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STUDENTS' EXPERIENCES OF GROUP WORK REVEALED THROUGH MATHEMATICS AUTOBIOGRAPHIES

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Collaboration and collective problem solving have been promoted as essential components of the 21st century skills and can be fostered through group work. Yet we know little about how students are experiencing group work in Canadian mathematics classrooms. Our analysis of Kindergarten to Grade 9 students' mathematical autobiographies shows that most students perceived group work as a way of offering and/or receiving help for individualized tasks but not necessarily as an opportunity for creative collaboration. Based on our analysis, we discuss the pedagogical implications for designing classrooms that can foster meaningful collaboration.

Keywords: Learning, mathematics, groups, experience, collaboration

PERSPECTIVES ON STUDYING STUDENTS' EXPERIENCES OF GROUP WORK

In mathematics classrooms, group work has been used to promote a wide range of mathematics learning. Collaboration, problem solving, and learning how to learn—essential components of the 21st century skills needed for navigating a rapidly changing society—can be developed through group work (Darling-Hammond et al., 2008; Trilling & Fadel, 2009). Moreover, beyond individual-level thinking and understanding, group work can foster collective mathematical thinking (Towers & Martin, 2014). Friesen (2009) promotes strong student relationships in the

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classroom as a basis for facilitating learning, and group work or pair work structures are frequently used in Canadian mathematics classrooms. Yet we still know little about students' perspectives on their experiences of group work in these settings. In this paper, we examine students' experiences of collaboration for mathematics, with the aim of strengthening the design of mathematics classroom practices in Canadian schools.

Both cognitive and social aspects of learning through group work have been researched by the mathematics education community (e.g., Barron, 2003; Esmonde, 2009; Ryve, Nilsson, & Pettersson, 2013; Takeuchi, 2016; Yackel, Cobb, & Wood, 1991). Research on complex instruction, which utilizes 'group-worthy' tasks and group accountability systems, has proven to promote both collaboration among students and high mathematics achievement (Boaler, 2006). During group work, students simultaneously engage in "a content space (consisting of the problem to be solved) and a relational space (consisting of the interactional challenges and opportunities)" (Barron, 2003, p. 310). It is thus important to examine students' experiences of group work holistically and with reference to both cognitive and social aspects of learning mathematics.

Towers (see, e.g., Martin & Towers, 2015; Towers & Martin, 2014) has studied extensively the ways in which collective mathematical understanding grows when groups collaborate in particular ways and we bring this theoretical positioning to our present study. We were, therefore, predisposed to think positively about the way that certain forms of collaboration can occasion learning and were surprised by some of what we heard from students in this study about their experiences of group work. We say more about this in our findings and discussion sections.

METHODS

The study from which the findings presented here are derived explores students' experiences of learning mathematics in Canadian schools and post-secondary institutions. Here, we focus on students' group work experiences revealed through students' mathematics autobiographies—autobiographical accounts of learning mathematics in schools and at home. The data we present here were gathered in the province of Alberta, Canada. The study's participants are Kindergarten to Grade 12 students, post-secondary students, and members of the general public, but we focus here on data collected in the first phase of the study, which includes students from Kindergarten to Grade 9. Forms of data include semi-structured interviews, drawings (that represent participants' ideas about what mathematics is, as well as their feelings when doing mathematics), and written and oral mathematics autobiographies. To date, 94 interviews with Kindergarten to Grade 9 students (41 girls and 53 boys) have been conducted.

All of the interviews were transcribed verbatim. We coded the transcripts, using *Nvivo*, by focusing on students' preferences regarding, and descriptions of, group work and/or pair work in mathematics classrooms. In order to reveal students' images of mathematics learning, in relation to their experiences of group work, we also looked at students' drawings to examine how students represented mathematics learning in the school.

FINDINGS

Students reported that their teachers often used group work or pair work but the ways in which, and the extent to which, group work was used varied. Tasks that were used for group work also varied. In some classes, students worked as a group for projects. In other classes, students

engaged in a worksheet assigned by the teacher, through group work or pair work. However, there was no mention of tasks that were specifically tailored towards group work.

While group work and pair work were used regularly in our respondents' mathematics classrooms, students' autobiographical interviews and drawings did not communicate an image of collaboration and working with others for mathematics learning. In students' drawings, most of the students represented isolated and individualistic images of classroom mathematics learning. One of the main themes of student drawings was a student sitting at a desk working alone (see Figure 1 for a representative drawing from our dataset). The student who drew this particular picture described it as follows:

> So there's my desk. And if there is a whole bunch of noise around me I get people yelling out answers and yelling stuff then I get scrambled. I had one number in mind when it is quiet and then I get a whole bunch of numbers thrown everywhere. (Grade 5 student, boy)

