ILLUMINATING PURPOSES OF GROUP WORK THROUGH TEACHERS' LANGUAGE IN EVERYDAY MATHEMATICS LESSONS

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Teachers have responded to NCTM's (2014) charge to enact student-centered pedagogy by having their students work together on mathematical problems in small groups. To investigate how teachers enact group work in everyday mathematics lessons, we analyzed 33 video recorded 4th-5th grade mathematics lessons using an inductive qualitative approach. Our preliminary findings report on 115 instances of group work across the lessons, revealing multiple simultaneous cognitive and social purposes of group work evident in teachers' language. We share a variety of examples from our data to illustrate the interaction between these purposes.

Keywords: Classroom Discourse, Elementary School Education, Instructional Activities and Practices

Many teachers have responded to the National Council of Teachers of Mathematics' (NCTM; 2014) charge to shift to more student-centered pedagogy by having their students work together on mathematical problems in groups (Featherstone et al., 2011). While researchers have documented productive conditions for cooperative small-group learning (Cohen, 1994), less is known about how teachers enact small group work in everyday mathematics lessons (Webb et al., 2019). Moreover, teachers' facilitation of small group work influences how students engage with each other's mathematical ideas (Yackel et al., 1991; Webb et al., 2006; Franke et al., 2015), students' dispositions toward mathematics (Jansen, 2012), as well as equitable participation (Cohen & Lotan, 2014; Featherstone et al., 2011). The goal of this study is to examine teachers' language as they initiated small group work to illustrate multiple simultaneous purposes of group work. Our research question is: What purposes of group work are conveyed by teachers' language?

Theoretical Perspectives

The perspective that learning and talking are inextricably linked underlies our work. Drawing from Vygotskian-inspired theories of learning (Sfard, 2015; Cazden, 2011), learners construct their own knowledge via language (both verbal and non-verbal) either internally or with others. Cognition (or thinking) cannot exist without communication, implying that communication is a necessary condition for thinking, and, in turn, learning. From this perspective, teaching and learning transpire through talk in the classroom (Mercer, 1995; Resnick et al., 2010; Michaels et al., 2008; Hufferd-Ackles et al., 2004). For our study, we are concerned with talk as it pertains to the immediate learning environment. Since we are interested in how talk influences classroom interactions, we operationalize teachers' language as *tools* (Michaels & O'Connor, 2015) for

structuring classroom discourse. That is, teachers' utterances surrounding group work become tools that communicate explicit and implicit purposes for group work.

Methods

Data were collected from 2014 to 2016 as part of a larger project. Participants in the study were 33 4th and 5th grade teachers in one mid-sized urban school district in the Pacific Northwest with teaching experience ranging from 1 to 30+ years (averaging 15.3 years). One full mathematics lesson from each of the 33 teachers was analyzed. The 33 lessons were sampled based on variation of Mathematical Quality of Instruction (MQI; Hill, 2014) into three categories: high, medium, and low (4,5=high, 3=mid, 1,2=low). This data was selected because it represents variation in mathematical quality of instruction across one school district. Therefore, we anticipated that teachers' language surrounding group work would vary across these lessons.

Our first analytic phase consisted of creating transcripts from the group work portions of the video recorded lessons. The criteria identifying instances of group work were: 1) students were prompted by the teacher to work in groups or with partners and/or 2) there was evidence that students talked to each other in pairs or small groups. Two coders independently viewed each lesson and identified *group work segments* (unit of analysis); 115 such group work segments were identified across the lessons. Next, we created segment memos (Creswell & Poth, 2016), then iteratively read through the data and memos to develop initial codes related to cognitive purposes (drawing on cognitive demand; Stein & Smith, 1998) and social purposes of group work that began to emerge (see Tables 1 and 2). One researcher coded all 115 segments, and a second researcher served to challenge interpretations. Any disagreements were resolved through discussion.

Table 1: Cognitive Purposes for Group Work

Cognitive Purposes	Description	Percentage
Facts/Answers	Recall facts, or share/tell, compare, check answers.	16%
Procedures	Complete procedural problems or talk about procedures without connections (Stein & Smith, 1998).	17.9%
Sense-making	Make sense of mathematical words/language, symbols, procedures with connections (Stein & Smith, 1998), contexts, representations, and relationships.	38.4%
Problem-solving	Analyze strategies, solve mathematical problems, pose problems, compare solutions or strategies.	21.4%
Justify/Generalize Math Claims	Construct mathematical arguments to justify a claim or statement; generalize a pattern or use a counterexample to disprove a claim.	6.3%

