MER and the consequent implications for MER as a field have been a focus of discussions in the TWG17 since CERME4. The question of how to address a diversity of theories continues to be of interest to the MER community.

Contrasting the emphases of different theoretical perspectives, Artigue (1999), for example, urged the field to reflect on the utility of theories for addressing problems of practice in university mathematics teaching. And Sriraman and English (2005) called for the MER community “to take stock of the multiple and widely diverging mathematical theories, and chart possible courses for the future” (p. 450). At CERME4, the theory group wrestled with the question of whether a diversity of theories might speak to the level of maturity of the field of MER (Kidron et al., 2018). In this context, the CERME4 theory group operated with the assumption that the diversity of theories should be treated “as an important *resource*, not as a defect” (Bikner-Ahsbabs & Prediger, 2006, p. 55).

At CERME13 TWG17, we have continued to navigate the diversity of theoretical perspectives and approaches. We use the term “navigate,” to refer to making our way through an abundance of theories. By choosing this term, rather than terms such as “deal with” or “handle,” we wish to communicate that the diversity of theories is not a problem to be remedied. Rather, there is a need to continue to explore ways in which the diversity of theories can enhance the quality of MER, by allowing

researchers to address the complexities of mathematics education, a task whose accomplishment seems to be central to scientific progress in our field (see also Bikner-Ahsbabs & Prediger, 2010).

The networking of theories, which emerged during CERME4 amidst a question of how to navigate a diversity of theories, now has become an established approach (Bikner-Ahsbabs et al., 2022). Broadly speaking, the networking of theories entails drawing connections between different theories, with different possible degrees of connectivity (Bikner-Ahsbabs & Prediger, 2010). More recently, Bikner-Ahsbabs (2019, p. 2) has expanded on the approach, to make explicit that networking should be done “for a specific purpose,” so that a dialogue can be created between different theoretical approaches (or at least parts of those approaches), “in a methodologically sound manner.” Furthermore, researchers should reflect on the approach of networking theories itself, while “respecting the identities of the theoretical approaches involved.” We note how Bikner-Ahsbabs (2019) addresses meta-issues involved with networking theories (e.g., researchers’ purposes for and reflections on the networking approach). Furthermore, meta-issues of theorising have spurred dialogue around MER.

Reflecting on the networking of theories, Radford (2008) contended that a “condition for the implementation of a network of theories is the creation of a new conceptual space where the theories and their connections become objects of discourse and research” (p. 317). Drawing on Lotman (1990), Radford (2008) argued that such a space could be conceived as a semiosphere, with a defining characteristic of heterogeneity; to enter the semiosphere would require a dialogue between theories, which involves the reciprocal elements of working to understand and be understood by other theoretical perspectives. In this context, Radford (2008, 2012) elaborated on theory as composed of principles (P), a methodology (M) supported by those principles, and paradigmatic research questions (Q) that can evolve as new interpretations are developed and principles are deepened. Furthermore, results (R) produced when researchers draw on a theory also could further theoretical development. Through the different components of theories, Radford provided one way to structure dialogue between different theories. Furthermore, Radford’s conceptualisation of theory illustrated that theories are dynamic rather than static.

Connections to previous TWG17s and the CERME13 call for papers

A contribution of the CERME12 TWG17 was a distinction between *horizontal* and *vertical theorising* (Bikner-Ahsbabs et al., 2022). *Horizontal theorising* focuses on the “how” of theory building and use and aims to illuminate new aspects of empirical phenomena. *Vertical theorising* refers to meta-issues of theory building and use, with the purpose of better understanding theories as entities in and of themselves. As an example of horizontal theorising, researchers might network the Documentational Approach to Didactics (DAD) and Valsiner’s Zone Theory to examine the development of preservice teachers (see Sødal’s paper). An example of vertical theorising could be to reflect on the approach of networking theories itself and to study possible types and forms of networking (see Johnson’s paper).

A contribution of the CERME11 TWG17 was a dialogue between theoretical and methodological working (Bikner-Ahsbabs et al., 2019). Chan and Clarke (2019) brought up the term “mutual affordance” to describe a reciprocal, rather than prescriptive, relationship between theory and methodology. The meaning of “affordance,” which is not easy to translate into other languages, spurred lively discussion. Chan and Clarke (2019, p. 1) contextualised the term this way:

The word *affordance* was coined by Gibson (1986) in ecological psychology to describe the possibilities that the environment *offers* to an animal as the animal inhabits and interacts with the environment. We use the term to refer to the investigative options made possible (and also constrained) by the choice of theory or methodology.

