DEVELOPING PRODUCTIVE DISPOSITIONS DURING SMALL-GROUP WORK IN TWO SIXTH-GRADE MATHEMATICS CLASSROOMS Teachers’ Facilitation Efforts and Students’ Self-Reported Benefits

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Through this exploratory study, I developed conjectures about classroom conditions that had the potential to support (or not) the development of productive dispositions toward mathematics. To do so, I listened to sixth-grade students’ voices about their experiences with small-group work in 2 mathematics classrooms and contrasted their teachers’ efforts to facilitate small-group work. I interviewed 12 students from each classroom (N = 24) to examine the benefits and drawbacks of small-group work that students noticed. Interview data were interpreted to assess the degree to which students’ self-reports reflected productive dispositions toward mathematics, and they were reported in the form of 2 composite cases from each classroom. Video recordings of mathematics lessons were analyzed to characterize how each teacher facilitated small-group work. Results indicated that students were more likely to hold productive dispositions (autonomy, belief that mathematical competence is malleable rather than fixed, focus on understanding over task completion) in a classroom in which the teacher transferred responsibility to students, solicited multiple solution strategies, provided process scaffolding, and pressed for conceptual understanding. In contrast, students were less likely to hold productive dispositions (relying on external authorities, belief that mathematical competence is fixed rather than malleable, focus on task completion over understanding) in a classroom in which the teacher provided content help that lowered the cognitive demand for students, focused on obtaining an answer rather than understanding strategies, and placed 1 “genius” in each small group (explicitly grouped students heterogeneously). Students’ self-report data provided insights for recommendations of dispositional outcomes to be assessed in future research on students’ experiences with small-group work.

BACKGROUND

Small-group work can be implemented during mathematics classes to achieve a range of purposes. Some teachers use group work to provide opportunities to learn mathematics content through explicitly teaching students how to interact (e.g., Fuchs et al., 1997). Other teachers
implement group work to provide opportunities for students to develop productive dispositions and intellectual autonomy (Yackel, Cobb, & Wood, 1991). Additionally, other teachers use group work to help students develop interpersonal skills and an appreciation for engaging in democratic processes (Dewey, 1916, as cited in Noddings, 1989). Some teachers pursue still other purposes or multiple purposes. Following Florez and McCaslin (2008), students’ voices about their experiences can serve as a measure of students’ awareness of benefits (or drawbacks) of group work in their mathematics classrooms. Among the potential purposes for and benefits of group work, which do students notice and report?

How students experience group work is likely to differ according to teachers’ expectations for group work (Webb, 1995). A range of research has demonstrated that careful structuring of group work matters; teachers who have worked with researchers to structure group work in particular ways have elicited positive outcomes (Fuchs et al., 1997; Yackel et al., 1991). However, it is worth exploring naturalistically how teachers facilitate group work when they are not implementing interventions developed by researchers (Florez & McCaslin, 2008). Comparing and contrasting teachers’ instructional practices qualitatively can inspire conjectures about conditions for effective group work (to be tested in future interventions). In particular, more research is needed to identify conditions that lead to the development of students’ productive dispositions toward mathematics in the context of group work. It seems particularly important to investigate how middle school teachers facilitate group work, as prior research indicates that middle school teachers exert more control over students’ experiences (compared to elementary school teachers) at a developmental period in which students are starting to desire more autonomy (Eccles et al., 1993).

In this study, I examine sixth-grade students’ self-reports about benefits and drawbacks of group work in mathematics classrooms, and I explore which classroom conditions appear to lead to productive small-group work experiences. Students’ self-reports are interpreted in light of perspectives on productive dispositions toward mathematics. Each teacher’s efforts to facilitate small-group work are interpreted to explain why they could have led to the particular benefits or drawbacks that their students reported. The contributions of this study are conjectures of classroom conditions that promote the development of productive dispositional outcomes when engaging middle school students in small-group work and descriptions of dispositional outcomes inferred by students’ self-reports.

Outcomes of Productive Group Work

A range of outcomes are useful for determining whether students have productive experiences during small-group work. Regarding behavior and engagement, students could improve their engagement over time by becoming more collaborative with each other. With respect to learning, small-group work has the potential to promote conceptual understanding of mathematics and development of mathematical reasoning skills in addition to procedural fluency, depending upon how group work is structured and how students engage. Additionally, small-group work could promote positive dispositions toward mathematics as well, if structured to do so. These outcomes can serve as lenses through which students’ self-reports can be interpreted: which outcomes for productive group work do students notice?

Productive Behaviors: Collaboration

For the purposes of this study, small-group work is defined as three or more students sitting together and working on a common mathematical task. However, not all small-group work is collaborative group work. Small-group work is collaborative when students are interdependent upon one another. Collaboration is beneficial because students make more
productive small-group self-reports on problematics. Each all-group work could have drawbacks that contribute to individual weaknesses in the group. Each all-group work could have drawbacks that contribute to individual weaknesses in the group. Each all-group work could have drawbacks that contribute to individual weaknesses in the group.

**Small-Group Work in Sixth-Grade Mathematics**

Small-group work is productive for determining productive outcomes: Conceptual Understanding and Reasoning Skills

Conceptual understanding and adaptive reasoning are two interrelated strands of mathematical proficiency (Kilpatrick, Swafford, & Findell, 2001) that are relevant for small-group work. Reasoning aloud about one’s mathematical thinking can help students develop one’s understanding through making connections while explaining to peers. Additionally, explaining to peers provides opportunities to fill in gaps in one’s understandings that he or she recognizes while explaining to classmates (L. S. Fuchs et al., 1997).

**Productive Dispositions Toward Mathematics**

Dispositional outcomes are not commonly measured in classroom studies of group work, but they are valuable to consider in mathematics classrooms. In mathematics classrooms, students are not only learning mathematics, but they are learning about what it means to be a learner and doer of mathematics (Boaler, 2002). Productive dispositions toward mathematics include a high sense of competence in math, seeing mathematics as useful and worthwhile, and persisting in the face of challenge (Kilpatrick et al., 2001). Students with productive dispositions are more likely to engage effectively with mathematics. For instance, a student with a high sense of competence in mathematics would be more likely to put forth effort into mathematics and to choose to work on mathematics in the future out of his or her own volition (Zimmerman, 2000).

