Field-Based Perspectives on Enacting Alternatives to Ability Grouping in Elementary Mathematics Instruction

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Ability grouping is a common practice in elementary mathematics instruction, but some research suggests that grouping by ability can exacerbate existing inequities, and there is evidence that alternatives to grouping can improve learning experiences for all students. In this paper, we describe an effort to support teachers in using equitable teaching practices that was part of an Elementary Mathematics Specialist (EMS) certification program at a public university in the United States. We employ multiple perspectives in our collaborative action research approach: the first author was the director of the EMS program, the second author was a graduate researcher working to support the program, and the third, fourth, fifth, and sixth authors were all teachers in the program. We start by introducing efforts to address equity from the perspective of program designers, including specific activities used during a Summer Institute to prompt consideration of alternatives to ability grouping. Then we share several experiences of reducing ability grouping from the perspectives of four teachers who were participants in the program, noting successes and challenges. We conclude with implications for research and practice.

Keywords ability grouping · Elementary Mathematics Specialists · equity · heterogeneous grouping · collaborative action research

Introduction

While placing students into groups according to their “ability” is common practice in elementary mathematics classrooms in the United State (Loveless, 2013), it has been critiqued as limiting opportunities for all children to engage in high quality learning opportunities (Cheeseman & Klooger, 2018; Clarke & Clarke, 2008; National Council of Teachers of Mathematics [NCTM], 2020). Research suggests that alternate approaches to grouping can improve learning experiences for all students (e.g., Murata, 2013; Sullivan et al., 2009). In this paper, we describe some of these approaches, drawing on data from our own work in multiple roles within the context of an Elementary Mathematics Specialist (EMS) certification program at a public university in the United States.

We used a collaborative action research approach (Miller & Pine, 1990) to investigate our efforts to reduce ability grouping and support student learning. First, we share our efforts to address equity from the perspective of EMS program designers (Webel and Dames), including specific activities used during a Summer Institute to prompt consideration of alternatives to ability grouping. In the next section of the paper, each of the teacher authors describes the rationale for our decisions, the details of how we went about reducing ability grouping in mathematics, and, drawing on artifacts from our instruction, provide some evidence about the changes we witnessed in our classes as well as the challenges we experienced.

In the final section of the paper, we summarize general patterns across our different experiences and discuss implications for alternatives to ability grouping in elementary mathematics. This paper adds to research on ability grouping by providing insider perspectives from classrooms where teachers are working to alleviate the inequities that can result from ability grouping. These perspectives illuminate how specific practices can shift classroom culture in ways that make productive use of, and even celebrate, a range of different ideas from students. It also reveals the orientations that guide teachers as they make specific decisions about when and how to group elementary students in mathematics.

Theoretical Framework: Equity and Ability Grouping

We draw on two sources for a theoretical critique of ability grouping. The first is based on the idea of "opportunity to learn," which Hiebert and Grouws (2007) describe as the "key enabling condition" of learning. Opportunity to learn is not the same as "being taught" or "covering content," but "includes considerations of students' entry knowledge, the nature and purpose of the tasks and activities, the likelihood of engagement, and so on" (p. 379). When students are separated into groups by ability, there is possibility for variation in the quality of opportunities to learn, which typically results in students designated as "low" ability receiving lower quality learning opportunities (Cheeseman & Klooger, 2018; Clarke & Clarke, 2008; Gamoran, 1992; Ireson, Hallam, & Hurley, 2007; Zevenberger, 2005).