For the call for CERME13 TWG17, we drew on the notion of navigating a diversity of theories to address new questions emerging from and contributing to our theoretical progress. First, we encouraged researchers to focus their attention on the ontological, epistemological, axiological, and ethical dimensions of theorising and asked, how do researchers take these dimensions into account when they make decisions regarding their theoretical and/or methodical approaches? For example, in what sense could the axiological dimension of our research activity be relevant to our decisions regarding the theoretical and methodical approaches we choose? Second, we asked to consider how new theoretical and/or methodological questions can emerge from contemporary situations. For example, how could the impact of the global pandemic on students' schooling influence researchers' need to cross theoretical, methodological, and/or disciplinary boundaries? And third, we asked how horizontal and vertical theorising could contribute to theoretical progress in MER. For example, how might further developing the networking of theories approach and design-based research help the field of mathematics education to recognise its strengths and its potential to cross boundaries to contribute to other disciplines?

Contributions of CERME13 TWG17: emerging themes

Nine papers and two posters were presented, spanning seven countries and three continents. As is typical for TWG17s, the contributions spanned a wide range of theoretical perspectives. This made it challenging to use tenets of particular theories as footholds to organise discussion. Hence, we turned to theoretical approaches (e.g., networking, horizontal theorising, vertical theorising) to cohere discussion across a diversity of theories. For instance, one of the things we explored, as reflected in Johnson's paper, was how the networking of theories might fit within a landscape of approaches that concern work with individual theories or involve dialogue across theories. As there was ample time for whole group discussions, a number of recurring themes emerged over the course of the conference, three of which we wish to discuss in more detail. The first two themes address particular discussions during the conference, and the third theme furthers those discussions.

Theme 1: Negotiating shared meanings for the terms we use

A relevant proportion of our discussions revolved around negotiating shared meanings for terms we employ in our theoretical and methodological workings. One salient example was a discussion focusing on the different meanings of the word 'affordance' in ordinary English language. While trying to make sense of what exactly it might mean for the relationship between theory and methodology to be one of "mutual affordance," one participant, for instance, asked whether the word, as it is used in everyday discourse, incorporates both a positive or enabling as well as a negative or constraining aspect. And from this initial question, then, a vivid discussion evolved in which we as a group worked to generate everyday examples of the different meanings of the word. While in the phrase "The chair affords me to sit," the positive or enabling side becomes apparent, the phrase "I can only buy what I can afford" rather highlights the negative or constraining side. We then continued to discuss the conceptual relationship between these two meaning components in more detail and

arrived at the conclusion that, in many cases these two sides do not work against each other, but rather, as in the case of the relation between structure and agency, it is precisely the constraint itself which may function in an enabling manner. We found it fortunate that an ordinary English word could encompass these two meanings and felt these discussions contributed to dialogue between theory and methodology.

Conversely, following the norm of negotiating shared meanings for terms allowed us to address the difficulties that may arise when using terms that do not translate well to English. In his poster, Zagorianakos, for instance, examined the Vygotskian concept of *perizhivanie*, which involves a person's "processing of a dramatic experience;" he illustrated this through analysis of a prospective teacher's drastic change in her attitudes toward mathematics. Another example can be found in Kolloosche's paper which, among other things, focused on the German tradition of *Stoffdidaktik* as "a manifestation of didactical content analysis." The German word "Stoffdidaktik", however, is a compound noun, whose two components – "Stoff" and "Didaktik" – do not have a direct equivalent in English. We as a group found it very valuable to bring up such challenges and share our personal experiences of being "lost in translation" (Proulx, 2018).

Across the contributions, we also discussed how meanings of theoretical terms may evolve when we "de-locate" them from one discourse and "re-locate" them into another (Bernstein, 1996). Eilers' poster de-located discourse around concept image and concept definition from the mathematical sphere (Tall & Vinner, 1981) and re-located them to the field of MER. Wu's paper de-located discourse around *qubits* and *qubytes*, which are processing units in quantum theory, to discourse around emotion and cognition. One way to negotiate the consequences of such moves could be via dialogue between the different discourses.