**Conditions That Support Productive Group Work**

Whether or not students have the opportunity to receive particular benefits of group work depends upon how group work is facilitated (classroom conditions) and students’ histories as learners (individual conditions). Conditions that lead to productive group work include the nature of the task chosen, whether and how students are explicitly taught to interact with classmates in groups, and transferring responsibility to students. However, individual variation among students, based in part upon their histories as learners, also affects the degree to which group work is productive for specific students.

**Classroom Condition: Task Selection**

According to Cohen (1994), to foster collaboration and interdependence, tasks should be challenging and require more intellectual resources than the resources of one individual student. To progress on these challenging tasks, input from classmates is needed. Additionally, when students work together on challenging, group-worthy tasks, there are a number of ways to enter into and solve the problems; thus, there are more opportunities for more students to demonstrate competence and be viewed by others as competent in mathematics (Boaler & Staples, 2008).

**Classroom Condition: Teaching Students the Value of Classmates’ Contributions**

An important condition for collaboration is that students need to see their group members’ contributions as valuable resources. Teachers can support collaboration among students by purposefully using status treatments (Cohen, 1994) such that teachers highlight valuable contributions made by particular students. This helps students see why a type of contribution is a valuable resource. Additionally, the teacher indicates that a particular student is capable of making a valuable contribution.

**Classroom Condition: Teaching Students How to Interact**

Intervention studies indicate that students can be taught how to interact with one another...
during small-group work in ways that can improve students' achievement. For instance, students who are explicitly taught to provide more elaborated conceptual explanations to each other have higher achievement compared to other students who were not explicitly taught these explanation skills (Fuchs et al., 1997). However, for this explanation to benefit the student receiving the help, not just the person giving help, there must be a good match between the help requested and the help received. Also, the student receiving the help must have a chance to think about the explanation provided (Webb, Farivar, & Mastergeorge, 2002). Students benefit from being taught how to interact with their peers when working in groups.

**Supporting Students' Dispositions**

Few intervention studies designed to promote effective group work interactions include disposition measures as an outcome variable; less is known about which small-group instructional practices promote productive dispositions. However, qualitative research suggests the value of some instructional practices in promoting positive dispositions through group work. For instance, explicit negotiation of social and sociomathematical norms (talking about talking) while working together on challenging tasks (Yackel & Cobb, 1996; Yackel et al., 1991) and transferring responsibility to students (Cohen, 1994; Turner et al., 1998) has promoted autonomy among students.

**Individual Condition: Students’ Histories With Achievement in Mathematics**

Achievement differences are likely to affect how students experience group work. According to Cohen (1994), status differences between students (arising from differential achievement) are likely to become more apparent when students work in small groups, and lower achieving students may become more passive as a result. For instance, Mulryan (1994) found that low achieving students were less likely to report giving help and sharing ideas as the purposes of group work, compared to higher achieving students. Attending to the experiences of students with varying achievement is particularly important when students enter middle school, as this is already a time when students' dispositions tend to decline (Eccles et al., 1993).

**Students’ Voices About Experiences With Small-Group Work**

Teaching is mediated by students’ thought processes, and teaching can be improved by understanding how students think about their experiences in school (Wittrock, 1986). In foundational research on how students’ thought processes mediate teaching and learning, Peterson and Swing (1985) found a positive relationship between students’ perceptions of giving help and the nature of help that students provided to classmates when working in groups. Based upon findings such as these, the importance of studying how students think about their behavior is apparent. However, most research studies on group work processes do not investigate what students think about their experiences with group work. Instead, these studies tend to begin with predetermined outcomes and assess the degree to which teachers' facilitation of group work leads to these outcomes (e.g., Fuchs et al., 1997; Gillies & Haynes, 2010). Exploring what students notice and report about their experiences in group work would illuminate why classroom conditions did or did not lead to particular outcomes. Additionally, characterizing students' voices highlights outcomes that matter to students.

Although it is rare to find research studies that characterize students' voices about their experiences with group work, a few studies provide some insight. Students' self-reports indicate they attempt to meet social and academic goals concurrently during small-group work (Florez & McCaslin, 2008; Mulryan, 1994). Florez and McCaslin's (2008) study of
elementary students’ perceptions of small-group work, these students reported two academic purposes for group work at a particularly high frequency: completing the work and understanding the work. These students also reported that they sought affiliation and academic goals concurrently and that they enjoyed group work. In Mulryan’s (1994) study of fifth- and sixth-grade students, the most prevalent benefits of group work reported by students included learning to work well with others, getting help, and obtaining additional ideas about the work. Students’ reports about their experiences in structured collaborative groups differed from what students report in unstructured small groups (Gillies, 2003); specifically, among eighth-grade students in Australia, those who were in structured collaborative groups were more likely to report that group work was enjoyable and that they had opportunities to do quality work. Looking across these studies, it appears that students attend to a range of benefits for group work—whether they find it to be enjoyable and whether they achieve academic benefits or social benefits (or both).

Although some prior research identifies productive outcomes for small-group work, students’ talk about their experiences with group work, and dispositions implied by their talk, is worth investigating. After all, even when students enact behaviors promoted by teachers, students’ perceptions of the purposes may not align with what their teacher promotes (Levenson, Tirosh, & Tsamir, 2009). Also, students who appear to cooperate with their teachers’ purposes may not necessarily value these purposes (Cobb, Gresalfi, & Hodge, 2009). So, it is worth noting which outcomes students attend to and value, not only outcomes valued by researchers.

METHODS

The methods described below addressed the following research questions: How did two sixth-grade mathematics teachers facilitate small-group work? What did sixth-grade students report about the benefits of small-group work in their two respective classrooms, and what can be inferred about students’ dispositions based upon these self-reports? Given the different self-reports from students in each classroom, which classroom conditions appeared to support the development of productive dispositions?