The second theoretical basis for a critique of ability grouping comes from a broader perspective that views mathematics classrooms as spaces that, along with schools more generally, tend to reproduce societal hierarchies (Battey & Leyva, 2016; Stinson, 2006; Martin, 2009a). From this perspective, we can see mathematics classrooms as spaces in which children from marginalized communities experience exclusion, and ability grouping as a practice that can reinforce this exclusion (Aguirre et al., 2013). For example, Martin (2009b) argues that mathematics learning and participation can be conceptualized as a racialized experience, where the African American voice is 'de-valued' within schools. Ability grouping reinforces this marginalization, as minority and lower-SES students are more likely to be placed in lower tracks (Oakes, 2005). In contrast, middle-class white parents of 'high-achieving' students tend to prefer heterogeneous modes of instruction where students are separated in order to maintain social and political power through the status that comes from academic attainment (Gilmer, 2001).

Literature Review

Often mirrored after levelled 'reading groups,' within-class ability grouping (WCAG) involves separating students into groups based on a determination of their "need," and then providing targeted instruction to each group according to that determination. Criteria for placement into tracks or groups varies, but often include formal assessments and teacher recommendations. In some cases, policies regarding ability grouping are established by district and school leadership (Park & Datnow, 2017). The use of WCAG in elementary classes has been rising in the United States and elsewhere (Loveless, 2013; Forgasz, 2010), and many teachers see it as necessary for meeting the needs of diverse classes of students (Loveless, 2013).

Despite the often-stated intent to target instructional supports for students deemed as low-achieving (e.g., Webel et al., accepted; Webel & Dwiggins, 2019), ability grouping can limit learning opportunities for students who are designated as "low" (Oakes, 2005; Aguirre et al., 2013). While there is little data on differences in instructional quality in mathematics for different groups in WCAG, class-based tracking shows that opportunities to learn are indeed often inequitable across different tracks (Gamoran, 1992; Ingram et al., 2020; Ireson et al., 2007; Webel et al., accepted; Zevenbergen, 2005). For example, Macqueen (2010, 2012, 2013) reported the prevalence of direct instruction and memorisation tasks for "low" classes in Australia, while high level-classes were provided "extensions" and "quality work" (Macqueen, 2013, p. 304).

Webel and colleagues (accepted) shared the case of a 5th grade teacher, Keri, who taught four different mathematics classes into which students were tracked by ability. Teaching observations showed that in the "low" classes, Keri positioned herself as the primary arbiter of mathematical correctness and articulated an emphasis on "procedural performance over connections between multiple strategies and representations." In contrast, in the "high" class, Keri's instruction was "more inclusive of student voice, afforded students opportunities for justification of their solutions, and had more intentional emphasis on the use of multiple solution strategies through a variety of contextual situations." Discussions in the high class "included more peer-to-peer interaction and tended to focus on the construction of ideas and definitions rather than modelling and evaluating algorithmic procedures." Survey data showed that Keri had the knowledge and dispositions to provide rich learning opportunities for all of her students, but interviews showed that she believed she was meeting students' needs through ability grouping, and she described efforts to separate students into smaller groups within her classes in order to further individualize her instruction. The researchers noted that Keri's decisions involved lowering expectations for some students in ways that "unnecessarily limited their learning opportunities."

Even if learning opportunities were equal, we suggest that ability grouping creates status differences that are harmful to students. Again, data regarding WCAG is limited, but Webel and Dwiggins (2019) found that preservice teachers (PSTs) often connected ability grouping to their negative experiences in mathematics class, linking it to feelings of failure, inferiority and marginalization. Many described these experiences as occurring during elementary school, prior to class-based ability grouping. However, several PSTs also defended ability grouping, claiming it helped target the provision of learning opportunities ("Having different opportunities to learn doesn't hold back the students, but focuses on their needs to help them be the most successful student they can be"), or justified group separations by referring to "work ethic" or bad behaviour, articulating some of the coded stereotypes that are often used to perpetuate inequitable systems (Stinson, 2013; Shah, 2017).

