Promoting Student-to-Student Discourse in Small Groups: Findings of a Practitioner Action Research Project

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"Effective discourse happens when students articulate their own ideas and seriously consider their peers' mathematical perspectives as a way to construct mathematical understandings" (NCTM, 2010). Establishing a classroom community in which discourse is an integral part of teaching and learning can be challenging, especially if students are more accustomed to being passive listeners rather than active participants in the mathematics classroom. As a classroom teacher, I found myself in this situation. Although I incorporated both small-group and whole-class discussions into my lessons, I was particularly interested in promoting discourse between students while they were working in small groups: How should I help students when they are working in groups? Do my interactions promote or hinder student-to-student communication? How do I encourage students to listen to and evaluate each others' explanations?

I set out to explore these questions by studying my own practice; that is, I utilized practitioner action research (Anderson, Herr & Nihlen, 2007) with one of my geometry classes, which had 16 students (15 to 16 years old) in four groups of four students. To understand how my students were initially communicating, what teacher responses supported or obstructed student-to-student discourse, and whether the students' communication improved over time, I needed data. Therefore, I audio-recorded the students while they were working in groups as well as when I was helping the groups. The recordings for one of the groups (pseudonyms: Laura, Kevin, Ellen and Beth) were transcribed. I also wrote notes after each class detailing my interactions with the students and solicited students' perceptions by asking them to complete several questionnaires which focused on how they communicated with their group members and my interactions with the group (Quebec Fuentes, 2011). With the data, I was able to make informed decisions about how I could best help my students with the goal of improving their discourse.

In what follows, I share my discoveries about the initial challenges students had in communicating with each other, the type of help that promoted student-to-student discourse, the interactions that worked best in different situations, and the ways in which the students' communication improved over time.

Initial Discoveries

By reading the transcripts, I was able to assess the students' discourse as well as the effects of my interactions with the students on their communication. In particular, I learned that my students had trouble listening to each other, evaluating what they heard, and providing feedback. Interestingly, the students frequently asked their group members to appraise their work by asking questions such as "Right?", "Does that make sense to you?", or "Do you see what I am saying?" However, the students' responses to these questions indicated their inability to critically evaluate a statement as demonstrated by agreeing to incorrect or incomplete statements. For example, the following excerpt occurred when the students were finding the converse of the inverse of a conditional statement.

Laura	*The converse, so that's like them flipped around, of the inverse, so it's negative, because the not, and then them flipped around so then it's … yes. Alright, I got it, I think. …does that make sense?*
Beth	*That makes sense.*
Kevin	*Yeah, that makes sense.*

Beth and Kevin both indicated that they followed Laura's reasoning even though it was neither clear nor complete. Along the same lines, students also had difficulty assessing their own work and comparing it to the work of others.

With respect to my interactions, I discovered that the type of questions that I asked had an influence on the subsequent interactions between me and the student(s). Refer to Table 1 for dialogues that occurred between me and my students. There are several key differences between the two example interactions. In Dialogue A, I am talking with only one student in the group and there is a teacher-student-teacher-student communication pattern. On the other hand, in Dialogue B, my questions initiated responses and interactions between several students resulting in a teacher-student-student-student communication pattern with all four students participating in the conversion.

Table 1 Two examples of teacher and student communication patterns

Dialogue A		Dialogue B	
Teacher	*And what's the, they, in that sentence?*	Teacher	*What are you guys working on?*
Laura	*The parallel lines. No, no, no. The angles.*	Beth	*Yeah, they equal 180.*
Teacher	*What type of angles?*	Laura	*We were working on this one, and then we got... we... so we said that these are supplementary, so we had that, and then we did this, and then we tried to do this, and it just wasn't...*
Laura	*The corresponding angles.*		
Teacher	*Okay. So, even though we just have, they, there, what is, really is our conclusion?*	Kevin	*… squared.*
Laura	*The corresponding angles will all have the same measurement.*	Beth	*We tried to factor.*
Teacher	*Okay. So, if that's really your conclusion, then how could we, what would we say for our converse?*	Laura	*So, now we tried to factor it, and that's as far as we got before we just gave up.*
Laura	*If the corresponding angles had the same measurement.*	Teacher	*[With some prompting from the teacher, the students continue to explain what they have done.] Okay, now, I want to just go to one thing that Kevin said here, because Ellen said $8x$ plus x^2 is x^3, is that what you said? Is that true?*
Teacher	*Okay.*	Kevin	*This is the x.*
		Ellen	*I thought you couldn't combine them. No, no, because that's why you factored.*
		Beth	*I thought you could only combine like, x^2 with x^2 and like*
		Ellen	*Yeah.*
		Teacher	*Did you hear what they said?*
		Kevin	*Yeah, you can only combine them.*
		Beth	*Like, you can't combine x^2 for instance, with an $8x$, they...*
		Kevin	*Oh, okay.*

