Strength in Numbers: Collaborative Learning in Secondary Mathematics

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Fostering Positive Interdependence through Activities and Assessments

Group work involves more than students sitting around a table working on the same task. To reap the academic benefits of collaborative learning, students need to work together in ways that deepen everybody's understanding. For this reason, fostering *positive interdependence* is a primary goal for successful group work.

> ***Positive interdependence arises when students feel mutual accountability for their learning and believe that their own learning will benefit through their interactions with each other.***

In earlier chapters, some of the strategies and concepts developed serve this purpose. In chapter 1, I talked about creating and maintaining *classroom norms* that support, among other things, students' sharing and use of each other's ideas. In chapter 2, I developed four principles for equitable teaching that guide teachers' understanding of the students in their classroom. In chapter 3, I built off these principles to challenge commonplace ideas about *smartness* and described how teachers can cultivate *equal-status interactions* in their classrooms by using *multiple-ability treatments* and *status interventions*. Students want to know what others think only if they believe that information will be useful. Traditional notions of smartness and common perceptions of status make it seem as if only certain people's thinking is worth engaging. In chapter 4, I discussed the kinds of activities that might be *groupworthy*—mathematics tasks that, among other things, create an authentic reason for students to solicit each other's thinking. Together, all these ideas and tools help teachers build learning environments that foster positive interdependence among students.

If interdependence is a value, teachers need to consistently communicate its worth through classroom norms, routines, and—most consequentially—assessments. In this chapter, I discuss aligning norms, routines, and assessments to the framework of equitable mathematics teaching in ways that support effective collaborative learning.

Norms and Routines

Norms to Support Positive Interdependence

As discussed in chapter 3, norms are a part of every classroom. Recall that classroom norms are agreed-upon ways of behaving. Here, I present some norms that apply specifically to collaborative learning and support positive interdependence (adapted from Cohen [1994]):

Stay focused on your group's work. No talking outside your group.
Students need to work only with the students in their assigned group. If students are not accustomed to working with any student in the class, they might try to communicate with friends in other groups or seek out answers from the "smart kids." Status plays into the desire to go outside the group, indicating that students do not believe that their group has the wherewithal to successfully do an activity together. By requiring students to work with the people at their table, teachers insist that every group has the capacity to make progress on the problem.

You have the right to ask anybody in your group for help.
Make explicit to students that they can ask anyone in their group for help. With this norm in place—and, ideally, visibly posted in the room—students who need help can appeal to the class rules if they are stuck. The next norm complements this one.

You have the duty to give help to anybody who asks.
Many students have learned that getting work done quickly is an effective way to do school. They are often reluctant to slow down and help a peer. They may feel that giving help interferes with their own learning, but on the contrary it often enhances it by presenting them an opportunity to make sense of their own thinking. In well-functioning collaborative classrooms, I hear teachers reminding students, "Use your group!"

Helping is not the same thing as telling.
Students often need guidance on what helping means. They must understand that they are teaching each other, not simply exchanging answers, which is a more common form of collaboration in school (see chapter 3's limited-exchange model). Two behavioral rules that might help support this particular norm are (1) "you can write only on your own paper" and (2) "you can let people see your paper, but you cannot hand it over to somebody else."

During whole-class discussions, teachers model asking questions to make sense of another student's mathematical thinking and communicate to students that their small groups should imitate this behavior (for more on the relationship between small-group norms and whole-class discussion, see chapter 6). As discussed in chapter 1, having conversations with students about acceptable behavior is one way of working toward certain norms. If classroom routines and activities contradict these conversations, students will usually gravitate toward familiar behaviors. I will discuss the potential contradictions between spoken and enacted norms in the next section.

Analyzing Activities

Norms are often more powerfully enacted than stated, so classroom activities require careful scrutiny for their contribution to messages about acceptable behavior. Simply stating norms is usually not sufficient for making them a reality in your classroom learning environment. Aligning routines and activities to be consonant with norms for productive collaborative learning poses a deep and ongoing challenge for teachers. Many activities are so commonplace, we often do not realize the messages that they send to students about norms, smartness, status, and mathematics itself. Teachers who are figuring out how to implement effective group work in their math classrooms are often surprised at how much they need to question the purpose, meaning, and messages of the most basic activities of classroom teaching and learning.

For example, a teacher may be working toward a classroom norm that *thinking carefully about a problem is valuable*. An activity that involves a speed calculation competition may work against this norm because it sends a strong (and familiar) message that quick computation is the primary way of being smart in mathematics. In fact, any competition runs the risk of reestablishing existing status hierarchies. (Some children, of course, enjoy competition. You can frame competitions to highlight their place and keep them from defining students' mathematical ability. For example, competitions on Pi Day [March 14] in which students see who can recite the most digits of π can be fun if they are communicated as one of many ways of being smart.)