Indeed, ability grouping is likely to especially impact racial and ethnic minorities and other marginalized groups, as explicit and implicit bias has been documented among preservice and in-service teachers (Battey et al., 2021; Copur-Gencturk et al., 2020; Wager, 2014) and is likely to influence within-class grouping decisions. Research shows that between-class ability grouping does in fact often preserve or exacerbate status differences, particularly along lines of class, race, and gender (Oakes, 2005; Dunne et al., 2011; Boaler 1997; 1998). For example, Boaler (1997; 1998) found that in tracked classes at a school that emphasized answer-getting, girls more consistently reported a lack of confidence and enjoyment of mathematics than boys, while at a nearby school employing a problem-based approach and no tracking, there were no gender distinctions.

Students accustomed to being grouped by ability described themselves and each other in terms of ability: “smart,” “fast,” “math wiz,” while students in mixed ability settings described themselves as part of a group working toward a common goal (Boaler, 1998; Boaler & Staples, 2008).

Finally, there is research suggesting that teachers can provide high quality opportunities for students with a range of background knowledge without grouping by ability through open-ended problems and the sharing of different solution strategies (Clarke et al., 2014; Murata, 2013; Russo et al., 2020; Sullivan et al., 2009). For example, Sullivan and colleagues (2009) shared how children with a range of incoming knowledge were able to engage substantively with common open-ended tasks, supported by a teacher who used enabling and extending prompts to engage different students in relation to their specific strategies. Both “competent” and “struggling” students were able to “participate fully in the lessons, to contribute to discussions, and to use and explain strategies that were meaningful to them” (p. 39). Recent research also suggests that teachers can be supported in effectively using such alternatives to ability grouping. Hunter et al. (2020) described a year-long program supporting 24 teachers to use heterogeneous or mixed ability grouping (where groups are formed so that students with differing incoming knowledge work together), open tasks, and meaningful use of student discourse. While there were challenges as teachers made substantial changes to their teaching of mathematics, overall they relinquished their beliefs in the necessity of ability grouping and researchers noted “a change in perspective about who could be successful doing mathematics” (p. 48). Students also saw the changes in grouping as positive, a “way for them to engage with a wider group of peers” (p. 52). This research shows that teachers can mitigate marginalization and reduce the stigma of “low/high” by creating spaces where “low” status students can make valued contributions (e.g., Russo et al., 2020).

These patterns and findings have led the National Council Teachers of Mathematics to call for an end to ability grouping and tracking at the elementary level, arguing that “any ability grouping in mathematics education is an inequitable structure that perpetuates privilege for a few and marginality for others” (2020, p. 27). However, simply putting students in mixed ability groups does not by itself mitigate the role of status. In some cases, teachers employ mixed ability grouping with the expectation that “higher performing students” can teach “struggling students," which may unintentionally exacerbate status differences (Jansen, 2012; Park & Datnow, 2017; Webel, 2013). In other cases, teachers are willing but unsure how to enact alternatives to ability grouping, expressing a need for school-based leadership and administrative support (Anthony & Hunter, 2017). More research is needed to provide additional examples of inclusively responsive instruction at the elementary level, where all students can be supported without grouping by ability. In this paper, we share our efforts to reduce ability grouping and to provide models for how more equitable approaches can be enacted. The research questions we address are:

1. What approaches did we (program designers) take to try to raise awareness about inequities in mathematics education, and how did this support critical reflection on the practice of ability grouping?
2. What approaches did we (teachers) implement in our efforts to reduce ability grouping, and what were our goals?
3. What successes and challenges did we experience in our efforts to reduce ability grouping and support equity in opportunities to learn?

Methods

Context

Webel and Dames were the Principal Investigator and Doctoral Research Assistant for the Missouri Elementary Math Leaders Initiative (MEMLI) Project funded by the National Science Foundation (NSF). The project funded 24 teachers in two school districts in a state in the Midwest portion of the United States to complete an Elementary Mathematics Specialists certification program (McGatha & Rigelman, 2017). The program takes two years to complete and includes 24 hours of graduate coursework focused on mathematical content and leadership. The MEMLI project continues to fund each of the participants for an additional four years to serve as leaders in their schools and districts. Funding for the project is not contingent upon positive findings regarding the use of ability grouping or any specific student outcome.

