Chapter 7
Assessing Mathematical Writing: Comparative Judgment and Professional Learning

Ian Jones
Loughborough University, UK

Jodie Hunter
Massey University, New Zealand

ABSTRACT

The chapter discusses potential professional learning benefits for educators who engage in assessing students' mathematical writing. It draws on interview data from twelve mathematics educators who were experienced in assessing primary students' written responses to free response prompts covering a range of topics. The first stage of the interviews used a stimulated recall protocol that followed a comparative judgment procedure in which each participant was presented with pairs of students' written responses and asked to decide which was 'better'. The second stage was semi-structured with questions about how participants made their comparative judgment decisions, and whether doing so improved their understanding of students' thinking. The findings are that assessing mathematical writing can provide educators with insights into students' representations, underlying ideas and learning trajectories, and can also provide stimulus for changing classroom practice.

INTRODUCTION

It has been well documented in research literature (e.g., Carpenter et al., 1996; Jacobs et al., 2022; Krebs, 2005; Wilson et al., 2014) that there are a range of positive outcomes when educators learn about students' mathematical thinking. These include shifts in pedagogical approaches and beliefs, and the development of educators' own mathematical understanding. There have been varied professional learning approaches to providing educators with opportunities to both understand and learn from examples of students' mathematical thinking. Examples include watching video excerpts of classroom instruction, conducting task-based or clinical interviews of students, and examining students' written work (Krebs, 2005; Wilson et

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al., 2014). For example, Krebs (2005) investigated how teachers could analyze mathematical writing as a form of professional learning. Teachers examining responses from students in eighth grade in relation to a task that involved generalizing a quadratic pattern. Key findings indicated that engaging in analysis of mathematical writing offered teachers opportunities to both identify the mathematics in the task and how the student responses built on this mathematics. Further opportunities included teachers being able to 'see' aspects of student thinking and understandings that they had not predicted as well as considering the next steps in learning mathematics for the students. A study by Wilson et al. (2014) involved teachers using a learning trajectory to make sense of students' written work. Findings demonstrated how using a learning trajectory approach supports teachers to examine student work beyond correct or incorrect responses and instead understand conceptual development as a continuum.

Our focus in this chapter is to build on this work by examining the potential professional learning benefits for educators who engage with students' mathematical thinking by assessing their mathematical writing. To achieve this, we describe an alternative approach that we have adopted based on comparative judgment, which we introduce below. We frame the chapter in terms of the literature on peer assessment in mathematics education with a focus on the potential learning benefits for assessors, and extend this theoretical framing so that educators rather than peers are the assessors. We argue that this approach has potential both in relation to considering how to assess mathematical writing and through the opportunities for teacher learning and professional development afforded by the approach.

PEER ASSESSMENT

Peer assessment involves students making judgments about the quality of their peers' work (Topping, 2009). Learning benefits have been cited both for the activities of judging quality, and of receiving feedback from peers (Falchikov & Goldfinch, 2000) and it is the first of these that we are interested in here. The learning benefits of samples of others' work for the case of mathematics have been reported across topics and age ranges, from school students learning algebra (Rittle-Johnson & Star, 2007), fractions (Jones & Wheadon, 2015) and mathematical problem solving (Evans & Swan, 2014), to undergraduates learning calculus (I. Jones & Alcock, 2014) and proof (Davies et al., 2020).

Reviews of the evidence of the learning benefits peer assessment highlight the importance of using detailed assessment criteria (e.g. Orsmond et al., 1996; van den Berg et al. 2006). This might involve provided criteria that the students are expected to internalize, or it might be student-generated criteria that are then used for making judgments of peers' work. Our approach challenges this assumption that detailed assessment criteria are indispensable, and argues there are peer assessment contexts in which avoiding detailed criteria benefits learning.

COMPARATIVE JUDGMENT

The comparative judgment approach we present here is simple. It involves presenting two pieces of written work to an assessor (examples are given in Figure 1), and asking them to make a holistic decision about which piece demonstrates the 'better' understanding. This process is usually conducted with several assessors making holistic decisions about many presented pairings until every piece of work has been