Theme 2: Interrogating the question of the scientificity of MER

Another issue that kept coming up in our discussions was the question of the *scientificity* of MER, that is, the question of what exactly makes MER a scientific discipline. Our discussions concerned theory development, methodological and methodical issues, and different forms of theorising.

We addressed tension between theory use and theory development as well as the need for theory development specific to MER. In Herbst and Chazan's paper, they sketched out "components of a descriptive theory of mathematics teacher education." Their focus was on what they called "practice-based mathematics teacher education" (PBMTE), which meant that as teachers learned to teach, they would engage in activities comparable to those that are part of the work of actual classroom teaching. One contribution of this theory development was a meta-perspective on the role of instructional exchanges between mathematics teacher educators and prospective teachers, when the content at stake involved practices of mathematics instruction.

Another aspect under discussion was whether scientificity ultimately means the same thing across disciplines, or whether this may differ greatly depending on the respective objects of study. In his paper, Lensing made an argument for domain-specificity. Drawing on an example from belief research, Lensing argues that methodical approaches in MER necessarily need to take into account that the objects studied are individual agents or social systems that have always already conceptualised themselves and their environment in meaningful ways. And likewise, Kolloosche's paper, in which he argued for the need of a methodology of didactical content analysis, can also be

read from this point of view. For when he reconstructed didactical content analysis as a method in which the “educational suitability of different mathematical approaches towards a given curricular content [is evaluated] on the basis of didactical background theories,” he pinpointed a research task that was *specific* to MER due to the very nature of its objects of study. And finally, the way in which Herbst and Chazan advised us to *methodically* approach the collective work of teacher educators and prospective teachers in PBMTE clearly depends on their *theoretical* account of what was actually transacted in PBMTE activities and thus might be learned.

Moreover, the constructs of horizontal and vertical theorising, raised in CERME12, proved useful for navigating the different theoretical approaches in the contributions. This distinction allowed us to highlight different levels of theoretical working, which helped to anchor discussions across various theories. A key point raised at CERME13 was what could constitute problems for each type of theorising, and how we might tackle those problems. For example, problems addressed by horizontal theorising could include answering empirical research questions to make sense of different phenomena. Problems addressed by vertical theorising could include navigating, and choosing theories, as well as reflecting on the meanings, multiplicities, and diversities of our theoretical constructs, terms, and approaches.

Huth and Schreiber’s paper illustrated how horizontal theorising could lead to expansions in the use of existing tools and methods. Drawing on Peirce’s semiotic theory, Huth and Schreiber showed how the analytic tool of semiotic process cards could be used not only to study students’ inscriptions (the original usage), but also to examine students’ gestures and utterances.

Additionally, problems of vertical theorising permeated our discussions. As one example, we addressed how the sources of different theories might create tensions when engaging in networking. In Sødal’s paper, she included elements of vertical theorising to bolster her decisions and claims. In particular, she explained why it could make sense to network theories with different heritages, with DAD having constructivist roots and Valsiner’s zone theory having roots in the socio-cultural theory.

Theme 3: Reflecting on the value-ladenness of MER

The paper of Gascón and Nicolás, drawing on the Anthropological Theory of the Didactic, addressed the limits and transforming power of didactics of mathematics. There, they made a clear case that MER, if it is to be scientific, cannot prescribe how teachers are to teach. Discussions around this paper gave rise to a third theme to which we continued to return, namely the axiological dimension of MER. These discussions stuck with us as group leaders and led to further discussions in the preparation of this paper. We asked ourselves what we actually might mean when we speak of the value-ladenness of MER. And even though in what follows we unfold the question a bit further rather than provide definitive answers, we believe that these reflections hint at the kinds of considerations in which we, as contributors to TWG17, are particularly interested, and which we therefore want to make available to a wider audience in our field.