Context

Data were collected at one middle school (Grades 6 through 8) in the Mid-Atlantic region of the United States during the third quarter of the 2007-2008 school year. This school was purposefully selected for this study because the mathematics teachers at this school used the Mathematics in Context (National Center for Research in Mathematical Sciences Educational Staff at the University of Wisconsin-Madison, 2006) textbook series, which is a set of curriculum materials developed with funding from the National Science Foundation; the materials include mathematical problem solving tasks that have the potential to foster collaboration among students (e.g., group-worthy tasks). The demographics of the school’s student population were the following: 50.6% African American, 27.5% White, 21.5% Latino/a, and 0.5% Asian-American. According to data from the state’s Department of Education, 69% of the students at this school lived in “low income” households. (The definition for “low income” was not provided by the Department of Education.) Approximately 800 students enrolled in the middle school each year, which included about 250 students in sixth grade.

Two teachers’ classrooms were purposefully chosen for this study among a group of teachers who volunteered to participate. During a session of statewide professional development for secondary mathematics teachers, I solicited volunteer teachers by describing my interest in interviewing students about their experiences with group work. I wanted to work with teachers who reported that they imple-
mented group work in their mathematics classrooms regularly and were open to having a researcher interview their students. (For the professional development activity, the teachers studied students’ participation during mathematics class by video recording their class and focusing the video on particular target students that they hoped to reach more effectively. Teachers revised their mathematics classrooms based upon what they learned about their focus students in the context of the professional development.) This study focused on a larger number of students in each classroom than each teacher’s particular target students chosen for the professional development activities, and the professional development sessions did not explicitly focus on group work.

Mr. Winter and Ms. Summer (all names are pseudonyms) were the two teachers in this study. They were selected out of the volunteer teachers because they taught at the same school, did not have dramatically different numbers of years of mathematics teaching experience from each other (Mr. Winter was a second year mathematics teacher at the time of this study. Ms. Summer was in her sixth year of teaching at this school.), and they both had experience using their curriculum materials for at least one school year prior to this study. Both teachers were White. Both teachers were highly qualified to teach mathematics, based on their education backgrounds.

These classrooms were an appropriate site for this study because both teachers implemented small-group work in their classrooms. By “implement small-group work,” I mean that these teachers had their students work together in small groups of three or more students at least once during each class period that I observed (both formal video recorded observations and informal observations before and after student interviews). However, results will describe the ways in which small-group work was facilitated differently in each classroom.

The student population in each classroom was similar. Ms. Summer’s class had 28 students and Mr. Winter’s class had 26. In Ms. Summer’s classroom, 12 students were female and 16 were male. In Mr. Winter’s classroom, 12 students were female and 14 were male. The racial demographics in each classroom reflected the school’s student population.

**Data Sources**

Two data sources were drawn upon for this study: video recorded observations of mathematics classroom instruction and interviews with students. Video recorded observations were used to assess how teachers facilitated group work. Interviews were used to assess the benefits and drawbacks of group work that students perceived.

**Video Recorded Observations**

Five class periods from each teacher across the school year (from November to March) were video recorded. The teachers obtained parental consent and student assent for videotaping classroom instruction for research purposes. Video recordings were examined to describe the ways in which the two teachers facilitated classroom discourse and small-group work. I completed field notes of additional observations as well, and triangulated the findings from field notes with the more detailed analysis of videos.

**Interviews**

I conducted one-on-one interviews with each of 24 students (approximately 30 minutes long), and I was the interviewer. Twelve from each of the two classrooms were purposefully selected to be interviewed among the students from whom human subjects parental consent and student assent was provided. I asked each teacher to identify students that the teacher considered to be generally successful problem solvers, generally struggling problem solvers, and students who were sometimes successful and sometimes struggling, as well as an equal number of male and female students. Of the 12 students in Mr. Winter’s room five as Latino, and six as Latino. These benefits about small class. I co

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These interviews provided data about the benefits and drawbacks that students perceived about small-group work during mathematics class. I conducted interviews in February and March. Students responded to a range of interview questions such as: Why do you think your teacher asks you to work in groups during mathematics class? Do you like (or dislike) working in groups during math class? Why? If your teacher was to stop having you work in groups during math class, how would you feel about that? (Additional interview questions are integrated throughout the presentation of results.) Probing questions were posed to request elaboration from students. Students behaved in a range of ways in the interviews, from being hesitant and distant without much to say on the topic of group work in the classroom (thus, the need for probing questions) to being quite animated and providing extended responses to interview questions. Variations in students’ demeanors were similar among students from each classroom. Only one interview was conducted with each student to provide a snapshot of what it was like to be a student in the classroom across a range of students. Follow up interviews for member checking purposes were not conducted because the purpose was to construct claims about significant themes in students’ experiences across the classroom rather than claims about particular students. Interviews with students were video recorded and transcribed.

Data Analysis

In this study, I took a multiple embedded case study approach, which included multiple levels of units of analysis (Yin, 2003). Each classroom was a unit of analysis (two cases of classrooms) and embedded within each classroom, I constructed composite cases of students’ experiences in each classroom. The two different classrooms afforded contrasting situations (Yin, 2003), which provided benefits over looking at a single classroom to develop conjectures about how classroom conditions affected students’ experiences.

Teachers’ Facilitation of Small-Group Work

When analyzing video-recorded observations, I sought to describe how each teacher facilitated group work—how they monitored and debriefed group work—to infer what teachers could be communicating to students about the purposes (and potential benefits) of group work. This process involved multiple passes through the data. During the first pass through the videos, I initially described patterns of facilitation that appeared to occur across the videos. In subsequent passes, I sought either confirming or contradictory evidence to revise the patterns of facilitation. Two additional researchers (a doctoral student in mathematics education who had experience teaching middle school mathematics and an undergraduate student who was studying to become a middle school mathematics teacher) also analyzed the video-recordings and described what they observed with respect to how each teacher monitored and debriefed group work. I refined my descriptions of teachers’ facilitation of group work based on the observations of these additional researchers.

