



Different modes in teachers' discussions of students' mathematical texts



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HIGHLIGHTS

- Interviews with nineteen mathematics teachers in groups.
- Teachers' collective discussions on students' mathematical texts.
- Teachers work in two modes when assessing students' texts: a pedagogical mode and an assessment mode.
- Teachers move seamlessly between these modes.

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ABSTRACT

The study aims to examine elementary school mathematics teachers' ways of discussing students' mathematical texts. Nineteen teachers were interviewed in groups and asked to discuss 15 texts. The object of study is the teachers' collective discussions, analyzed using a discourse analytic approach. Findings indicate that two different modes are visible in the discussions: a pedagogical mode, connected to the teachers' position as pedagogues and where identification of students' strategies is foregrounded, and an assessment mode, connected to the teachers' position as examiners, in which a deficiency perspective is adopted that views particular features as 'missing' from the texts.

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1. Introduction

The study presented here takes its starting point in teachers' interpretations of students' mathematical texts. A mathematical text can be produced by students as a response to a variety of different tasks and addressed to one or several interpreters (i.e. teachers or examiners). In this study, the term 'mathematical text' refers to the written work produced by a student in response to a mathematical problem-solving task. The definition of text is extended to include non-language elements such as images, numerals, graphs, tables and symbols. Mathematical texts are produced throughout students' school years and may be seen to serve different functions in different contexts. Morgan argues in her seminal work, *Writing Mathematically* (1998), that teachers, as well as examiners, tend to view students' mathematical texts as transparent records of students' intentions as well as their

understandings and cognitive processes. This view, she claims, is also complemented by a general assumption among teachers and mathematics educators that the act of writing and the process of interpreting and assessing students' writing are something to be taken at face value. She then demonstrates ways in which this view is problematic. Teachers' assessment practices are complex, and in order to refute the 'myth of transparency', Morgan illustrates how the teachers she interviewed interpreted the meaning of the same passages of texts produced by secondary students very differently. She argues that there is no simple correspondence between the texts and the readers' interpretations of them:

Rather, the meanings constructed will depend on the interaction between the text and the resources brought to bear on it by individual readers, varying according to the discourse with in which the text is read and the positions adopted by the a particular reader with in that discourse, as well as the reader's previous experience. (Morgan, 1998, p. 198)

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With the introduction of reformed curricula in a number of western countries (for examples see Boesen et al., 2013) paired with an international focus on large-scale testing such as PISA and TIMSS, the relative importance and rising complexity of assessment practices is ever-increasing, but under-researched and in need of further critical investigation (Crisp, 2012; Cumming & Wyatt-Smith, 2009; Klenowski, 2013). Traditionally, a large part of the research on teachers' assessment practices has adopted a measurement perspective in which teachers have been criticized for failing to meet standards of reliability, objectivity and validity (Allal, 2012). In mathematics education researchers (see for example Morgan, 2000; Morgan & Watson, 2002; Shepard, 2000) have questioned this focus and argued for an alternative perspective that accounts for the fact that assessment is a social, interpersonal and interpretive practice.

The intended contribution of this study is to add to the body of research on teachers' assessment practices in mathematics. The study presented here is set in Sweden, where a new curriculum was introduced in 2011. Teachers of mathematics in grades 3 (age 9–10) and 6 (age 12–13) are now involved in administering and grading national tests against a set of national knowledge criteria, but different schools use different practices to ensure equity, reliability and consistency in grading. For example, teachers may grade their colleagues' students' tests or jointly grade the tests of several classes (SNAE, 2013).

The aim of the present study is to examine how mathematics teachers in elementary¹ school discuss students' mathematical texts outside of the context in which those texts were created. It takes a discourse analytical approach to constructing an understanding of local communicational events associated with assessment of mathematical texts.

The research questions are:

1. What approaches to interpreting, understanding and assessing mathematical texts are visible in the discussions?
2. How are the tensions between the different functions of writing dealt with in different approaches?