To begin, we first need a rough model of what we do when we conduct MER. One way to answer this question begins by distinguishing three different *layers* or *contexts* that, according to Edmund Husserl (1992), can be found in any scientific discipline. First, there is the *epistemic context* which comprises the acts of knowing, through the performance of which the respective discipline is actualised. One might think here, for example, of acts of questioning and assuming or observing and

questioning, of grasping and theorising or documenting and publishing. The epistemic context is distinct from the *ontic context*, that is, the context of the objects that are conceptually grasped and theoretically recognised in these very acts. As Husserl (1992) stated: “The context of researching and cognising is plainly quite different from that of the researched and cognised” (p. 182, our translation). Finally, there is the *theoretical context*, which includes the various formations of meaning *through which* the epistemic activities relate to their objects of study. Examples include concepts and conceptual relationships (i.e., propositions), propositional relationships and theoretical pieces, up to whole theories and their interconnections. The *theoretical context* thus contains the entire conceptual apparatus of a discipline. Once this threefold division has been made clear, one can now ask in what ways values and norms can play a role inside these three contexts and, in this way, further investigate the axiological dimension of MER.

First, it can be assumed that the course of human activity is quite generally regulated by certain norms and values. With respect to the *epistemic context*, it would therefore be naïve to believe that researchers in MER can somehow detach themselves from this social integration in their concrete actions. Like all other people, mathematics education researchers are also guided in their actions in a normative way: which questions researchers ask, which aspects of mathematics education seem important and relevant to them, and which purposes they want to pursue with their research activities. In all these issues personal values as well as the normative expectations play an important role. However, it does not follow from this insight that the *questions* researchers pursue and the concepts and theories they draw on are therefore imbued with these values. For example, mathematics education researchers may desire to engage in research just for the sake of developing new knowledge. Yet, external normative forces, actualised via promotions, awards, publications, invited positions, and so forth, can also influence the kinds of research topics or questions that researchers may choose to explore. Hence there can be a value-laden tension that, however, does not necessarily compromise the validity of the research results.

Because MER directs its activities towards a practice in which certain norms and values have always already been formed, it seems beyond question that values and norms play an important role in the *ontic context*. In mathematics classrooms, certain norms are established about what counts as relevant mathematics, what makes a reason a mathematical reason, or which of the participants has what rights to speak, and so forth (see Herbst & Chazan, 2012; Yackel & Cobb, 1996). When MER research turns to these classroom practices for research purposes, it is thus dealing with actors and practices that are normatively oriented. However, it by no means follows that the concepts and theories that MER forms about these normatively structured practices must themselves be normative in character. One can indeed formulate *descriptive* statements about the fact that certain norms regulate the activities in a classroom and set up *explanatory* accounts of how this has come about.

Whether and to what extent MER can include normative concepts and propositions in its theories, and also to what extent these normative propositions can be justified, are issues that concern the *theoretical context*. These issues also concern the question of which logical forms and modalities the propositions in MER can take at all. Does MER have to limit itself to propositions that say how mathematics education *is and can be*, or can it also justify claims about how these practices of teaching and learning *should be* constituted? Or to put it more bluntly: “Can didactics say how to teach?” (Gascón & Nicolás, 2017, p. 9). Thus, even these rudimentary considerations show that the

question of the value-ladenness of MER is in fact a multifaceted one. For depending on which of the three distinguished contexts one has in mind, the question presents itself quite differently.

Concluding Remarks: Looking Ahead to Future TWG17s

A focus on theoretical approaches afforded discussion of theories as objects with which researchers can work, and with this arose a continual tension to stay grounded. At CERME11 and CERME12, Bikner-Ahsbabs cautioned that while our heads may be in the clouds, our feet should be on the ground. At CERME13, we extended this metaphor to gardening: as plants reach to the sky, their roots dig deeply into the ground to bolster the plants in times of climate variability. In a similar way, our theories are rooted in cultural traditions, and our theoretical approaches need to honour the tenets of theories with which we work (see Jablonka et al., 2013). Results of our empirical studies serve as roots for our theorising and allow our theories to evolve. Furthermore, we draw on results and examples to “root” our broader discussions around theoretical approaches.

Overall, there is an urgent need not only to use particular theories and/or methodologies, but to explain our reasons and purposes for our research approaches. At the CERME13 TWG17 we have worked to make these decisions explicit during our discussions, which promoted lively conversation across participants with different levels of experience, from PhD students to established professors. A strength and challenge of the TWG17 is the breadth of the work, as theory use is relevant to each and every CERME TWG. In our view, the TWG17 is a place for researchers to foreground theoretical working across a variety of research topics. This can open opportunities for PhD students who are working on theoretical framing of their PhD projects. Furthermore, this can be a place for CERME members to expand on why they are adopting the theoretical and/or methodical approaches that they are, and how they are managing the consequences of their theoretical and methodical choices.

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