Learning, Culture and Social Interaction xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Learning, Culture and Social Interaction

journal homepage: www.elsevier.com/locate/lcsi

Full length article

Language use and participation in discourse in the mathematics classroom: When students write together at an online website

Svein Olav Norenes, Sten Ludvigsen

Department of Education, Faculty of Educational Sciences, University of Oslo, Norway

ARTICLE INFO

Article history:
Received 8 July 2015
Received in revised form 9 May 2016
Accepted 18 May 2016
Available online xxxx

Keywords:
Classroom discourse
Mathematics
Collaborative writing
Online text
Verbal mediation
Dialogic processes

ABSTRACT

This article examines how students use language and participate in discourse during shared authoring of online texts in a mathematics classroom. The paper presents an intervention study conducted in an upper secondary classroom in Norway, where a wiki website was provided for the students to create mathematical explanations together. The students were organized in dyads. Considering the students' written products, work patterns, and ongoing speech and interaction between collaborating students, the use of language and participation in discourse in the classroom was genuinely altered by introducing the wiki. The wiki and the students' textbook were the main mediating resources used. A discursive space was demonstrated, where articulating and evaluating mathematical descriptions was realized through writing. When writing together, the students' articulatory processes and thinking became overt and socially shared between collaborating students. Here elaborations and deepening of arguments took place as the students' thinking and mathematical efforts became explicit. The results suggest that the wiki text authoring was experienced as a discourse having a different purpose—as opposed to what is regularly associated with teacher-led instructional schemes—and thus the discursive activities went beyond a merely transmissional discourse. Implications for mathematics teaching and learning are discussed.

1. Introduction

Stimulating learners' articulation and communication is viewed as one important approach to enhancing student participation and the development of conceptual understanding in mathematics (e.g. Brown, 1994; Pimm, 1987; Radford, 2000; Sfard, 2001; Stahl, 2006, 2009; Yackel & Cobb, 1996; Zack & Graves, 2001). Participation here is seen as a resource and a means for developing the students' conceptual understanding. In this paper, we address how information and communication technology (ICT) can be used to stimulate mathematical dialogue in the areas of probability and conditional probability. This area is used as an example of how a specific instructional design can help enhance students' capacity to engage in communication and discourse activities in a classroom setting. The mathematical activities were played out in an upper secondary classroom, and the students used a wiki website to explain and share mathematical solutions and concepts. Wikis are particularly suitable for collaborative authoring (e.g. Mader, 2006). (See Table 1.)

While mathematical discourse is recognized as a fundamental part of students' development of mathematical thinking, making students' verbal activities and language utilization an integral part of the mathematics classroom has been a long-standing educational concern (e.g. National Council of Teachers of Mathematics, 2014). It is argued that the mathematics classroom often suffers from its structures and its ways of organizing students' discourse (Bauersfeld, 1980; Pimm, 1987; Voigt, 1995; Yackel & Cobb, 1996). Moreover, studies have emphasized that students' communication in the mathematics classroom is either ineffective or does not occur at all (e.g. Dolonen & Ludvigsen, 2012; Forman, McCormick, & Donato, 1997; Ivarsson, 2002; Kluge & Dolonen, 2015; Samuelsson, 2006; Sfard & Kieran, 2001; Wyndhamn, 2002).

http://dx.doi.org/10.1016/j.lcsi.2016.05.003
2210-6561/

Table 1
Overview of the study and data.

1. Pre-study	Current teaching
- Observation, field notes (5 × 90 min-lessons)	Visiting five classes (different teachers and students) working with the same course within the same school.
2. Intervention	The wiki classroom
- Observation, field notes (6 × 90 min-lessons)	One class working with wiki tasks over six lessons.
- Wiki data log	Wiki texts and text history.
- Video recording (2 × 90 min-lessons)	Video recording of lessons 5 and 6. Camera A: overall classroom situation in focus, student and classroom organization and development. Camera B: students' work on the wiki, focusing on how they were working at the micro level.
- Focus group interview (post project)	Students' reflections and considerations about the activity, their understanding of the activity, and their learning experience.

