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Introduction to the papers of TWG19: Mathematics teacher and classroom practices

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INTRODUCTION

This Thematic Working Group (TWG) together with TWG18 and TWG20 addresses questions related to mathematics teachers, teaching, and their development. TWG19 focuses particularly on mathematics teaching, including important micro and macro factors that frame it. Classroom research has been the focus for many years in mathematics education, but new theoretical and methodological directions have been reported in this group aiming to study on the one hand the overall complexity of teaching and on the other the particular aspects that characterize it.

TWG19 initially received 64 proposals (56 papers and 8 posters), and being the largest group in CERME9, it was split in two new groups (TWG19 and TWG20). Finally, 31 papers and 6 posters remained in the group. The reviewing process led to revisions in most of the papers and eventually 27 papers and 6 posters were presented in the conference and are included in the proceedings. The papers and posters were classified in three thematic groups: instructional practices (14 papers and 4 posters); classroom interaction (8 papers and 1 poster); and tasks and teaching resources (5 papers and 1 poster). The papers and posters in the first thematic group mostly concern general teaching practices, whereas there are some which focus on teaching practices related to the teaching and assessment of specific mathematical issues. In the second thematic group, the topics addressed are patterns of interaction, teacher's questioning, and classroom discourse. In the third thematic group task and textbook analysis is the main focus. Below, we discuss the papers and posters with reference to these thematic areas.

INSTRUCTIONAL PRACTICES

Most papers and posters in this area report on small-scale, qualitative studies of the interactions in one or a few school classrooms aiming to support practices for effective teaching, but also to gain a better description of teaching practices by looking for patterns of argumentation in classroom interaction (Zalska & Tumova). However, there are also examples of more quantitative approaches (Felmer et al.; Gunnarsdottir & Pálsdottir) and of researchers who do not report on their own observations of classrooms, but on teachers' interpretations of classroom events (Reid et al.) or task design (Opheim). Between them, the papers deal with all levels of schooling, from primary (Allard; Caseiri et al.; Gade; Velez & Ponte; Taylan), over middle (da Ponte & Quresma; Zalska & Tumova) to secondary (Dias & Santos; Mata-Pereira & da Ponte; Reid et al.) and vocational (Opheim). One paper addresses instructional designs of novice teacher educators and the practices that unfold in their course for in-service teacher education (Kalogeria & Psycharis), and another one does not deal directly with interpretations of classroom events, but is based on interviews with teachers on how imposed assessment practices may significantly transform teaching practices in ordinary schools (Pratt). Also one of the posters deals with external evaluation and the teachers' attitude towards it (Signorini). Two posters explore the effects of formative assessment on teaching practice (Anderson & Boström; Vingsle).

Theoretical and methodological issues

Pratt's paper highlights the significance of taking contexts beyond the individual classroom and school into consideration. His theoretical framework, based

primarily on Bourdieu, allows him to do so. *Context*, in one or other understanding of the term, is dealt with also in other studies (Reid et al.; Opheim; Taylan), and in fact the notion of context is mentioned in 10 of the 14 papers. However, it is not always clear how the term is used and how its significance is taken into account in the theoretical framework and the methodology. This seems to be an issue that needs attention in research on mathematics classroom practices.

The theoretical or conceptual frameworks that are used vary. Gade draws on CHAT, Reid and colleagues on Maturana (among others), whereas Allard as well as Kalogeria and Psycharis refer to the French school. Others base their studies on more local theories of classroom communication, problem solving, or the teaching and learning of particular mathematical topics. Clearly, there are strong limitations to what theoretical frameworks can be presented in a conference paper. Nonetheless, the interest in *context* combined with the limited attention paid to theoretical frameworks in most of the papers may indicate that it is a challenge to develop and use approaches that allow for a combined analysis of micro-, meso-, and macro issues of significance for instruction.

The approach in most of the papers is a carefully conducted qualitative analysis of unfolding classroom events, sometimes combined with stimulated recall interviews and textual analyses of tasks and student work. Other studies are based exclusively on interviews. In both cases, the research participant(s) are often purposefully selected teachers, who are either co-researchers engaged in teacher-researcher collaboration (Gade; Dias & Santos), experienced teachers whose participation in the study is based on their reputation and/or their participation in long-term teacher development initiatives (Allard; Taylan), or teachers who are engaged in focused collaboration with their colleagues on issues of interest to the study in question (Velez & da Ponte). In these studies, the research participants qualify as critical cases (Flyvbjerg, 2006), this means, as particularly useful cases that allow for conclusions of the type: *if reform intentions do not materialise with these teachers, they never will*. Although some of the studies invite this type of conclusion (Allard), most of them do not. As mentioned above, most of the papers report fairly positive findings, and the general conclusions seem more related to ways in which interventions or the work of competent teachers may inform teacher education or induction

programmes. This is so for instance with a series of studies from Portugal by Caseiro and colleagues; Mata-Pereira and colleagues; da Ponte & Quaresma; and Velez & da Ponte and with the Turkish study by Taylan.