The aforementioned differences resulted from the types of questions that I asked. In Dialogue A, I asked closed questions about the content (e.g., What type of angles?); whereas in Dialogue B I asked open questions that required the students to explain (e.g., What are you guys working on?), evaluate (e.g., Is that true?), and listen to each other (e.g., Did you hear what they said?). Dekker and Elshout-Mohr (2004) categorize these two types of questions as *product help*, inquiries about the mathematical content, and *process help*, interactions that promote communication between the students. When I was present with a group, I wanted more student-student interactions rather than teacher-student interactions. When I was not present with a group, I wanted the students to listen to and critically evaluate each others' ideas, behaviors promoted and modeled by process help. Therefore, my goal was to find different ways to provide process help and advance student discourse.

Scenarios within Group Interactions

I found that there was not one best way to interact with my students. How I helped the students depended on factors such as particular group dynamics or the nature of a task. Through the data analysis I discovered ten different scenarios which describe issues with group communication, organized into three different categories: helping students communicate, improving student communication, and changing the socio-cultural norms of the classroom. For each scenario, I used the action research cycle (planning, acting, observing, and reflecting) (Anderson et al., 2007) to test and refine my interventions. Specifically, I was attempting and then reworking interventions so that they initiated student-to-student communication as exemplified in Dialogue B (Table 1). Tables 2, 3, and 4 outline the scenarios, corresponding interventions, and specific examples of the revised teacher interventions which came from the transcriptions of my interactions with the groups. The following sections briefly describe each of the scenarios and summarize the intention of the interventions.

Helping Students Communicate

The first goal is to help the students talk with each other. There are four scenarios that fall under the communicate category, as outlined in Table 2.

Table 2 *Scenarios, corresponding interventions, and examples for the Communicate category*

Scenario	Intervention	Example Teacher Responses
CANNOT WORK WITHOUT TEACHER OR DOMINANT STUDENT	What are your questions?	Can you ask me a specific question?
	Redirect questions to group	Teacher restates student question directed at teacher to the rest of the group.
	Direct explanations to group members	Explain that to your group members.
	Refer to other resources	Where can you find the answer to your question?
HELP/LEAVE/SILENCE	Leave group with a task	Each write down your explanation and then compare it with those of your group mates.
	Follow-up on progress	Did you compare your explanations? What are the similarities and differences?
OWN ZONES	Redirect questions	Could you answer her question?
	Individual work and then compare strategies	Explain your strategies to each other and then compare them.
NON-PARTICIPATORY STUDENT	Explain what has been done	Can you explain what they were just discussing?
	Another student explain	Can you explain your strategy to him?
	Restate in own words	To person being helped: Now what are you going to do to figure out …?
	Answer another student's question	Could you help her with her question?

The first scenario represents the situation where students cannot work without the presence of the teacher or a student that dominates the interaction. If the teacher or dominant student is not present, the students either sit silently not partaking in the task or participate in off-topic conversation. The second scenario, *Help/Leave/Silence*, happens when the teacher works with a group to assist in their communication about a particular task. When the teacher departs, the students either discontinue the interaction or engage in off-task discussion. When the students are in their *Own Zones*, they are all individually working on the mathematics; however, there is no interaction between them. The final scenario, the *Non-Participatory Student*, refers to a student who is not verbally engaging in the conversation with the other group members. The communicate category, therefore, contains a range of scenarios from all or some of the students not partaking in the mathematics and not communicating to all or some of the students engaging in the activity but still not communicating.

To initiate and promote student communication, teachers need to first determine the scenario that is occurring; that is, they need to figure out why all or some of the students are not participating in a discussion. With an appropriate teacher intervention, the students are then encouraged to identify and state their questions, ask those questions to their group members, share their approaches, and contrast their different strategies.

Improving Student Communication

Once the students are communicating with each other about the tasks, the next goal is to enhance the quality of those interactions. Three scenarios arose in reference to improving student communication (Table 3). The first, *Need for Appropriate First Question*, is in reference to a teacher's initial intervention when a group requests help. The challenge is to give the group appropriate help based on work they completed when the teacher was not present. In addition, the teacher needs to help the students realize their mistake(s) instead of identifying the error(s) for them. The second scenario describes a situation when a student does explain his or her strategy in an attempt to help one or more group members. However, the students do not comprehend the explanation. The final scenario, *Dominant Student*, takes place when one student directs the discussion often ignoring the input of other group members.