Composite Cases of Students’ Experiences: Benefits and Drawbacks of Small-Group Work

Interviews were analyzed in three stages: coding, individual case reports, composite case studies (cross-case analysis within each classroom). During the coding phase of analysis of interview data, I sought to identify what students perceived to be benefits and drawbacks of engaging in small-group work in their classrooms. This analysis was conducted through
an emergent process (Corbin & Strauss, 2008), with multiple passes through the data, and it involved a content analysis of students' talk. Initial conjectures of significant themes were developed based upon a first pass through the data, and individual case reports for each student were written. During additional passes, I revisited these conjectures and individual case reports and sought to revise them by seeking confirming or contradictory evidence. Given prior research indicating that students' experiences could vary depending upon students' histories with achievement (e.g., Cohen, 1994; Mulryan, 1994), I constructed four composite cases that represented the most common themes reported by the more successful problem solvers and the less successful problem solvers in each of the two classrooms.

**Trustworthiness**

To reduce bias and seek alternative interpretations (in the process of revising conjectures and seeking confirming or contradictory evidence), I presented my research findings to a group of education researchers and teachers for feedback locally in the Fall of 2009. Specifically, I requested alternative interpretations for why students in math classrooms may report different benefits and drawbacks for group work. I also solicited feedback about whether or not my findings resonated or seemed plausible. These perspectives led me to revisit my conjectures about classroom conditions for small-group work that affected the development of students' positive dispositions. This process followed Yin's (2003) recommendations for seeking critical feedback and alternative explanations during case study research.

**RESULTS**

Below, I first present contrasts between how each teacher facilitated small-group work, and then I present students' self-report data about the benefits and drawbacks of small-group work. Teachers' efforts to facilitate small group work are described to present the conditions in each classroom. Then, I present students' self-reports in the form of four composite cases of students, two from each classroom. Finally, through a cross-case analysis, I interpret the ways in which different methods of facilitating small-group work appeared to provide conditions that do and do not support students' productive dispositions toward mathematics.

**Two Middle School Mathematics Teachers' Efforts to Facilitate Group Work**

Although there were some general similarities between these classrooms, the two teachers facilitated small-group work differently. Similarities were the use of identical curriculum materials and the expectation that students would work with classmates on mathematics tasks during class. There were differences between the teachers' efforts to monitor and debrief small-group work.

When monitoring small-group work in progress, Mr. Winter did more cognitive work for the students than Ms. Summer. For instance, when he visited a group of students that was trying to estimate the percentage for a fraction (e.g., 156/216), after the student used a calculator to divide and held it up to the teacher, Mr. Winter looked at the calculator and said, "Point 72, 72 hundredths, what percentage is that? 72% What is that, almost? 75% what do we know about that? It's close to three quarters, you could have estimated..." If a student asked Ms. Summer for help when she monitored the small groups, she would say, "That's why you're in groups—to be open to multiple strategies and teach each other." Then she would walk away and leave the group to work on the task.

When debriefing with the class after group work, teachers posed different types of questions and appeared to hold different expectations for students' participation. During whole-class discussion after small-group work, Mr. Winter asked the question, "What's the question which answer it? He regularly when going through the cases that represented the most common students' response discussion conflict, and the climax if there was any. He would ask students posing questions in the Fall, Ms. Summer's "why" question work?" These questions coming from students coming spent the time spending time over the, and especially in the classroom. Other students a pressed peers for understanding why students posing questions in Winter's class.

Table 1 summarizes these two teachers' efforts for group work.

Looking across these two teachers' efforts for group work,....
work, Mr. Winter's questions were "how" and "what" questions. He asked students to share which answer they found, and how they found it. He regularly asked which step came next when going through a procedure with the class. He would ask students to raise their hands to see how many of them agreed with a classmate's response to one of his questions. The discussion continued if there was disagreement, and the class went on to the next problem if there was agreement. In contrast, during whole-class discussion after small-group work, Ms. Summer's questions included many "why" questions, such as "Why does that work?" These questions were in the context of students coming up to the overhead as a group, spending time writing out solutions at the overhead, and explaining the solution strategy. Other students asked their peers questions or pressed peers for elaboration (e.g., "I don't understand why you...") I did not observe students posing questions to their peers in Mr. Winter's class.

Table 1 summarizes differences between these two teachers' efforts to facilitate small-group work.

Looking across the two classrooms, these teachers appeared to promote different purposes for group work and scaffolded students' participation differently. Given that Mr. Winter asked the students for single answers or individual steps during whole-class discussion, the purpose of group work appeared to be to prepare for whole-class discussion by finding a single correct solution. In contrast, the purpose of group work in Ms. Summer's classroom appeared to be to prepare for whole-class discussion by finding multiple solution strategies and being prepared to explain why the strategies worked. Mr. Winter provided content-specific scaffolding, such as hints about strategies to use, and Ms. Summer provided process scaffolding, such as encouraging students to find another strategy or to listen to each other.

Contrasting Students' Benefits and Drawbacks of Group Work Between Classrooms: Four Composite Cases

Prevalent perspectives from students in each classroom are presented below in the form of composite cases. Perspectives of successful and struggling problem solvers are presented from each classroom to explore the degree to which a range of students' needs are met in each classroom (the needs of historically more successful and less successful students). Students' perspectives in the context of their teachers' efforts to facilitate small-group work are provided.

<table>
<thead>
<tr>
<th>Mr. Winter</th>
<th>Ms. Summer</th>
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<tbody>
<tr>
<td>Content help, reduced demand: During small-group work, the teacher did some cognitive work for students (e.g., &quot;I'll give everybody a hint.&quot;)</td>
<td>Process help, transfer responsibility to students: During small-group work, the teacher attempted to turn the cognitive work back to students.</td>
</tr>
<tr>
<td>Reduced demand: Teacher's questions during whole-class discussion elicited a single step of a procedure or a one word / one number answer (e.g., &quot;And what is the next step?&quot;)</td>
<td>Multiple strategies: Teacher's questions during whole-class discussion elicited multiple, elaborated solution strategies.</td>
</tr>
<tr>
<td>Resolution through consensus: After a student responded to the teacher's question, the teacher would ask, &quot;How many people agree?&quot; Students would raise hands in response.</td>
<td>Press for conceptual meaning: Teacher's questions during whole-class discussion elicited pressed students to explain meaning behind solutions (e.g., &quot;Why does that work?&quot;)</td>
</tr>
<tr>
<td>Narrower distribution of mathematical authority: One &quot;genius&quot; in each group.</td>
<td>Wider distribution of mathematical authority: Students would go to an overhead (as a group) to write solutions and explain them to the class. Other students would ask questions of the group at the overhead.</td>
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work suggest conditions under which group work is more or less productive.