Reid and colleagues do not make use of critical cases, but adopt a second order perspective on classroom practice: they analyse groups of teachers' collective interpretations of video recordings of "typical" and "exemplary" lessons from their own classrooms. The intention is to understand the criteria that guide the teachers' observations. It is interesting that research participants focussed on different aspects of typical and exemplary lessons, when they had access to the videos and when they did not. Reid and colleagues argue that this indicates the research design needs to allow for different ways of accessing teachers' views of what is valued in mathematics education.

Substantive issues

There seems to be a shared vision of quality teaching underlying most of these papers. Some papers make explicit reference to *the reform*, but, even in the majority of papers that do not there appears to be a set of shared understandings inspired by current reform efforts about good classroom practice. In particular, students are expected to become involved in independent and creative activities much beyond their repetition or imitation of ready-made concepts and procedures as presented by the teacher or the textbook. In turn, this requires teachers, for instance, to organise problem solving activities (Felmer et al.); to orchestrate whole-class discussion and promote other forms of classroom communication (Gade; Ponte & Quaresma; Mata-Pereira, Ponte & Quaresma); to facilitate the development of students' ability to assess their own mathematical progress (Dias & Santos); and to base instruction on interpretations of the students' mathematical thinking, including their unexpected questions, comments, and suggestions (Taylan).

The papers mentioned report on relatively successful examples of instruction, when seen from the perspective of the researchers. Some studies are part of or follow up on intervention programmes and in these studies research participants generally appear to cope well with the challenges of teaching according to the reform (e.g., Felmer et al.). The most significant of these challenges appears to be the contingencies that arise as students are to make their own mathemat-

ical contributions to classroom practice. The specific contents of students' inputs are not necessarily part of the teacher's agenda, as their contributions may take the form of a surprising question or an unforeseen conjecture (Ponte & Quaresma). In this sense, the reform inserts an element of planned unpredictability in instruction that teachers need to capitalise on in the moment (Skott, 2004). One major challenge for teachers is to cope with the inherent unpredictability.

Despite the positive descriptions of the interactions in most of the papers, some point to problems in relation to the reform. Gunnarsdóttir and Pálsdóttir report on a study from Iceland on dominant ways of organising instruction in grades 1 to 10. There are examples of group work and whole class discussions, but students appear to spend most of their time working individually on textbook tasks. Allard's paper points to problems that arise because of difficulties involved in linking instruction to students' thinking. Her study on a highly qualified elementary teacher in France shows a tension between devolution and institutionalisation, that is, between handing over initiative to the students to support their independent activity and ensuring that what is learned is decontextualized and in line with the discipline of mathematics. One particular problem when taking students' thinking into account is that of the time needed for task completion. Opheim, working with vocational schools in Norway, suggests that the diversity of the student population poses particular problems related to timing for teachers' selection and use of tasks.

A somewhat different approach is adopted by Pratt. Working in the UK, he reports on part of a study of how a dominant assessment culture influences the position of teachers and the relationships among them. In turn, this is likely to significantly influence instruction.

CLASSROOM INTERACTION

The papers in this area consider various aspects of the interactions taking place in mathematics learning and teaching settings and the ways these interactions shape participants' learning. All but one of the papers concern small-scale, qualitative studies often situated or initiated in the context of a larger project. Only the study by Seker and Ader adopts a quantitative approach, focusing on teachers' written answers to items allowing for tensions between

students' perceptions and teachers' intentions to be explored. The remaining research reports deal with aspects of interactions taking place in various mathematics education contexts: teachers' discussions in mentoring sessions (Mosvold); teacher practices when exploiting contingent opportunities (Kleve & Solem) or when aligning values to smoothen learning (Seah & Andersson); whole-class discussions (Drageset; Larsson); and students' grasp of teaching changes initiated by an intervention (Evans & Swan) or by a national reform (Wester, Wernberg & Meaney). Most studies are based on observations, the exceptions being the ones by Larsson and by Wester, Wernberg & Meaney, which are predominantly based on interviews. The interest in the impact of the emergent interactions on students' mathematics learning and directly or indirectly on teachers' learning about teaching mathematics is central to all the studies presented here, whose focus extends from the upper primary to the secondary school level.