Table 1: Additional information about each teachers' professional context.

	Woldruff	Lindaman	Daugherty	Brown
Grade Level	Kindergarten	2nd	3rd	5th
Years of Experience	14	5	5	11
Number of students in class	19	22	24	22
School Pseudonym	Palm		Briar	
Size of school	~675 (K-5)		~680 (K-5)	
Percent FRL	~35%		~25%	
White percent	~60%		~75%	
Percent Black	~20%		~10%	
Percent Asian	~15%		-	
Percent Multi-race	~10%		~10%	

Webel and Dames worked closely with the 13 teachers who completed the program at the University where they worked, and Webel taught several of the courses taken by participants. Within this community, teachers and instructors shared a variety of professional experiences as they developed in their understanding of mathematics, their visions of mathematics teaching and learning, their conceptions of themselves as teachers and leaders, and their relationships with each other. Authors Woldruff, Lindaman, Daugherty, and Brown were teachers in the MEMLI Program who were invited to co-author this paper based on their commitments to alternatives to ability grouping as expressed through conversations and course assignments, as well as observed in teaching episodes. Details about their backgrounds and teaching contexts are provided in Table 1. At the time of the writing of this manuscript, teachers had been participating in the MEMLI Project for approximately 19 months.

Collaborative Action Research

This study fits within the general principles of "action research," which

> refers to a disciplined inquiry done by a teacher with the intent that the research will inform and change his or her practices in the future. This research is carried out within the context of the teacher's environment—that is, with the students and at the school in which the teacher works—on questions that deal with educational matters at hand. (Ferrance, 2000, p. 1)

More specifically, we see this project as *collaborative* action research (Miller & Pine, 1990), in which "teachers examine their own teaching and students' learning through descriptive reporting, purposeful conversation, collegial sharing, and critical reflection for the purpose of improving classroom practice" (p. 57). The goals of collaborative action research include bridging gaps between universities and schools, stimulating classroom reform, enhancing the professional status of teaching, and improving teaching and learning (Raymond & Leinenbach, 2000). In our case, each member of the team was oriented toward the same goal of reducing ability grouping in elementary mathematics teaching, but taking different paths, assuming different roles, having different experiences, and interpretations of those experiences. In bringing these experiences and reflections into conversation, we blur the roles of practitioner and researcher (e.g., Cai et al., 2017) and provide what we believe is a more complete and complex portrayal of a group of practitioners focused on a common problem.

In the production of this paper, our goal is to position each author as making contributions in line with their expertise. Woldruff, Lindaman, Daugherty, and Brown are experts with regard to their schools, their students, their curriculum, and many other aspects of their context. We acknowledge the power differential between the first author (Webel), who is a tenured professor at a research university, the second author (Dames), a doctoral student, and the remaining authors, teachers who are students in a program designed and often taught by Webel. However, in the production of this paper, our intention was that power would be used 'with, not over others,' (Irizarry & Brown, 2014, p. 65); we are all participants and we are all investigators. For Webel and Dames, we want to understand how the equity-focused activities we facilitated in the Elementary Mathematics Specialist program supported (or failed to support) teachers in trying substantially different and potentially risky instructional strategies. For Woldruff, Lindaman, Daugherty, and Brown, we want to understand how our efforts to eliminate ability grouping in favour of mixed or random grouping (placing students into groups using a random selection method) might have led to more equitable learning opportunities and experiences for our students.

Sources of Data

We draw on three sources of data to address the research questions. First, we include materials that were used to focus attention on equity within the EMS program, such as planning documents, assignment descriptions/instructions, and completed assignments submitted by teachers. Two assignments are particularly relevant to this paper: an Action Plan that was created by school based teams and then revised and updated over the course of the 2019-2020 school year, and a Target Student Journal, in which teachers selected a student whom they believed had been underserved with regard to mathematics instruction and documented their attempts to provide supports to this student (described more fully in the Results section).