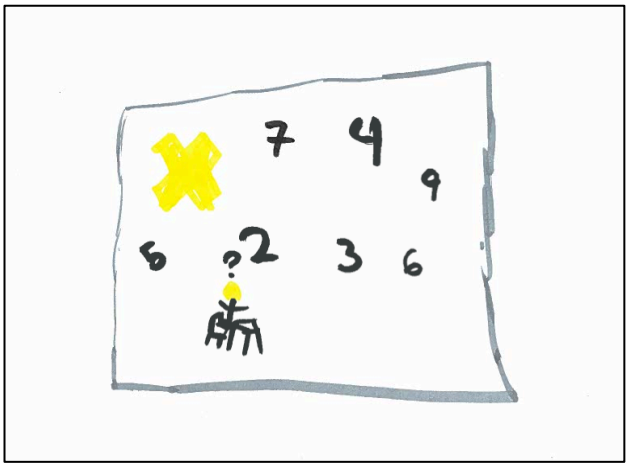

Figure 1: Student drawing depicting an isolated self sitting at a desk

The drawing and the description provide an image of a classroom where other students' utterances are considered as noise and distraction. This student felt he was "scrambled" with noise and yelling in the classroom, and he preferred working alone, quietly, on a mathematics

problem. It is noteworthy that this student drew a picture of himself surrounded by numbers and the multiplication symbol. In describing what he is currently learning in his mathematics classroom, he answered: “Well, we’re just um, going to do a multiplication test.” As such, students’ images of collaboration in mathematics classroom are not independent from the tasks and activities on which they are working. The pressure to perform well on the test possibly affected his image of others as a distraction.

Our data reveal that most of the students perceived group work as a way of offering and/or receiving help for individualized tasks (e.g., worksheets) but not necessarily as an opportunity for creative collaboration. For example, the following quote represents how students viewed group work mostly as a way of receiving help: “There are other people to help you with math equations that are normally a lot better.”

While 29.4 % of the students preferred group work and/or pair work to individual work, the number of students who recognized the benefits of working collectively with others other than offering/receiving help was rather small (8.5%) and in fact many students did not recognize the benefit of working with others despite often being asked to work in groups. Some students lamented that working alone would be more effective because they would not have to be challenged. Here is one such example: “I prefer working alone just because I feel as though I don’t question as much. If I’m working with someone else and we get separate answers, then it just creates [a] big dilemma.” Similarly, many students perceived others’ utterances as distracting and noisy. The following quotes represent this kind of student disposition towards group work and help to explain why students preferred to work alone:

> "Because then I get more concentration. Because when I'm working with a friend they're talking and I'm trying to work and I say 'Please will you be quiet?' and they keep talking." (Grade 1)

> "Because you have your own space and people can't copy you." (Grade 2)

> "Because, then you don't have people distracting you really." (Grade 5)

> "Because it is more easier because in groups people tend to yell and take control." (Grade 8)

While there were students who enjoyed group work and working with others, their images of group work tended to be focused on the process of receiving and offering help, rather than the process of creative knowledge building.

TOWARDS THE DESIGN OF MATHEMATICS PEDAGOGY FOR COLLABORATION

Our findings are important for designing group work pedagogy in mathematics classrooms that can foster creative collaboration. Sawyer (2007) explained that creative collaboration among group members can be facilitated when the task is new and unfamiliar to all members and collective visualization and abstraction are encouraged. In other words, students should feel the *need* for collaboration in order for group work to have a purpose. Group-worthy tasks such as those proposed by Cohen and Lotan (2014) promote such creative collaboration by making tasks open-ended and requiring complex problem solving and multiple intellectual abilities. Our findings are a reminder of the necessity to design group-worthy mathematics tasks that embrace students' questions and dilemmas as a resource for meaningful mathematical learning. We see it as important, too, that mathematics teachers discuss with students the purpose of being in a group to learn mathematics so that everyone understands how group work can be an aid to learning and what to do if the group is not functioning well. Nevertheless, we do not want to presume that group work is necessarily and always effective and we take seriously the finding that many

students in our study expressed concern about classroom noise generated during group work. This finding suggests that more work may need to be done in mathematics teaching to invite children to talk about their experiences of group work and to work with them to ensure that their experiences in groups are worthwhile ones.

Another significant pedagogical device that can meaningfully facilitate collaboration is a common artefact that makes diverse ways of thinking visible. For example, Towers, Martin, and Heater (2013) described a Canadian mathematics classroom that was highly effective in facilitating collective thinking. In that classroom, while students were actively talking, their verbalizations were not considered as "noise" by other students. One of the key structures of the physical environment in that space was the actively-used whiteboard space. All students used the whiteboard space as a place to record their working and as a source of ideas. Students in the class used others' work written on the whiteboard as a clue for further developing their ongoing work and also as shared intellectual property. In that classroom, "the collective [was] valued as a means through which mathematical errors [were] caught and modified, ideas [were] questioned and exposed to challenge and verification, and mathematical conventions [were] agreed upon and then reinforced" (Towers, Martin, & Heater, 2013, p. 429). Liljedahl (in press) offers a similar argument for the use of vertical, shared whiteboards as spaces of joint learning.

Our analysis of mathematics autobiographies in our present study showed limited genuine collaboration among students, despite the frequent use of group work and pair work in Canadian classrooms. Elsewhere, drawing on other aspects of the data collected for this study, we have shown how students are developing, through their engagement in the culture of school mathematics, a narrow vision of the nature of mathematics, one that does not include the full territory of mathematical ideas and topics (Towers, Takeuchi, Hall, & Martin, 2015). Our current

findings, along with previous research findings, suggest the importance of careful design of tasks and classroom configurations that can foster meaningful collaboration and positive dispositions towards collective thinking among students.

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