**Enrique: Successful Problem Solver, Mr. Winter’s classroom**

Enrique said that math had been his favorite subject ever since the fourth grade. He reported earning grades near 100% during the most recent marking period. Enrique was aware that his peers and teacher considered him to be mathematically competent. He reported that peers relied on him for help, and he also said that his teacher thought he was one of the more successful students in the class.

**Benefit: Complete Work Efficiently.** Enrique perceived that group work was beneficial if it provided an opportunity to efficiently complete work in class. He said that he liked working in groups, because “we can get more work done, like, faster ... let’s say that I don’t know something, but the kid that I’m working with does? We can help each other out.” But he also said, “Sometimes I would rather work by myself.” When I asked why, he said, “Because I’m good at math. I’m done faster by myself.” When given a choice of talking to a teacher or a peer during mathematics class, he said, “More to a teacher. He knows more.” In his talk about group work, he emphasized efficiency, and at times he appeared to find the shortest route toward completing the task to be through his teacher. Other times, he found an efficient route through distributing the work among peers. His perception of the importance of completing the task aligned with the focus of whole-class discussion in Mr. Winter’s class, which was usually on finding a single strategy that resulted in a correct answer.

Sometimes we just like, tell each other so we all get the one part. Like, there’s four, um, four kids in each group, and there are four problems, we just say, “you do this problem, you do this problem, you do this, you do this.” Then we just share.

Although he said that he would rather work alone or get help from a teacher, Enrique was willing to work in a group of peers if it helped him get the work done efficiently.

**Benefit: Work With Friends.** Additionally, Enrique noted that a benefit of group work was an opportunity to work with friends. A drawback was when he was asked to work with people who were not his friends. He said that he preferred his small group in his social studies class “because the person sitting next to me is my friend.”

Enrique did not actively resist group work, but he did not appear to value working with all of his peers. When I asked him why he worked with his classmates in a group, he said, “The teacher tells us to work with a group.” His emphasis on doing what the teacher told him to do suggests that he cooperated with his teacher’s request to work in groups (for the purpose of efficiently obtaining an answer), but he didn’t necessarily value working in groups with peers (as he would rather talk with his teacher or a friend). Although Enrique was willing to participate to comply with his teachers’ expectations, he did not see much benefit in group work, unless it helped him efficiently complete his work.

**Kiara: Struggling Problem Solver, Mr. Winter’s classroom**

When I asked Kiara what I should know about her as a mathematics learner, she self-identified as “one of the middle-low students, but not the lowest.” Kiara said that she had been having trouble with math lately, but she said that she liked math, particularly when she had a nice teacher, as she said that did that year. Kiara said, “I like doing math, I just have problems... I’ve been struggling through math, but Mr. Winter and my group helps me out.” She also said that she attended help sessions after school with her teacher.

**Benefit: Learn Social Skills.** When Kiara talked about group work, she perceived that the purpose was to develop social skills.

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However, Kiara emphasized that she was open to consistent help from the teacher, and she attended help sessions with her teacher. She appeared to value learning with others, and she was willing to work with others in the group to solve problems efficiently. Kiara spoke of herself as a mathematical genius, but she also acknowledged that working with others could be helpful. She appreciated the authority of her teacher and the potential for learning through group work. Overall, Kiara perceived group work as a way to learn social skills and improve her mathematical understanding.
the purpose of small-group work was to develop social skills.

when we grow up we are going to have to work with people that maybe we might not like, he [Mr. Winter] tells us this, with people we might not like, but we have to work with them, anyway. So he kind of puts us with people maybe that we don’t talk much with, and then we start getting used to working with people.

She appeared to buy in to what her teacher told them about the benefits of group work, particularly with respect to learning to work well with others.

However, even though Kiara appeared to be willing to work in a group, her preference was to get help from her teacher; she did not appear to consistently value working in a group. I asked her with whom she would rather work during math class. Kiara said, “Sometimes the group, but mostly, in my opinion, would be the teacher …. Well, Mr. Winter says he puts geniuses in our groups, so I listen to [classmate], and he gets it right.” She preferred to work with the person who would be most likely to help her obtain a most direct route to the correct response, such as a “genius.” This suggests a preference for solving problems efficiently through relying on an external authority (other than herself).

Kiara spoke about others as being mathematical geniuses, and she did not characterize herself that way. A concern about characterizing others as mathematical geniuses is that she appears to believe that competence in mathematics is fixed (e.g., some people are geniuses and others are not). In contrast, others believe that mathematical competence is malleable (every learner can develop mathematical competence over time with effort and support). Students who believe that mathematical competence is malleable (rather than fixed) may be more likely to believe that it is possible to develop their own mathematical competence (Dweck, 2007).
Carolina said that she liked doing what her teacher asked them to do, which was finding multiple solution strategies.

**Benefit: Hear Peers’ Explanations:** Also, Carolina expressed that a benefit of small-group work was the opportunity to be able to hear mathematical explanations in the language of peers.

**I:** What helps you learn math the most [in groups]?

**Carolina:** Like they [peers] can, like explain it better ... like, let’s say if Ms. Summer is talking about something that I don’t understand, I ask them first and then I ask her. So I ask them first, and they explain it better.

She valued the opportunity to hear from her peers (“they explain it better”), even though she was often mathematically successful herself. She did not like it when her peers did not let other students try the mathematics themselves.

**Carolina:** like, he like, tries to take care of everybody’s work. Like we got different work—

**I:** And you don’t like that?

**Carolina:** It’s taking over our work. It’s like, he’s taking over the whole group.

**I:** And what do you think he should do instead?

**Carolina:** Like work, like, do his part, and everybody else does their part.

Carolina wanted to learn from her classmates, and she did not like it when peers tried to impose their ways of thinking onto her or others. She valued collaborative interactions.

**Benefit: Intellectual Autonomy:** When I asked Carolina for advice to give her teacher, she said, “Like to her, like not to always, like, talk. Like, she can talk and whatever, but ... we can, like, brainstorm it.” I asked her whether her teacher let them brainstorm it, and she said, yes, that was what her teacher did, and she wanted her teacher to continue to let them brainstorm.