Table 3 *Scenarios, corresponding interventions, and example for the Quality of Communication category*

Scenario	Intervention	Example Teacher Responses
NEED APPROPRIATE FIRST QUESTION	Explain what has been done so far	What did you do to figure out …?
	Errors as opportunity for inquiry	Without directly identifying error, the teacher models the process of evaluating work.
		Do you agree with what he did? Why not? What is the difference between your strategies?
STUDENT UNSUCCESSFULLY TRIES TO HELP ANOTHER STUDENT	Restate in own words Agree with restatement	Can you explain what she is saying/doing?
		Do you agree with how he described your strategy/reasoning? Why or why not?
DOMINANT STUDENT	Restate in own words	Can you explain what they just said?
	Highlight overlooked idea of another student	How did you (ignored student) solve the problem?

When any of these scenarios transpire, the focus of the teacher interventions is to improve the quality of the communication between *all* of the group members. First, students need to understand that discussions about challenges encountered or errors are an integral part of the learning process. These discussions involve appreciating the contributions of all group members by sharing ideas and listening to those of others and making certain everyone understands each other's ideas.

Changing the Socio-Cultural Norms of the Classroom

The final category concerns redefining the students' and teacher's role in learning mathematics. For instance, in response to a question about how my class differed from previous mathematics classes, one of my students wrote: "This class was different because we spent a lot more time working together to figure things out instead of being given the answer." Three scenarios arose in this category (Table 4). When the students *Rush to Complete a Task* they either stop work on a problem when they get stuck or when they arrive at *any* answer. They are not concerned with the strategy used or the feasibility of the result. When the students see the *Teacher as the Only Resource*, they direct their questions to the teacher rather than their group members. Finally, in a situation when a student listens to and agrees with a faulty explanation, that student *Blindly Accepts the Work of Others*.

Table 4 *Scenarios, corresponding interventions, and example for the Socio-Cultural Norms category*

Scenario	Intervention	Example Teacher Responses
RUSH TO COMPLETE TASK	Compare strategies	Compare your answers/strategies.
	Evaluate work of others	Can you determine which answers/strategies are correct and which are incorrect?
TEACHER AS ONLY RESOURCE	Redirect questions to group	A student asks the teacher a question. The teacher restates the question to the group.
	Ask student to redirect question to group	Can you ask your question to them (other group members)?
	Explain work to others	Explain to the group what you did and maybe they can come up with a suggestion.
	Ask others to evaluate work	Do you agree with what he said? Why or why not?
BLINDLY ACCEPT WORK OF OTHERS	Restate in own words	Can you explain it now in your own words?
	Evaluate student's ideas	Does that explanation make sense? Why?

The scenarios in this category reflect the students' perception of learning mathematics. Through the teacher interventions, the students evolve from passive recipients of information dependent solely on the teacher to active participants who share, compare, listen to, and evaluate strategies. The conversations are about the process and solution which can both be appraised based on the soundness of the mathematics rather than the approval of the teacher.

Evidence of Improvement in Student Communication

As demonstrated in the opening excerpt, my students initially had difficulty listening to and evaluating the explanation of another student. The study was conducted over three months, and starting in the second month the transcriptions of group interactions revealed that student discourse in these areas started to improve, as demonstrated in the following two examples. In the first, the students were writing arguments using congruent triangles.

Ellen *Is it the midpoint of A and C, though, isn't it?*

Laura *No. Because, look, these two have different measurements. It's not the midpoint. These two are the same, these two are the same but these two aren't the same. So, it's not the midpoint.*

In the second example, the students were composing a conjecture about the relationship between the lengths of the sides of a triangle.

Laura … *Okay. So conjecture, so that one just write that the sum of …*

Kevin *two sides … must be greater than the sum if the third side, right?*

Laura *Is it possible … alright, so on one and then, so it's greater in between. Three and 8, greater than 7. And then, 7, 8 and greater than 3, so yes.*

Kevin *Because if you were to add on, up any other two sides, no matter in like order, it would also be greater than the third side, right?*

Laura *Yeah.*

The two situations differ in that the initial statement was incorrect in the first instance and correct in the second. However, in both circumstances, the responding student evaluated the assertion and, instead of simply agreeing or disagreeing, justified her reasoning, actions supported through the teacher interventions outlined in the tables.

Concluding Remarks

Utilizing small groups does not guarantee that there will be student-to-student discussions about the mathematics. The teacher needs to assist students in learning how to effectively communicate with each other. However, the ways in which a teacher interacts with a group may help or hinder student-to-student conversations. Effective interventions are needed to help the students improve their communication and reasoning skills and, in turn, develop a stronger understanding of the content. The interventions and example teacher responses described in this article were found to promote and improve communication between students, in addition to speaking to what is valued in learning mathematics. More specifically, the interventions encourage behaviors such as directing questions to group mates, sharing ideas, listening to others, and critically evaluating the work of others. In conclusion, the findings of this practitioner action research enable teachers to recognize the patterns that exist in groups' interactions in their classroom, and, based on that assessment, choose effective intervention(s) that promote student-to-student discourse.

References

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