Theoretical and methodological issues

The design and the implementation of the research reported in the papers are framed by the conceptual focus chosen, the theoretical perspective adopted and the methodology employed. The studies deal predominately with classroom practices related to promoting interaction and thus facilitating particular aspects of mathematics learning, mainly through teachers' management of teaching incidents (e.g., Seah & Andersson), classroom communication (e.g., Larsson), tasks (e.g., Evans & Swan), tools (e.g., Seker & Ader) and resources (e.g., Wester, Wernberg & Meaney). The theoretical frameworks employed in the studies concentrate on mathematics classroom interactions related to advancing students' learning or to developing teachers' knowledge for teaching. The former might refer to management (e.g., Drageset; Evans & Swan) or socio-cultural (e.g., Larsson; Seah & Andersson) issues of the interactions involved, whereas the latter frameworks adopt either a practice oriented (Kleve & Solem) or a discursive perspective (Mosvold). Finally, the methodological choices are qualitative in character (with the exception those of Seker and Ader), include mostly selection and analysis of classroom events, sometimes combined with interviews (e.g., Larsson) and involve teachers who agree or are willing to experiment with new ideas (e.g., Wester, Wernberg, & Meaney). The results reported are generally positive, illustrate how and shed some light on why interactions can promote classroom par-

ticipants' learning, but may also limit their learning opportunities.

Substantive issues

The research presented in the papers under consideration is based on a shared view of learning as a process of pursuing challenging tasks and activities via student-student and/or teacher-student interactions. Opportunities for such tasks and activities to be introduced are sought in instances of the moment-to-moment decision making or in carefully planned and implemented teaching interventions, aiming in all cases at particular, well defined learning outcomes. In the former category, we find contingent moments of teaching seen as unplanned opportunities of supporting students' mathematical learning (Kleve & Solem); unexplained students' answers exploited as occasions for effective intervention (Drageset); tensions between teachers' intentions and students' interpretation taken as instances for improving participatory learning (Wester, Wernberg & Meaney); teachers' value alignment strategies related to the quality of the students' learning experiences (Seah & Andersson). As for the tasks and activities that are planned, some are based on and explore the power of theoretical models of learning, cognitively (Seker & Ader; Evans & Swan; Klein) or a socio-culturally oriented (Larsson; Mosvold).

The classroom practices supported by the tasks and activities utilized in the studies described above are characterised by significant to moderate teacher-student and only occasionally noticeable student-student interaction. For example, unexplained answers appear to attract teachers' attention (Drageset) and the same is true for contingent teaching moments (Kleve & Solem), leading to a range of teacher-student interaction strategies, which are generally beneficial for students' learning. Similarly, well-designed and established social and socio-mathematical norms contribute to pupils interacting effectively with one another, giving rise to an inquiry classroom culture (Larsson). However, overall, students find it hard to cope with and build on interactions with their peers in the classroom (e.g., Evans & Swan).

Overall, the studies reported here reveal that mathematics classroom interactions constitute critical teaching incidents that function in complex ways and offer opportunities for students' and teachers' individual and collective learning. However, the studies

also indicate that there may be difficulties involved that we are just about to begin identify and understand.

TASKS AND TEACHING RESOURCES

Teaching can be regarded as plausible conceptions of teachers' professional practice, and most of the papers in TWG19 deal with such conceptions. Among the different approaches to conceptualize the work of teaching, one considers teaching as a didactic encounter between teacher and students about a certain mathematical content. In such an encounter, the teacher presents the content by using mathematical tasks or resources. Two of the papers discussed here, mainly concentrate on the content of textbooks and textbook tasks (Burke; Wijayanti), whereas three papers focus more on teachers' use of tasks in their work of teaching mathematics (Ayalon & Hershkowitz; Kwon; Matic & Gracin). In addition to these papers, a poster focused on mathematics teacher guides (Ahl & Koljonen).

Theoretical and methodological issues

The textbook is a central resource for mathematics teachers and students alike. Appraising, adapting and administering mathematical textbook tasks constitute professional challenges for the mathematics teacher. Textbooks are not only a source of mathematical tasks, but they also include demonstrations of techniques. When analysing Indonesian mathematics textbooks, Wijayanti focuses on tasks and techniques presented in the textbooks and uses Chevallard's Anthropological Theory of the Didactic (ATD) in her analysis. Burke focuses on the strategies deployed in textbooks and the pedagogical tasks embedded in them. As a theoretical framework, he applies Dowling's Social Activity Method (SAM). From such a theoretical perspective, he aims at describing possibilities for engagement between author and audience in a pedagogical relation.