The second source of data is a focus group that was conducted in the Spring of 2020 with each school-based team of teachers. In these focus groups, investigators talked with each team about their Action Plans: what they had envisioned at the start of the school year, how the plan had evolved, and what successes and challenges they had experienced.

The third source of data are artefacts drawn from our (teachers') classes related to our efforts to reduce ability grouping. These include student work, personal notes, teaching materials (both from our textbooks and created), and our own reflections about our teaching.

Data Presentation

In this paper, we present our data through descriptive narratives about the various components of the project with which each author had the most direct experience. As participant researchers who not only collected data but also created it, we have unique insights about the approaches we took, the processes in which we engaged, the reasons why we took certain actions, and the phenomena that we witnessed. We are also aware of the details of the context in which the data was produced and thus are uniquely positioned to interpret it. And finally, because we see the data from multiple perspectives, we understand different facets of the context in which our work was conducted, and in sharing these perspectives, we argue that we are establishing what Gellert, Hernández, & Chapman (2012) described as a "deeper ecological validity" (p. 346) than might be achieved were the narrative written by researchers only. That is, the validity of action research derives from doing research *with* participants rather than merely *on* them.

The narratives we share below are organized around the research questions, with different authors taking the lead in narrating different components and drawing on different data. We identify the lead narrators whenever there is a switch and use first person pronouns (both plural and singular) as appropriate. For example, to answer RQ1, we (Webel and Dames) draw primarily on the first and second sources of data to describe the kinds of activities we used to support teachers' critical reflection on equity in mathematics education. To answer RQs 2 - 4, we (Woldruff, Lindaman, Daugherty, and Brown), draw primarily on the third source of data to describe our experiences with reducing ability grouping.

Findings

Efforts to Address Equity on the Part of Program Designers

Summer Institute

One of the first experiences in the program was a Summer Institute, a week-long series of workshops providing an introduction to the content of the program and an invitation to begin (or continue) developing identities as leaders in mathematics teaching and learning. Prior to the Institute, teachers were asked to read *The Impact of Identity in K-8 Mathematics: Rethinking Equity-Based Practices* (Aguirre, Mayfield-Ingram, & Martin, 2013). During the Institute, teachers drew on ideas from the book to explore their own identities, identify ways to get to know their students' multiple identities, affirm those identities through their mathematics instruction, and promote positive attitudes towards mathematics for each student by understanding and drawing on student strengths (see Figure 1).

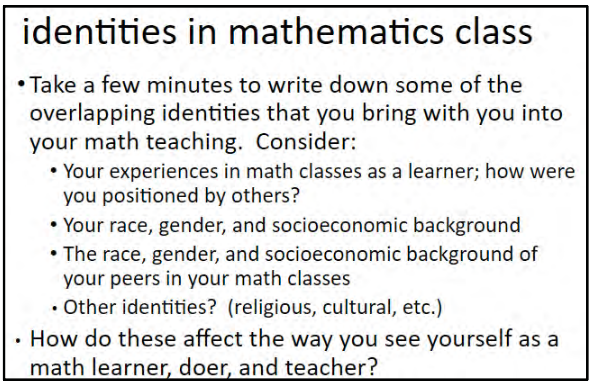

Figure 1. Identity reflection task from the Summer Institute.

The Institute also featured sessions in which teachers explored historic and current inequities in math education, including segregation of schools and disparities in discipline rates, funding, access to opportunities, and mathematics achievement based on race and income. For example, one evening they were asked to listen to the New York Times Daily podcast, *Linda Brown's Landmark Case* (Barbaro, 2018). The next day they shared what they had learned from the podcast in groups and created shared documents (see Figure 2), which reveal some insights about societal and educational inequities in the United States.