Carolina described students (in general, not just herself) as having the intellectual autonomy and capability to come to their own mathematical conclusions. She spoke about students being able to try the problems for themselves without a peer or teacher interfering with anyone’s opportunity to “brainstorm it.” She thought that individuals were capable of making progress on mathematics problems without direct instruction from an authority, and she was open to learning from her peers to learn multiple strategies. Carolina’s talk suggested that she valued interactions that afford opportunities for all group members to develop mathematical autonomy and enact their competence in mathematics.

**Julius: Struggling Problem Solver, Ms. Summer’s Classroom**

Julius self-identified as “not good at fractions,” which was the unit they were doing when I interviewed the students, but he self-identified as being generally “good with numbers.” He self-reported that he was earning a D in math at the time, and he said that he had gotten behind in his homework.

**I:** I don’t know you yet, so how would you say you are in math?

**Julius:** Well, I don’t really think nobody’s the best. I think we’re all the same, but, it’s to the point where someone, I think if they try hard enough, then they’ll all be, like, we’ll all be the same.

**I:** So, anybody can.

**Julius:** Yeah. They’re just not trying. They’re not trying to become better. They just decide, some people just decide not to do it, and that’s how they get bad grades.

**I:** Oh, it’s not that they can’t.

**Julius:** Everybody can do it!

Notice that he attributed lack of success in mathematics to lack of effort. He did not speak of mathematical ability as fixed, as if some students were geniuses and others were not. In this way, he appeared to report that students...
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were capable of enacting intellectual auton­
omy in mathematics class as well.

Julius was aware of what Ms. Summer
expected from students when it was time to
work in groups. He said, “When the teacher’s
stopped talking, she’ll say go, and she’ll say
‘math talk’ and all that other stuff, that’s when
I know it’s time to start talking.” He did not
appear to resist his teacher’s expectations.

Benefit: Multiple Solution Strategies. Similar
to Carolina, Julius reported that a benefit of
working in small groups was the opportunity
to learn multiple solution strategies. He
reported that he internalized the process of
finding more than one solution strategy. I
asked Julius what he would do if he was stuck
when working on a mathematics problem.

Julius: I would ask myself, like.
I: You would ask yourself a question. What
do you ask yourself?
Julius: Like, how would you explain it? I would
explain it another way [to myself], just in
case, like, somebody asked, I still don’t get
it, then I would explain it another way to
make it easier.

Julius described a metacognitive process of
asking himself for another strategy, which sug­
gests that he internalized his teacher’s expecta­
tions and used them as a strategy for learning.

Drawback: Social Conflicts. When I asked
Julius if he had any disliked about working in
small groups, he said that he didn’t like “peo­
ple who get nasty ... eye rolling and stuff ...”
He had some previous experienced working in
groups when his peers were rude to him.
Although he did not enjoy these social con­
flicts, he said that he would try to work through
the social conflicts and wanted to continue
working in groups.

Although Julius did characterize his compe­
tence as being somewhat lower in some areas
of mathematics, he generally believed that he
could improve with effort. At the point in time
when I interviewed him, he was not experienc­
ing success in his mathematics class, as mea­
sured by grades, but he believed that he was
capable of becoming more successful. Also,
Julius described having metacognitive strate­
gies that supported his persistence with chal­
lenging mathematical tasks.

Cross-Case Analysis: Conditions That
Support Opportunities for Students
to Benefit from Small-Group Work

To develop conjectures about how to sup­
port students during small-group work, I con­
trasted students’ experiences in each
classroom (see Table 2).

Not all of Mr. Winter’s students seemed to
value group work strongly, because it was not
always an efficient approach to completing
their work. In contrast, most of Ms. Summer’s
students seemed to value the process of group
work.

| TABLE 2 |
| Benefits and Drawbacks of Small Group Work: Differences Between Classrooms |
| Ms. Summer’s Students | Mr. Winter’s Students |
| Benefits | Multiple strategies | Efficiency |
| Peers’ explanations | Work with friends |
| Intellectual autonomy | Learn social skills |
| Drawbacks | Social conflicts | |
| Mathematical competence | Malleable | Fixed |
**Which Benefits are Worth Pursuing?**

Students in both classrooms expressed benefits that they could achieve through working in small groups during mathematics class; however, not all benefits reported by these students are equally valuable. In terms of benefits for developing conceptual understanding, efficiently obtaining an answer could be considered less valuable than the benefit of learning multiple solution strategies. Students who are focused on efficiently obtaining an answer may miss the opportunity to view mathematics from another perspective and extend their understanding. Comparing and contrasting solution strategies, although not necessarily the most efficient route to an answer, can lead to stronger mathematical understandings than learning only one perspective (Brenner et al., 1997). To have opportunities to compare and contrast solution strategies, students need to be in settings where multiple solution strategies are shared and valued over efficiently obtaining correct answers.

Regarding benefits for development of students’ dispositions toward mathematics, it is beneficial for students to view mathematical competence as malleable rather than fixed and for students to see themselves and their peers as intellectually autonomous and capable of constructing their own solution strategies. If students believe that effort can lead to improving their mathematical competence, they are likely to persist in the face of challenge (Turner et al., 2002). Additionally, when students believe that they and their peers are intellectually autonomous, they are more likely to believe that all their peers may have something to contribute to the small group discussion. Even if some of their peers have not been mathematically successful recently, students are more likely to listen to struggling classmates if they believe it’s possible that the struggling classmates are capable of improving and may have something to contribute.

Believing that mathematical competence is fixed can inhibit collaboration and opportunities to develop mathematical reasoning skills.

**Under Which Conditions Would Students Be Likely to Achieve These Benefits?**

In common across both classrooms was the use of similar curriculum materials, but the two teachers facilitated small-group work differently, and these differences appeared to moderate students’ experiences. The curriculum materials included group-worthy tasks that were challenging and had the potential to elicit more than one solution strategy. In other words, the classrooms’ curriculum materials included problems that had the potential to elicit interdependence and collaboration. However, the two teachers varied with respect to whether they provided content or process scaffolding during group work and whether they pressed for conceptual meaning when discussing group work as a class.