Table 2: Social Purposes for Group Work

Social Purposes	Description	Percentage
Optional	No clear purpose or prompt to talk, students can choose to work individually or with others.	11.6%
Sharing	Talk (e.g., share, tell, explain) with no additional social purpose.	43.8%
Sharing and Listening	Get help from each other, share ideas while others listen without defined roles, or read/interpret ideas without further engagement.	15.2%
Sharing and Listening +	Share and listen with defined roles or read/interpret ideas with further engagement (e.g., agree or disagree, why, think of a question).	16.1%
Comparing/Connecting	Compare or make connections between each other's ideas or other students' ideas.	4.5%
Interdependent	Co-construct ideas (e.g., come to an agreement, persuade each other).	8.9%

Preliminary Results

Our research question aimed to identify purposes for group work evident in teachers' language. The data displayed in Figure 1 illustrates the interconnection between cognitive and social purposes across the 115 coded group work instances (data points are scattered for clarity). We share examples from the data that highlight different interactions between cognitive and social purposes.

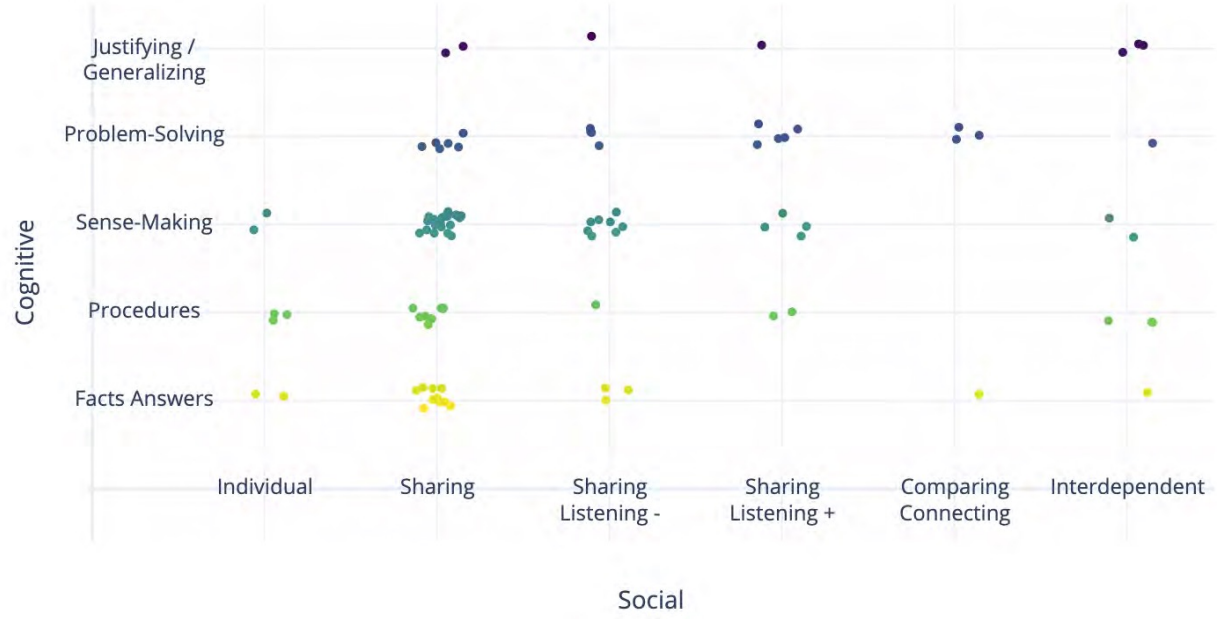

Figure 1. Interaction between Cognitive and Social Purposes of Group Work

Example 1: Sense-making and Optional Purposes

In a 4th grade lesson about modeling fraction multiplication problems with manipulatives, students sat together at table groups talking and exploring the manipulatives. The teacher

addressed the whole class, "a nice thing to do might be to see if you can put them together from the largest fractions to the smallest … and then do you know what each fraction is worth." Here the teacher's language indicated that the cognitive purpose was to order the fraction pieces while exploring the size or value of the pieces (Sense-making). However, students could have done this individually or together since there was no explicit prompt to talk to each other (Optional).

Example 2: Sense-making and Sharing Purposes

At the beginning of a lesson, a teacher asked students to first solve the problem 4 divided by 1/4, then prompted, "Why would I be dividing and then all of a sudden, it's multiplying […] why would I do that? Does that even make sense? What do you think? […] turn to your partner and talk about it." The teacher's language suggested that the purpose of group work was to "turn" and "talk about" "why" a procedure makes sense moving beyond just sharing procedures to making sense of why a procedure works (Sense-making), but without additional social structure for how to talk about it with their partners (Sharing).

