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Mathematical reasoning as a classroom discourse

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Introduction

Mathematical reasoning is recognised as an essential means for promoting students' mathematical understanding and is central to students' mathematical proficiency (e.g., Kilpatrick, Swafford, & Findell, 2001). However, the teaching and learning of mathematical reasoning – here understood as a discursive practice – remains challenging in secondary school classrooms, with students often relying on mathematically superficial reasoning (e.g., Sidenvall, Lithner, & Jäder, 2015). Teachers need to have at their disposal effective discursive teaching practices to foster students in developing their ways of mathematical reasoning. This raises the question of how teachers can be supported in developing such discursive teaching practices with respect to mathematical reasoning. This question is addressed in the PhD-project of the first author. The intention of this poster is to elicit feedback concerning the inferences made from the analysis of mathematical reasoning teaching practices, within a discursive framework.

Theoretical framework

Sfard (2008) argues that 'doing mathematics' is a *discourse*, that is, the use of specific, well-defined communication. As such, mathematical reasoning can be considered as the line of thought, both the inter- and intrapersonal discourse, that is utilised to produce statements and reach conclusions while solving a task. Mathematical discourses are framed as a type of communication that is distinct to others through the permissible "vocabularies, visual mediators, routines and endorsed narratives" (Sfard, 2008, p. 297). *Routines* are a set of rules defining a discursive pattern that repeats itself in certain situations. For example, the use of the quadratic formula is a routine. *Endorsed narratives* are an ordered sequence of expressions which are labeled as *true*. They describe mathematical objects (e.g. numbers, functions, and formulae), relationships between objects, and the processes through which the objects are constructed. Examples of narratives endorsed by the mathematical community (e.g., mathematicians and teachers) include definitions, axioms, and theorems as well as acceptable forms of presenting solutions to specific tasks (e.g., answer models within state exams).

The completion of a mathematical (school) task can be considered as the production of an endorsable narrative from existing narratives (Sfard, 2008). The activity of choosing which previously endorsed narratives are relevant to the task at hand and how these narratives are to be manipulated to create a new (endorsable) narrative is fundamentally what mathematical reasoning is. In this process, students need to adhere to well-defined rules within the mathematics community. Fostering mathematical reasoning thus requires the teacher to explain the rules and mechanisms of endorsing narratives in classroom conversations. Such a meta-discourse about rules and mechanisms can be considered as a mathematical discourse in itself because it has its own

vocabulary, visual mediators, routines and endorsed narratives. This discourse is coined *mathematical reasoning discourse*.

Methodology

As part of a larger project, the present study is conceived to examine the mathematical reasoning discourse that teachers employ in their classrooms. At the time of CERME11, the present study was in the data collection phase. The results of this exploratory study will be used as one of the inputs, in the following study, for the design and evaluation of a professional development module in relation to advancing teachers' mathematical reasoning discourse.

The exploratory study consists of ten lesson (video) observations and stimulated recall interviews with five Dutch mathematics teachers at the upper secondary level. The interviews consist of non-evaluative questions asked while watching pre-selected video-scenes of their classroom routines. The questions are designed to stimulate the participant to relive the lesson, and, through this, to reflect on his/her routines (Geiger, Muir, & Lamb, 2016), to identify the conditions influencing their choice of routines and the types of routines they employed (Cooper & McIntyre, 1996), and what they deem as a successful implementation of their routines (cf. closing conditions of routines, Sfard, 2008).

The planned approach to the data analysis is the following:

1. Video sightings for identifying teacher routines in the mathematical reasoning discourse (also used as stimulated recall)
2. Qualitative discourse analysis of the (video) observations to examine the discursive means (narratives, keywords, visual mediators) for fostering the students reasoning
3. Qualitative discourse analysis of the stimulated recall interviews to uncover teachers' intentions behind their routines and as such meta-rules for mathematical reasoning discourse

From the design of the exploratory study, the expected output would include (successful/promising) routines that teachers use, and the associated meta-rules in relation to mathematical reasoning discourse. However, this raises the following question for discussion in the context of TWG09: how can inferences be made from the here presented exploratory study to a broader teacher community in order to inform the design of the professional development module?

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