Ms. Summer’s efforts to facilitate small-group work appeared to provide conditions that elicited more ideal benefits for students as they worked in small groups. Her students were less likely to describe group work as an efficient approach to an answer, more likely to discuss the benefits of learning multiple solution strategies, to report opportunities to enact intellectual autonomy, and to report that effort leads to improvement in mathematics. Concurrently, Ms. Summer tended to use process scaffolding...
students who identified mathematics as their competence was fixed) time to hear from ever, in avoiding a classmate, they om that classmate. ay an opportunity and expand explaining to someone is inefficient for a hematology compete that her peers are ics as she is. To work with peers, they have someer.

Would Studentsreceive Benefits?

classrooms was the materials, but the ill-group work differences appeared to nces. The curriculum-worthy tasks had the potential to n strategy. In other curriculums, which the potential to collaboration. However, with respect to ent or process scaffolding and whether they ning when discussing to facilitate small-vide conditions that for students as they s students were less work as an efficient are likely to discuss tiple solution strategies to enact intellectual that effort leads to ities. Concurrently, process scaffolding (Baxter & Williams, 2010; Dekker & Elshout-Mohr, 2004) during group work and to conduct whole-class discussions by pressing for conceptual understanding. Social progress scaffolding occurred when Ms. Summers monitored group work by pushing students to (a) talk with each other rather than ask her for hints and (b) keep trying to find multiple strategies. Pressing for conceptual understanding (Kazemi & Stipek, 2001) occurred when she (and other students) asked students to explain why their solution made sense, which provided students with more opportunities to make sense out of solution strategies. The experience of group work in Ms. Summer's mathematics classroom was more collaborative than group work in Mr. Winter's classroom, as evidenced by how students talked about their experience and observations of the classroom. (Group work in her classroom was not ideally collaborative, as students described social conflicts at times, but no classroom is ideal.)

Ms. Summer's use of process scaffolding, such as encouraging students to keep talking with each other rather than the teacher and to seek multiple strategies, appeared to lead to a number of benefits. The teacher's effort to transfer responsibility to students seemed to support students' opportunities to enact autonomy, which aligned with prior research (Yackel & Cobb, 1996; Turner et al., 1998). Also, given that Ms. Summer's explicitly advocated for multiple solution strategies, it is not surprising that her students would report this benefit of group work. However, pushing for multiple solution strategies could lead to collaboration, because there is more to discuss. The conversation is not over once a correct answer has been determined. More students can contribute to the small group conversation by sharing another strategy. Additionally, it is more likely that students can see themselves and more of their peers as competent when pushed to provide more than one solution strategy, because there are more opportunities to appear mathematically competent (Boaler & Staples, 2008; Cohen, 1994).

Mr. Winter's facilitation of small-group work appeared to inhibit collaboration and did not provide students with ideal benefits. His students reported the benefit of efficiently obtaining correct answers and discussed mathematical competence as "fixed." Concurrently, he provided content-focused help (Baxter & Williams, 2010; Dekker & Elshout-Mohr, 2004), did not appear to press for understanding during whole class discussions beyond asking whether students agreed with a classmates' steps for solving the problem, and he communicated to the students that they were placed in groups that each had one "genius." His content-focused help was in the form of giving students hints and suggested solution strategies, which appeared to have the consequence of lowering the cognitive demand (Stein, Grover, & Henningsen, 1996) for students, because the teacher did some of the mathematical thinking for students. Collaboration during small groups in Mr. Winter's class his class appeared to be limited, because the goal of the group discussions appeared to be finding the correct answer. If the goal of group work is to find the correct answer, the objective becomes finding one solution efficiently. Once the answer is obtained, there nothing left to discuss.

Mr. Winter's choice to tell students that each group had a "genius" and focus on answers over solution strategies appeared to impact students' views about mathematical competence as fixed. Students from Mr. Winter's classroom informed me during interviews that he was explicit with them about purposefully placing a more successful student in each group. Multiple students told me that each group had one "genius," and they were aware whether or not they were expected to be the genius. This communicated stability in terms of who was good at mathematics (and who was not) rather than emphasizing that all students could become more capable at doing mathematics over time. Additionally, a focus on efficiently obtaining the correct answer limits opportunities to enact mathematical competence. If only one correct solution is needed,
DISCUSSION

Contributions of this exploratory study include descriptions of instructional practices for facilitating group work that appeared to be more and less effective for promoting productive dispositions among these students as well as descriptions of dispositional outcomes about which these students were aware. Given that dispositional outcomes were assessed through students' self-reports, these data illustrated dispositional outcomes that these students noticed. I recommend that future research on students' dispositions toward mathematics include outcomes informed by these data. Conjectures for future research are posed based upon these findings.

Teachers' Effective Facilitation of Small-Group Work

This exploratory investigation complements and extends existing research by documenting an existence proof of how these teachers were able to facilitate small-group work in ways that did and did not promote productive dispositions toward mathematics among their students. Prior research indicates that teachers' efforts to facilitate group work matter. Most intervention studies of teachers' facilitation and structuring of group work have assessed either learning or behavioral engagement outcomes (Fuchs et al., 1997; Gillies & Haynes, 2010; Leikin & Zaslavsky, 1997; Webb & Mastergeorge, 2003). This study is a contribution over those studies because the positive outcomes assessed in this study were primarily dispositional outcomes. This exploratory study contributed insights about how teachers can promote students' productive dispositions toward mathematics while facilitating small-group work.

Some researchers have examined qualitatively how teachers can facilitate group work to support the development of productive dispositions; results from this study both complement and extend these prior studies. Previously, researchers have found that explicitly negotiating classroom norms (talking about talking, such as what counts as a different solution) (Yackel & Cobb, 1996; Yackel et al., 1991) and transferring responsibility to students (Cohen, 1994; Turner et al., 1998) appears to support the development of autonomy. The findings of this study align with prior research, as Ms. Summer's students spoke about intellectual autonomy. Also, Ms. Summer appeared to transfer responsibility to students through process scaffolding (Baxter & Williams, 2010; Dekker & Elshout-Mohr, 2004) and pressing for conceptual meaning (Kazemi & Stipek, 2001). These ways in which Ms. Summer transferred responsibility to students were worth identifying, as process scaffolding and pressing for conceptual meaning tend to be discussed more in terms of their benefits for mathematical understanding rather than productive dispositional outcomes. Future research on promoting positive dispositions in mathematics classrooms through small-group work should investigate the role of process scaffolding and pressing for conceptual meaning in promoting students' intellectual autonomy.