Most textbooks also have a teachers' guide, and Ahl and Koljonen analysed the teachers' guides to the two most commonly used mathematics textbooks in Sweden. They apply content analysis in their analysis of these teacher guides.

Whereas the above-mentioned studies focus on the texts themselves – the textbook, the tasks, or the teachers' guide – the other three papers have a particular focus on teachers' use of textbooks and mathematical

tasks in the work of teaching. In their study, Ayalon and Hershkowitz survey 17 Israeli secondary school teachers. They attend to the teachers' rationale for selecting particular mathematical tasks from the textbook in order to facilitate argumentative activity in the classroom – considering argumentation as a social process. Whereas these researchers investigate teachers' different explanations for the choice of tasks, Matic and Gracin analysed two Croatian primary teachers' use of textbook tasks. When applying the socio-didactical tetrahedron in their analysis, the connection between student, mathematics and textbook appeared important. In her attempt to conceptualize the teachers' work in supporting students' development of mathematical explanation, Kwon focused on the encounter between an expert teacher and five different cohorts of students around some mathematical tasks. Kwon's analysis revolved around core tasks of teaching, and this corresponds somehow to Burke's focus on pedagogical tasks.

Altogether, the papers and poster presented in this group vary considerably in their use of theoretical framework, instruments, and methods of data collection and analysis. This variation can be seen as a challenge for the further development of the field.

Substantive issues

From these studies, some emerging issues can be observed. First, there is the connection between teaching and students. Investigations of this connection differ among the studies, but the teachers' work cannot be dissociated from the students' learning activities. Second, the connection between mathematical tasks and the decomposition of teachers' practice into core tasks of teaching emerged as a central issue (e.g., Kwon). Such tasks of teaching are arguably important to study when attempting to conceptualize teachers' professional practice. Finally, an issue emerges in the various theoretical conceptions of teaching. The papers in this group adopt different theoretical frameworks, and different interpretations of core concepts like tasks and teaching are applied. Some papers appear to describe tasks merely as mathematical problems from textbooks (e.g., Ayalon & Hershkowitz), whereas others also discussed pedagogical tasks (Burke), or tasks of teaching (Kwon). Future studies in this TWG need to be more specific about their use of such core concepts and develop shared language necessary for establishing solid conceptions of the professional work of mathematics teachers.

GENERAL ISSUES – MOVING FORWARD

Research on mathematics teaching has been developed in mathematics education during the last few decades. Different research questions as well as theoretical and methodological tools have been formulated throughout the years. The papers and the discussions in this TWG show that we have taken some steps forward. For example, we have developed questions and frameworks that allow us to: look closer into critical moments of classroom interaction; consider contextual, epistemological and social issues that frame mathematics teaching; build general models that describe mathematics teaching; understand better in what ways the resources and tools that teachers use in the classroom transform mathematics teaching and learning. We have also started to consider mathematics teaching in its complexity and move away from dichotomies of what is “effective” or not and adopt deeper explanations of teacher's decisions and actions. We work with teachers in more collaborative contexts and care more about what our research says for them.

However, we still need to look more critically at our research concerning mathematics teaching. For example, many papers study the teaching of an expert teacher. Do we work under the assumption that there is an ideal teacher and/or an ideal teaching? We possibly need other interesting cases of mathematics teachers in different school contexts that will allow us to understand better the dynamic character of teaching. We also see that many studies use multiple research methods. Is there the underlying assumption that different methods provide differential access to the same phenomenon, for example, teachers' meaning making? It may be that different methods shed light to teachers' views and meaning making in decidedly different contexts that frame teacher actions very differently. In the discussions in the group, it appeared that because mathematics teacher education and teacher resources were discussed in other groups, we missed the dialectical relationship between mathematics teaching, resources and teacher education. Do we really have theoretical and methodological tools that allow us to study this dialectical relationship?

We close this introduction by addressing a number of challenging questions that were discussed in the group: How can we link students' activity to teacher's activity? How can we include the significance of

context in our research on mathematics teaching? Can we listen to teachers' voices? How complementary are the different theoretical frameworks we use for studying mathematics teachers and teaching? Is there a coherent meaning underlying the different constructs we use?

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