Small-group learning (or peer learning) has proven valuable for students' mathematical development (Artz & Armour-Thomas, 1992; Cobb, 1995; Yackel, 1995; Yackel, Cobb, & Wood, 1991). It has also been emphasized that artifacts and inscriptions (analog and digital) can support students' mathematical reasoning and argumentation in dyads or groups (e.g. Cobb, 2002; Schwarz & Hershkowitz, 2001; Stahl, 2006, 2009). With the emergence of generic collaborative text and media platforms that support verbal interactions through effortless creating, sharing, and discussing of users' content (also referred to as Web 2.0 technologies, interactive cloud, or web-based tools), it becomes relevant to question whether everyday technologies can serve as auxiliary means of transforming students' discourse and engagement in domain-specific dialogues in classroom settings, and how.

In approaching this phenomenon, we need to develop a more advanced understanding of how students make connections and develop mathematical ideas when interacting with multiple representations, tools, and voices in a contemporary setting. In a recent study, White and Pea (2011) showed that students select specific properties within a designed environment in mathematics. White and Pea presented an overall argument that says, in principle, when students try to learn mathematics, they need to create connections among multiple representations. This finding is in line with mathematical studies focusing on semiotic activity, semiosis, and semiotic mediation (Vygotsky, 1978) that emphasize the relations among natural language (written and spoken), discourse, visual representation, and sign and symbol use (e.g. Lemke, 2003; O'Halloran, 2005; Radford, 2000). When students work to create linkages among representations (in the domain of algebra), the cognitive challenge is to identify the meaning potential in the representations and connect it with the students' tasks.

Building on this knowledge, this study is concerned with the overall question of how discourse and semiotic activities are realized and connected to students' learning when they share and discuss mathematical explanations and ideas on a shared wiki website. The students' situated practice and experience of participating in discourse in the classroom setting constitutes a central aspect of this issue. Our stance is that students' mathematical understanding is produced and coordinated at the intersection between social, cultural, and cognitive aspects. The cultural aspects involve specific tools for scaffolding students' learning.

Drawing on data from our case study in an upper secondary classroom in Norway, we examined how students' mathematical constructs are realized when they explained mathematical solutions to one another on a shared wiki website. In this discourse activity, the students needed to create connections among different properties (from the textbook, classroom activity, and on the wiki), which involved specific types of agency among the students. Focusing on the students' products and practices, we addressed the following questions:

1. How do the students work to solve the wiki tasks?
2. What speech and language use emerges from the students' work?
3. Are the students' language use and participation in discourse in the mathematics classroom altered by working on the wiki, and how?

To understand how learners take part in these mathematical activities, we used a perspective that made it possible to analyze higher-order thinking and development as a transformation from the interpersonal to the intrapersonal plane of thought through scaffolding processes (Cole, 1996; Vygotsky, 1978; Wertsch, 1991). Accordingly, the interpersonal plane of speech activity was understood as an entrance to the individual plane of thought. By applying this perspective, we connected the interdependencies between culture, social interaction, and cognition in the students' learning (Rasmussen & Ludvigsen, 2010).

2. Discourse and language use in the mathematics classroom

Long-standing research on mathematical discourse has emphasized that the mathematics classroom possesses distinct features and structures that significantly shape the quality of educational talk. This argument has implications for the kinds of discourse students engage in and thus, their ability to learn through discourse in the mathematics classroom. Classroom research has generally focused on the teacher-student classroom response and evaluation pattern, recognized as the Initiation-Response-Feedback (IRF) or Initiate-Response-Evaluate (IRE) (see e.g., Lemke, 1990; Mehan, 1979; Nystrand, 1997; Sinclair & Coulthard, 1975). Studies of mathematical discourse in the classroom setting extend the mechanisms related to the subject and domain of mathematics and mathematics learning.

Pimm (1987) recognized that students' participation in mathematics classroom discourse fails to have a real communicative purpose other than checking if they know what they should as a consequence of the teachers' instruction. Pimm argued that the mathematics classroom frequently suffers from its structures and its ways of organizing discourse, which suppress the

Please cite this article as: Norenes, S.O., & Ludvigsen, S., Language use and participation in discourse in the mathematics classroom: When students write together at an..., *Learning, Culture and Social Interaction* (2016), http://dx.doi.org/10.1016/j.lcsi.2016.05.003