Additionally, prior research describes the value of pursuing multiple solution strategies so that more students can see themselves as mathematically competent (Boaler & Staples, 2008). However, this study points to an additional dispositional outcome: believing that effort matters and mathematical competence is improvable (Dweck, 2007). Future research on promoting positive dispositions in mathematics classrooms through small-group work should investigate the degree to which expecting multiple solution strategies relates to seeing mathematical competence as improvable through effort.

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Dispositional Outcomes
Self-Reported by Students

By listening to these students talk about the benefits that mattered to them, dispositional outcomes were identified. Alternatively, dispositional outcomes could have been assessed through a survey instrument, identified by the researcher a priori. However, the priority in this study was to consider which outcomes mattered from these students’ perspectives. A contribution of this study is a recommendation of a set of dispositional outcomes to be measured in future research, as informed by these students’ experiences with small-group work.

These students’ self-reports about the benefits of group work both complemented and extended results from prior research. Previous studies demonstrated that students report meeting both academic and social needs concurrently during group work (Florez & McCaslin, 2008; Mulryan, 1994). Similarly, the students in this study mentioned both social needs (e.g., work with friends, learn social skills) and academic needs (e.g., enact intellectual autonomy, obtain multiple solution strategies, complete work efficiently, obtain help). Results from this study converge with Mulryan’s (1994) findings, in which fifth- and sixth-grade students reported benefits such as learning social skills and getting help from peers. Results from this study also converge with Florez and McCaslin’s (2008) data, in which elementary students reported that small-group work helped them both complete and understand the work. Thus, across both classrooms, there were some similarities in what these sixth-grade students reported and what students reported in prior studies. However, there were some outcomes unique to this study, including sixth-grade students’ reports of opportunities to enact intellectual autonomy and students’ views about whether or not mathematical competence was fixed or improvable.

Looking across the results from this study and prior research, future studies about promoting productive dispositions toward mathematics through small-group work should emphasize dispositional outcomes reported by students. These outcomes include: (a) whether students are focused upon completing work efficiently or understanding why the problem works through multiple perspectives; (b) the degree to which they value working with others, which includes both listening to peers’ explanations and providing explanations to peers, whether or not the classmates are their friends; (c) the degree to which students view themselves as intellectually autonomous; and (d) the degree to which students view mathematical competence as fixed or improvable through effort. Future research on developing productive dispositions toward mathematics could involve developing survey instruments to assess these outcomes, as these outcomes are among those that appear to matter to students when working in small groups.

Lower Achieving Students More Passive?
Not Always

Although I purposefully selected for diversity within classrooms in terms of students’ histories with achievement, more differences were found between these two classrooms than within each classroom. Previous research findings indicate that lower achieving students are more passive than higher achieving students when working in small groups (Cohen, 1994; Mulryan, 1994). Although this appeared to be true in Mr. Winter’s classroom, this wasn’t necessarily the case in Ms. Summer’s classroom. A key difference appeared to be whether students believed that their effort mattered and whether mathematical competence was improvable. This is a conjecture that should be
explored in future research: are lower achieving students less passive when working in small groups during mathematics class if they believe that mathematical competence is improvable (and more passive if they believe that mathematical competence is fixed)?

**Limitations**

A limitation of this study is its small sample size; future research should be conducted to examine whether these relationships between instructional practices and dispositional outcomes hold in other classrooms. However, this small sample size afforded exploration and identification of both dispositional outcomes (that students notice) and instructional practices that appear to influence whether students express these dispositions. Using an inductive, grounded theory approach (Corbin & Strauss, 2008), I was able to identify whether certain instructional practices were effective, such as those previously identified in qualitative research on supporting students' dispositions through small-group work. I also extended this work by identifying additional effective instructional practices. Case studies support the development of conjectures that are worth examining in larger scale future research.

Additional limitations could be addressed through future research as well. For instance, not every student in each classroom was interviewed (almost half of the students in each class were interviewed). If more students were in the sample, there would have been more information about the prevalence of the dispositional outcomes in each classroom. However, the process of surveying every student was sacrificed for the opportunity to capture students' voices and identify outcomes from their perspectives. Future research can capitalize on these outcomes and assess them through questionnaires or surveys.

**Implications**

Teachers may be aware generally that their efforts to facilitate group work make a difference, but specifically they may not be aware of the ways in which their instruction could either support or hinder the development of middle school students' productive dispositions. Teachers could be taught explicitly about how to foster small-group work to promote productive dispositions toward mathematics. Professional development could focus on analyzing cases, such as Mr. Winter's and Ms. Summer's classrooms, to contrast different instructional practices. Additionally, teachers could be encouraged to interview or survey their own students to determine whether their students are developing productive dispositions.

**Conclusions**

Teachers implement small-group work in middle school mathematics classrooms for a variety of purposes, and how they facilitate group work relates to which purposes can be achieved. From these sixth-grade students' self-reports, it appears that students' dispositions toward mathematics are a worthwhile outcome to examine further in research on small-group work. More specifically, productive dispositions toward mathematics that could be fostered through teachers' facilitation of group work include intellectual autonomy, a belief that mathematical competence is improvable, a focus on understanding rather than task completion, and a value for collaborating with peers. These results suggest that when the teachers studied implemented small-group work on group-worthy tasks, they might need to take care to do the following: (a) avoid doing cognitive work for students through their content scaffolding and transfer responsibility to students, (b) solicit multiple solution strategies, and (c) provide process scaffolding and press for conceptual meaning. Future research should assess the degree to which these instructional practices support the positive dispositional outcomes identified through this study in other classroom settings.

**Acknowledgment:** I would like to extend appreciation to the Mathematics and Science...
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Education Resource Center at the University of Delaware for supporting this study, as well as to the two teachers in this study for opening up their classrooms to me.

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