Even if the teacher does not have official classroom competitions, students whose sense of smartness comes from their mathematical quickness might create a competitive environment through their actions. For instance, they might turn tests into races by loudly turning over their papers to signal to others that they have finished first. Such contests run counter to the equitable teaching principle that *all students can learn mathematics more deeply,* because this kind of activity may limit some students' opportunities to think carefully about what they are learning.

Students try to reconcile spoken messages about valuing different kinds of mathematical contributions with the experiences of competitive activities, regardless of whether the activities are official. Because children usually arrive in math class believing that speed competitions are not simply one but the *only* gauge of smartness, the hidden message of the activity often trumps the teacher's statement of what is valued. Teachers can explicitly praise when students take the time to be thoughtful and can request that students not make displays of their quick completion.

Consider another example of the need to closely align classroom activities with classroom norms. One teacher routinely gave unit test review packets that were similar to the actual test. Students would work together on them, but the focus of student conversations was on completion and learning the steps for doing each type of problem. The teacher realized that her students were not engaging deeply in the mathematics—her intended goal—as they worked through the review packets. The length of the packets pushed students to work through problems quickly and without seeking justification. They certainly were not distinguishing much between *helping* and *telling*, as she wanted them to do during collaborative work time; a limited-exchange model (chapter 3) was, in fact, the most efficient way to complete these assignments. The structure of making review packets similar to the tests encouraged students' strategy of memorizing for the assessment and forgetting soon afterward. In fact, for a student, this approach would be, in many ways, an optimal way to use the review packets. Thus, the activity worked against some of the sense-making and collaborative learning norms the teacher had sought to establish.

Mathematics activities may also depart from teachers' goals when they depend more heavily on nonmathematical skills such as reading comprehension or time management. Nonmathematical skills can overtake activities such as lengthy and complex word problems or long-term projects. This is not to say that teachers should never give tasks that demand such nonmathematical skills. In fact, for students to be prepared to use their mathematical skills in higher education or the workplace, requiring that secondary students do demanding and integrative tasks seems sensible. Nonetheless, teachers should recognize the nonmathematical aspects of activities and support students in ways that keep the content in the foreground. By attending to these parts of the task, teachers can minimize opportunity gaps that limit students' access to the mathematics.

For a general strategy, teachers can ask themselves the following questions to ensure that activities work in conjunction with equitable collaborative learning:

- What is the purpose of this activity?
- How does it align with my goals for the class?
- What kinds of mathematical smartness does this activity value?
- Do students have the skills and resources to engage in mathematics through this activity?
- Do other kinds of skills overshadow the mathematics?
- How does this activity align with the norms I have set up in my class?
- When students complete this activity, are my learning goals for them being met?

Teachers can use these questions to think through their classroom activities that may, like the unit test review packets, carry unwanted messages about mathematical learning.

Using Group Roles to Support Collaborative Norms

Two marks of productive group discussions are a creative interchange of ideas and well-distributed participation. These are signs of positive interdependence. Students must be taught ways of interacting that support this ideal. The norms discussed in the previous section help lead students in this direction.

Recall a central dilemma of group work: groups need autonomy for sense making, whereas teachers need assurance that important content is the focal point of discussion. Teachers resolve this dilemma by finding ways to delegate their authority by means of classroom structures. *Roles* are one such structure. Roles may be awkward for teachers initially. They often remark that telling students what to do in an activity feels artificial. This approach works best if, instead of thinking of roles as an impediment to spontaneous conversation, teachers conceptualize them as a tool for teaching students about desired forms of exchange and a means for ensuring distributed participation.

Although many different types of roles are possible, I offer here the four that I have seen work well in mathematics classrooms. When crafting roles for students, make sure that the roles are what Elizabeth Cohen referred to as *how* roles, not *what* roles. That is, the roles should relate to how the work is done (e.g., facilitator), not the parts of the tasks themselves (e.g., grapher).

The four roles are the following (source: Phil Tucher, Ruth Tsu, Barbara Shreve, and Carlos Cabana):

1. Facilitator

- Gets the team off to a quick start
- Makes sure everybody understands the task
- Organizes the team so they can complete the task

2. Resource monitor

- Collects supplies for the team
- Calls the teacher over for a question
- Cares for and returns supplies
- Organizes cleanup

3. Recorder/reporter

- Gives updates on the team's progress
- Makes sure each member of the team records work or data
- Organizes and introduces a group report

4. Team captain

- Encourages participation
- Enforces the use of norms
- Finds compromises
- Substitutes for roles if anybody is absent

Roles delegate teacher authority by distributing participation, giving each student something to do in the activity. In typical classrooms governed by the IRE talk format (initiation–response–evaluation; see chapter 1), teachers control the flow and content of conversation by taking ⅔ of the turns. In a collaborative learning environment, students manage important instructional conversations. Because group work is a large investment of class time, teachers need a say in the conduct

of these conversations. Teachers do not abandon their authority; rather, it is decentralized and put toward fostering students' interdependence and autonomy.

