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# TWG09: Mathematics and language

## Introduction to the papers of TWG09: Mathematics and language

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### Introduction

Within the context of mathematics education research there is strong agreement on the importance of language for learning and thinking, and on the centrality of being able to communicate mathematically for learning and teaching school mathematics. These standpoints are particularly idiosyncratic of TWG09 and the group of papers presented therein on the occasion of CERME10. It is assumed that developing more knowledge about language and language processes can aid the field in terms of a better understanding of what is involved in mathematics learning, teaching and thinking. In the centre of important debates around which theories and conceptualizations of language to take, there is a growing awareness that dialogue between theories will help to refine our approaches to the various phenomena embedded in mathematics education and language research. Within the context of TWG09, this awareness has been present in many ways over the course of past editions (e.g. Planas, Chronaki, Rønning & Schütte, 2015; Rønning & Planas, 2013). Also in the TWG09 sessions at CERME10 participants did not restrict themselves to ‘defending’ their positions. They were interested in exploring common ground and opportunities to take the field forward.

The T of TWG09 stands for a number of topics, themes and theories. As a group, we cover frameworks drawing on linguistics, cultural and social semiotics, sociolinguistics, positioning theory, functional grammar, theory of didactical situations, social interactionism, and content analysis, to list only a few. The main idea we want to share in this short introduction is precisely the possibilities of dialogue between theories opened up to the group and to the domain by the existence of such theoretical diversification –i.e., the fact that theoretical perspectives mostly construct their identities by differing from others. Biehler, Scholz, Strässer, and Winkelmann (1994) recommend talking about diversification instead of diversity. Dialogue is seen to be one of the positive and productive outcomes of diversification, which can keep the domain moving in several ways.

### Diversification and dialogue in TWG09

In this section, we take the collection of TWG09 papers at CERME10 to illustrate the line of argument of a landscape of diversification and dialogue. By commenting on the joint discussions within different groups of papers, we will claim that both diversification and dialogue were present in our working sessions. Throughout these sessions, the emerging common themes showed that dialogue, even if it sometimes remains elusive, is worth pursuing. Dialogue between perspectives was actually made possible because people from different perspectives worked together.

In the first session, we had a discussion of four classroom-based papers by: Brandt and Keuch; Häsel-Weide; Ingram, Andrews and Pitt; and Tatsis and Maj-Tatsis. All these papers have in common that they represent studies of social interaction, each on the basis of different theories and methods. The number of differences visible in the use of terms competing with each other –e.g., deviations, mistakes and opportunities– turned into a collaborative search for common themes. One theme emerged regarding the relationship between long-term mathematics learning and short-term language accuracy in mathematics teaching and learning. Patterns of corrective responses and markers of authority, as reported in some of the papers, were viewed as indicators of discourses of language accuracy at the intersection with processes of meaning construction and negotiation, as reported in all four papers. A related issue in the discussion was the extent to which the suppression –if possible– of certain discourses of language accuracy was necessary for the development of mathematical activity in classrooms. Either explicitly or implicitly, the different analyses presented in the papers reveal this tension between mathematics learning and language accuracy.

The second session brought many of the methodological issues explored by the group to the fore. Four papers by Farrugia, Schubert-Meyer, Ní Ríordáin, Flanagan and Brilly, and Wessel each highlighted the back and forth flow between conceptual development in mathematics and language learning within classrooms with varying degree of linguistic diversity. The papers were each offering a different perspective on the relationship between word and use, including within which language the word is used, and learning mathematical ideas including subtraction, fractions, relative frequency and undergraduate mathematics. Again each of these papers drew from different theories and methods, and researched different settings, but each raised methodological questions at the core of language research within mathematics education. The discussion focused on how integrative frameworks can be developed that draw upon the different approaches that are grounded in the study of language in mathematics.