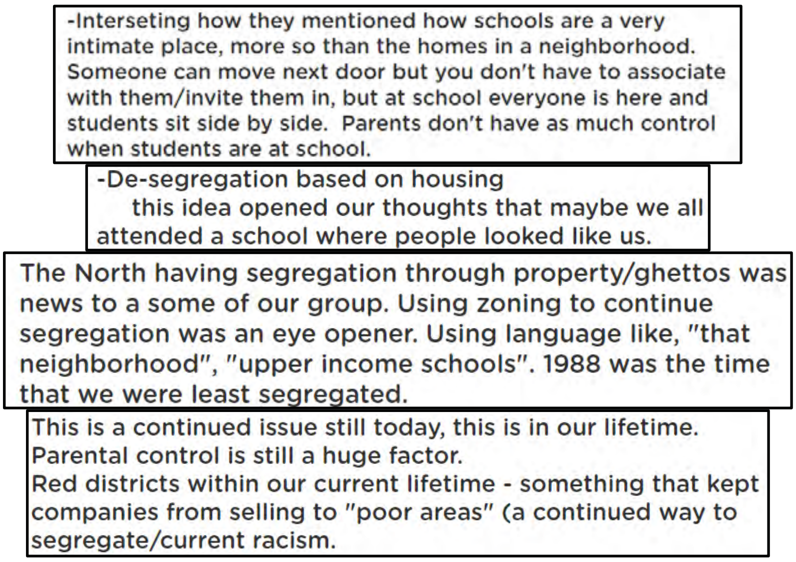

Figure 2. Examples of insights discussed related to the podcast on school segregation.

Another activity was to look up and discuss disparities using the interactive database at the Propublica website, *Miseducation: Is there Racial Disparity at your School?* (Groeger, Waldman, & Eads, 2018). On a later day, participants were asked to discuss the following scenario which specifically challenged the use of ability grouping and its consequences for equity:

> *You are expected to use ability groups (low, middle, high, etc.) for mathematics instruction. However, you notice that when you do so, almost all of the students of colour in the class are in the "low" group.*
>
> - *What are the implications of this situation?*
> - *What could you do to avoid this situation?*
> - *What could you do to raise awareness in your school about the potentially negative implications of this policy?*

Action Plans

At the end of the institute, school-based teams were asked to create Action Plans that they wanted to implement in their schools to improve mathematics instruction (see Appendix B). Several of the teams, including some of the authors of this paper, chose to address equity through curbing the use of ability groups (see Figure 3).

Action Plan Step	**Action Plan/Responses**
Goal for year: What do you want to accomplish this year? Be specific and keep in mind that we have 6 years of work towards your vision! (For example, your goal could be to implement number talks and to support other teachers in doing so.)	Implement student grouping strategies that are not focused on ability and provide access to tasks of higher cognitive demand to all students.
Actions to be Taken What specific steps will you take in reaching the vision you described above? (For example, development of instructional expertise, management of	2019-2020: • Restructure math block (no more ability groups) • Implement with number talks and multiple entry tasks. • Begin work with colleagues and gain teacher "buy-in" through our building's Math Committee.

Figure 3. Portion of Action Plan developed by Lindaman, Daugherty, and Brown during the Summer Institute.

The Action Plans were revisited, revised, and discussed throughout the subsequent school year (2019-2020). In the Spring of 2020, we engaged in focus groups with each school-based team to discuss their Action Plans, and we specifically talked with the Briar team about their plan to eliminate ability grouping. Over the course of the school year, the Action Plan assignment provided structure around which the Briar team was able to focus their efforts to reduce the use of ability grouping.