When assigning roles, teachers should make them public so that everybody recognizes students' authority within their roles. The chart in figure 3.1 is a good way to publicly display group roles. Other teachers tape playing cards on the four corners of each group's shared table. For instance, one group might be "the jacks" and have the jack of hearts, spades, clubs, and diamonds on their desks. Each suit can represent one of four roles (e.g., the jack and 10 of hearts are the resource managers in their respective groups). This system makes apparent to everybody around the table which role each student is meant to play.

In addition to making roles public, teachers need to specify the expectations of people in each role, both in general and, on occasion, within a particular activity. The general expectations can be posted in the classroom, with the preceding text of the role descriptions. For a given activity, the specific role expectation can be written on a task card. (See chapter 4 for more on the design of task cards.)

Teachers are often inclined to assign leadership roles to students who are viewed as natural leaders. From a classroom management perspective, this approach is sensible, because it takes advantage of existing resources in the classroom. From a perspective of status, however, this approach is problematic because it reinforces existing hierarchies and does not give other students opportunities to develop leadership skills and contribute to collective thinking. With an eye toward equitable learning, teachers should give every child a chance to try all the roles. Doing so affords opportunities for students to increase their participation and learning while also raising their status, particularly if teachers are careful to ensure that the students assigned a role are also the ones to carry it out. A common status problem is for a higher-status student to take over a higher-status role.

Just as norms cannot be implemented by teachers' decree, roles also take some time and consistency to become effective. Students need to be taught to use roles well. In addition to clarifying expectations for the roles, teachers should supply explicit criteria for good group discussions. Not surprisingly, these line up with the norms for effective collaborative learning. As discussed earlier, three important norms are as follows:

1. Everyone gets a turn.
2. Give reasons for ideas.
3. Listen to different ideas.

We now add to that list a new norm. A key to fostering positive interdependence is giving each student something meaningful to do during collaborative work time: *Remember to play your role*. As teachers circulate around the classroom during collaborative learning time, they can remind students of these expectations.

Classroom Routines

Routines help the functioning of a classroom by giving students a predictable template for activities. Effective routines contribute to the functioning of the classroom by offering an efficient way to get things done. Students know the how, when, and where of things without having to ask. Routines also communicate norms and should be scrutinized for the messages that they communicate.

Most teachers have routines for turning in homework or taking tests. Students come to know the script for these activities and eventually can proceed with little need for explanation. Teachers can also create *interactional routines*—that is, routines that support positive interdependence among students. In chapter 4, I described the *group question* routine, in which teachers accept a question from the group only if the students have ensured that they have asked each other first. In addition to the described routine, note that only the *resource monitor* may ask the teacher to come over in the first place. This routine takes deliberate effort for both teachers and students to establish, because teachers tend to be inclined to answer any question posed to them. The payoff

in fostering interdependence among students makes it a worthwhile endeavor, however, and that is one of the first routines teachers should invest themselves in.

Another important routine is called *quick start*. In this routine, students are expected to get themselves ready to work at the start of class. Their backpacks and materials should be in the expected place, out of the way. They should be at their desks or tables. The teacher should have an established way for class to begin, and students should get right to work. Teachers can make these expectations explicit and keep the structure the same so that students enter the room ready to work.

Some students have a difficult time starting an activity with their groupmates. Such students need time to process a task themselves before they start a discussion. Incorporating an *individual think time* routine might be wise. That is, when groups begin a task, tell facilitators to have the group take two minutes of quiet time to make their own notes before the groups' discussion begins. Alternatively, students can be asked to do a *quick-write activity* about their own thinking before they share with the group. For individual think time or quick-write routines to be effective, the activity must truly be groupworthy in that it requires multiple perspectives. If an individual student can complete the problem in that brief time, status problems will only be exacerbated.

Sentence starters can help students find the language for discussing their thinking together. If students have not had much experience in collaborative learning, they might have a hard time meeting norms such as *helping is not the same as telling;* they might know only how to tell. Teachers can post sentence starters in their classroom. Students may use them in a playful, singsong way at first. As they recognize their value, they can become natural ways for students to speak to one another.

Some good sentence starters include the following:

- *"How did you know how to _____?"*
- *"What does _____ mean?"*
- *"_____ because _____."*
- *"Why did you _____?"*
- *"Why are our _____ different?"*

These sentence starters embody a strong push toward justification. The goal of sentence starters is to give students a way to have deeper mathematical conversations. In a limited-exchange format, students are used to asking each other, "What number are you on?" or "What did you get for problem 3?" These sentence starters help communicate different expectations and set them toward more creative interchanges. Likewise, sentence starters offer teachers a tool to support students in this work.

I will discuss other routines below, because they contribute to the accountability system in the classroom.

"I think I figured out the importance of holding groups accountable for each other's understanding. When I consistently hold kids accountable for each other, I find understanding becomes more important then completion or product—which is what I wanted!"

—Laura Evans, Complex Instruction Educator, Mathematics Teacher, and Coach