The third session included five papers that focused on higher grades in mathematical education. The paper presented by Wille dealt with the topic of the shift from difference quotient to the derivative, moving from algebraic to analytic concept formation explored through imaginary dialogues. With this method, different perspectives (horizontal and vertical) could be identified with preservice teachers, which helped focus on the diversity of conceptions later in class. Related to this topic, Zweidar also worked with the topic of functions and its implicit meanings in the classroom. Her research focused on mathematics lessons through a lens that shows the invisible demands of mathematical discourse. Ulises pointed his research also in the direction of mathematical discourse. He examined the signs of vector quantities and their corresponding gestures in regard to novice teachers and he raised awareness of the semiotic dimension. Schlager examined the connection between language proficiency and achievement in mathematics with 10<sup>th</sup> grade students, who work on tasks with different linguistic characteristics. The results demand further research but suggest that extremely difficult linguistic structures should be avoided to reduce the achievement gap. Finally, Arce, Ortega and Planas researched students' mathematical notebooks. They analysed comments into different groups of knowledge to later conceptualize them as a learning resource. Especially interesting in this session was the focus on higher grade mathematics education. These papers all showed that mathematics and language is not a topic that is solely important in early education. Ideas of interactionistic learning theories of mathematics (Krummheuer 2015; Schütte 2014) are not just about building a foundation for later learning but also can be used in higher classes with exceptionally

more complex topics. As all papers stated, research in the specific fields has to be extended to draw broader conclusions but the results look promising.

All four papers presented in the fifth session deal, in various ways, with learning by participation in practices. Another theme, common to most of them, is that they are concerned with explanation and logical reasoning. Logic is central to mathematics but in the paper by Ludes and Schütte the authors take this out of the context of mathematics when they discuss a project which aims to include computer science in primary education. An important aim is to look for possibilities to integrate computer science and mathematics and in the paper, competencies in mathematics from the German core curriculum are listed alongside relevant competences from computer science. Carotenuto, Coppola and Tortora also report from a project which is about logic. In the project the students are working with logical riddles, which are not about mathematics but where logical reasoning is needed to solve the riddles. Erath is interested in how students learn to participate in mathematical practices, and in particular how they participate in explaining practices in whole class discussions. The paper is based in interactional discourse analysis and builds on data from grade five classes. The paper by Fetzer and Tiedemann is of a more theoretical nature. Their interest lies in reconstructing mathematical learning processes with a special focus on the interplay between language and objects. They discuss and compare three theoretical frameworks: by Aukerman on language and context, by Bauersfeld on domain-specific learning and by Latour on objects as actors.

In the sixth session connections between the modality of the language used and the learning of specific mathematical concepts became the focus. The relationships between informal everyday language and formal mathematical language, between informal gestures and sign language, between visual, dynamic and verbal modes are explored, considering not only how the mathematics is learned, but also how the mode influences how the mathematics is conceptualised. Here the links between diversification and dialogue are readily apparent. Each paper draws upon different frameworks, with Ferrari drawing upon Systemic Functional Linguistics, Khalloufi-Mouza drawing upon the Theory of Semiotic Mediation, Krause drawing upon the Theory of Embodied Cognition, Mizzie drawing upon Cummin's model of language use, and Rønning and Strømskag drawing upon the Theory of Didactical Situations, and indication of the diversification within the field. Yet the dialogue within the group focused on the commonalities between each of the papers, that is the relationship between the mode of language and the conceptualisation of the mathematics.

Four posters were also part of our group. Using a meta-analysis, and a qualitative analysis of its results, Dyrvold investigates demanding textual features of mathematics tasks, and the relevance of these features to the mathematical content. Rauf and Schmidt-Thieme sketch the required linguistic competencies of mathematics teachers, and outline a "language curriculum" recently introduced for future mathematics teachers at the University of Hildesheim. Similarly, Krosanke presents a study investigating the effect of integrating inclusive language teaching into the education of mathematics teachers in Hamburg, using analysis of interviews and video-vignettes. Kenton, meanwhile, examines the role of metaphor and language in the development of individuals' understanding of risk, confirming that this understanding is enhanced when probability is expressed in natural language.

## Old debates, contemporary challenges

Debates regarding dialogue between perspectives are not new and are not unique to our research domain (Bikner-Ahsbals & Prediger, 2014). In particular, in mathematics and language research, the risks of moving towards a fragmented domain cannot be underestimated. The last decades of increasing research on mathematics and language have provided a serious and valuable diversification of theories and lines of interest, inside (Morgan, 2013) and outside ERME (Pimm, 2014). We are progressively including work of a review nature in the agenda in order to recognize what different theoretical perspectives have in common. As a group, we are mature enough to know that the multiplicity and richness of theoretical positions go with articulation and dialogue.

Throughout the reading of the following collection of papers, we invite you to look for common grounds emerging from contemporary ERME research on mathematics and language. Although it may be easier to grasp differences rather than commonalities between papers, careful attention to questions, approaches and methods will offer evidence of similar problems and theoretical challenges. Hopefully some of these challenges have been discussed in this introduction.

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