1.1. Written communication and representation in mathematics

On a very basic level, writing is a form of communication that can travel in time and space away from its author (Gee, 2008). What writing cannot do, Gee argues, with reference to Plato, is stand up to questioning; it cannot defend itself and provide a reader with the answer to the question *what do you mean?* The only way a text can answer questions about its meaning is to have a reader interpret it, a reader who can read the text in whatever way she² chooses. A written piece of text, separated from its author, often has to do all its communicative work at once. An author must then reflect on the function of her text as well as the possible readings of it (Gee, 2008). In mathematics, as in any discipline, the documentation of activity may result in a text which then stands independently from the activity through which it was created. With this separation in space and time, a description of a mathematical activity is sometimes viewed as evidence of a particular process that may or may not have taken place, which opens up for a number of different readings. How does mathematics education deal with this problem? Drawing on discourse theory and other theories that foreground the social aspects of communication, it is possible to say

that knowing *what* and *how* to write a mathematical text is one definition of learning, what Wittgenstein referred to as a language game, or to becoming a member of the mathematical community (Potter, 2010; Sfard, 2008; Wenger, 1999). Consequently, learning to communicate as a *goal* of instruction cannot be cleanly separated from communication as a *means* by which students develop mathematical understandings (Lampert & Cobb, 2003). This dual nature of writing as a means and as a goal in mathematics has long engaged scholars in mathematics education and other fields. One example of this is the so-called genre wars (Pimm & Wagner, 2003; Solomon & O'Neill, 1998), in which the two sides take different positions on how to teach communication. One side advocates paying explicit attention to the form, making a point of teaching students to write in and understand different genres. The other favors ignoring form and instead focusing on authorship and creativity in the hope that successful communication eventually will become inculcated without explicit instruction. Similarly, representation has been described as having a dual nature, as the term refers to both the process of representing something and the product. A representation is something that re-presents, encodes, stands for, or embodies a meaning or idea (Goldin, 2014). Goldin differentiates between external representations, which exist outside of the producer and, as such, are accessible for others to observe, interpret and manipulate, and internal representations, which are mental or cognitive constructs. Representations in mathematics can be seen as lying somewhere along a continuum between the conventional, part of an institutional mathematical discourse, and the personal and idiosyncratic and students' texts can be viewed in this way as well (Goldin, 2014; Smith, 2003). Although mathematical representations do not have to be written, school mathematics often involves reporting mathematical work in written form, producing a mathematical text. Morgan (2001) argues that this work typically serves two very different functions. It can be seen as a part of a learning process in which writing is used to record and perhaps reflect on various mathematical ideas; hence, the text is written by and for the student herself. It can also, however, be seen as a product for the purpose of assessment written for a teacher or examiner. Unlike the work of professional mathematicians, the work in school mathematics often serves both functions at the same time (Morgan, 2001).

A number of studies have identified these two different functions, albeit with different terminology (Fried & Amit, 2003; Stylianou, 2011, 2013). Stylianou (2011, 2013) investigated the different functions that representing and representations have in expert mathematicians', as well as elementary-school students', problem-solving activities. In her framework (2011) she differentiates between representing as an individual cognitive activity and representing as a social activity. In the context of individual problem solving, Stylianou suggested that representations can function as tools in four different ways: 1) to process information, 2) to record information, 3) for exploration, and 4) to monitor and assess progress. As a social activity, Stylianou suggests two different functions for representation: conscription and presentation. Similarly, in a study on the public and/or private character of notebooks in two mathematics classrooms, Fried and Amit (2003) conclude that a notebook, although partly belonging to the private domain, was treated as a public object and as such may serve as a text to be assessed.

Many of these dualities—communications as a means to learn and as a goal, representations and representing, product and process, internal and external representations, cognitive and social functions for representations and, finally, public and personal writing—deal in one way or another with inner communication or thinking, on the one hand, and outer communication, talking, writing and acting on the other. It is important to recognize that the dichotomous perspective used here to frame the issue at hand may

¹ Grades 1 through 6 ages 7–12.

² For stylistic as well as ideological reasons the pronoun 'she' is used throughout the paper when referring to an unidentified person.

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