Example 3: Comparing/Connecting and Problem-solving Purposes

A 4th grade teacher made two students' work publicly available for the whole class. After providing individual time to study and think about the two students' strategies, the teacher then initiated small group work: "Since some of you are on the floor and stuff with your elbow partner or in a small group of 3… talk about what you notice about the two works, about how they're similar and how they're different, go." The language here is reminiscent of the Sharing social purpose ("talk about what you notice" with a partner), however the social purpose went beyond sharing *their own* strategies (Problem-solving) to comparing *two different* student strategies with someone else (Comparing/Connecting).

Example 4: Interdependent and Sense-making Purposes

During a lesson about solving equations, a teacher wrote 5 = 3 on the board, and asked students a warm-up question to learn about what they think an equal sign means: "So what does that equal sign *mean* when you see that? I would like you to turn to your color partner and see if you can decide– agree on a different definition for an equal sign." The social purpose here was not just to share ideas, but to *agree on* a definition with their assigned partner (Interdependent), while the cognitive purpose was to come up with a definition for an equal sign – making sense of the meaning behind a common mathematical symbol (Sense-making).

Conclusion

Teachers' enactment of small group work in everyday mathematics lesson has received little attention in the literature. The contribution of our preliminary analysis revealed multiple simultaneous cognitive and social purposes of group work evident in teachers' language. We shared a variety of examples from our data to illustrate the interaction between these purposes. We argue that by making subtle purposes of small group work visible, the research community can better understand how teachers' language shapes student-student interactions and impacts students' opportunities to access and engage in mathematical discourse with their peers. This work provides further insight into the complexities of enacting group work to achieve simultaneous goals during mathematics lessons, and has the potential to inform existing teacher professional development programs focused on talk in the classroom (Michaels & O'Connor, 2015).

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References

Cazden, C. (2001). Classroom discourse: The language of teaching and learning (2nd ed.). Heinemann.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. Review of Educational Research, 64(1), 1-35.

Cohen, E. G., & Lotan, R. A. (2014). Designing groupwork: Strategies for the heterogeneous classroom (3rd edition). Teachers College Press.

Creswell, J. W., & Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches. Sage publications

Featherstone, H., Crespo, S., Jilk, L. M., Oslund, J. A., Parks, A. N., & Wood, M. B. (2011). Smarter together! Collaboration and equity in the elementary math classroom. NCTM.

Franke, M. L., Turrou, A. C., Webb, N. M., Ing, M., Wong, J., Shin, N., & Fernandez, C. (2015). Student engagement with others' mathematical ideas: The role of teacher invitation and support moves. The Elementary School Journal, 116(1), 126-148.

Hill, H. C. (2014). Mathematical Quality of Instruction (MQI): 4-point version. University of Michigan Learning Mathematics for Teaching Project.

Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). Describing levels and components of a math-talk learning community. Journal for Research in Mathematics Education, 81-116.

Jansen, A. (2012). Developing productive dispositions during small-group work in two sixth-grade mathematics classrooms: Teachers' facilitation efforts and students' self-reported benefits. Middle Grades Research Journal, 7(1), 37-56.

Mercer, N. (1995). The guided construction of knowledge: Talk amongst teachers and learners. Multilingual matters.

Michaels, S., O'Connor, C., & Resnick, L. B. (2008). Deliberative discourse idealized and realized: Accountable talk in the classroom and in civic life. Studies in philosophy and education, 27(4), 283-297.

Michaels, S., & O'Connor, C. (2015). Conceptualizing talk moves as tools: Professional development approaches for academically productive discussion. In L. B. Resnick, C. Asterhan, & S. Clarke (Eds.), Socializing intelligence through talk and dialogue (pp. 347-362). American Educational Research Association.

National Council of Teachers of Mathematics (2014). Principles to Actions: Ensuring Mathematical Success for All. Author.

Resnick, L. B., Michaels, S., & O'Connor, C. (2010). How (well structured) talk builds the mind. In D. D. Preiss, & R. J. Sternberg (Eds.) Innovations in educational psychology: Perspectives on learning, teaching and human development (pp. 163-194). Springer Publishing Company.

Sfard, A. (2015). Why all this talk about talking classrooms? Theorizing the relation between talking and learning. In L. B. Resnick, C. Asterhan, & S. Clarke (Eds.), Socializing intelligence through talk and dialogue (pp. 245-254). American Educational Research Association.

Stein, M. K., & Smith, M. (1998). Mathematical tasks as a framework for reflection: From research to practice. Mathematics teaching in the middle school, 3(4), 268-275.

Webb, N. M., Nemer, K. M., & Ing, M. (2006). Small-group reflections: Parallels between teacher discourse and student behavior in peer-directed groups. The Journal of the Learning Sciences, 15(1), 63-119.

Webb, N. M., Franke, M. L., Ing, M., Turrou, A. C., Johnson, N. C., & Zimmerman, J. (2019). Teacher practices that promote productive dialogue and learning in mathematics classrooms. *International Journal of Educational Research*, *97*, 176-186.