Target student journals

As a part of their coursework, we asked teachers to select a "target student" who "has not been adequately supported with high quality opportunities to learn mathematics in school" (see Appendix A for the full guidance we provided for Target Student selection). Over the course of the school year, they were asked to keep and share journals documenting their efforts to address issues of identity and practices to support marginalized students. We included the instructions:

> In all of these journals, you are strongly encouraged to see ***students in terms of their assets (what they can do, what they know, etc.) rather than their deficits (what they can't do, what they don't***

> ***know, etc.)*** If students are, or have been, unsuccessful in mathematics, *you are strongly encouraged to see this lack of success as a function of the opportunities they have been provided with in school rather than a function of their inherent ability* or the resources and support they are provided at home. (emphasis in original)

The rationale for this assignment was that, in focusing attention on the experiences of a single student (who might otherwise be overlooked), teachers might become more aware of how their current mathematics teaching practices might exclude or fail to support students on the margins more generally, and then make changes to their practice. Teachers were paired together to share their journals and discuss what they had learned from trying to understand the experiences of their target student and how this impacted their instruction. They were encouraged to think of their work as "collaborative problem solving" and to "provide compliments, suggestions, and insights as you work to support your students." In later sections, Woldruff and Lindaman will share how she used the Target Student assignment to document how her efforts to reduce ability grouping impacted her target student.

Summary

Our efforts to support teachers in considering equitable mathematics instruction were embedded across multiple courses and activities. We examined equity at various grain sizes, from society at large to interactions with individual students, with the goal of empowering teachers to recognize ways in which their mathematics instruction can either reinforce or challenge these inequities. In the next section of the article, Woldruff, Lindaman, Daugherty, and Brown share some of their experiences in attempting to enact more equitable instruction, specifically by reducing their use of ability grouping.

Woldruff's Story

In my mathematics teaching, I (Woldruff) see my role as the facilitator and ask questions to help students make mathematical discoveries and connections between concepts. I work to implement math experiences that provide students opportunities to practice previously learned skills, make connections to new math skills/concepts, and analyse/justify their strategies through various discussions. For 12 years, I taught math in thematic units: a month on shapes, three weeks on numbers 0-10, etc. For the past three years, I have used a curriculum that utilizes a spiral approach to teaching math concepts. In both instances, when I noticed students were disengaged and weren't mastering grade-level expectations, I searched for new strategies and activities. I often thought, "How can I keep them engaged while developing their mathematical understanding?" In the fall of 2018, I started implementing daily collaborative math groups in my kindergarten classroom where students were grouped by mixed ability levels – heterogeneous groups.

Dana's assets and challenges

During the 2019-2020 school year, I noticed a kindergarten student named Dana (a pseudonym) struggling with various math skills/concepts, such as counting using one-to-one correspondence, rote counting, subitising, number identification, and number writing. She also struggled with confidence in making contributions to class discussions. She loved raising her hand, but when she was called on to share her ideas, she would become uncomfortable and shut down. I interpreted these patterns as related to discomfort with increased attention and a lack of confidence in her mathematical ideas. I wanted to know more about how she thought of herself as a learner and whether I could use my mixed ability math groups to better support Dana's learning and confidence.

I selected Dana for my Target Student Journal assignment and began to track her mathematical assets, her successes, and progress over the course of the year. In my first journal entry (September 16, 2019), I noted that Dana was "eager to share her ideas," and described some of her math capabilities: "During Math class, we have recently started using 'Quick Looks' with dot images to five and she does a good job 'seeing' the dot arrangement and is improving on her ability to describe what she sees." However, I also believed that Dana "does not necessarily like everyone's attention on her," and in a later entry I shared about how the presence of other students seemed to affect her participation:

> Dana was excited to check out a new activity called "Block Buddies" where students visually build a structure to match a picture card. Another student saw us and asked to join, which of course we let him. While working, I noticed that Dana gradually stopped working. I discovered that when she would place a block incorrectly, the other student would quickly fix it and this was bothering her… After seeing how Dana was "shutting down", I know that I am going to watch her group carefully and make sure that she doesn't "shut down" as she sees other students solving problems/completing tasks quicker.

Focusing on how Dana was experiencing working in a group helped me see that her disengagement could be related to how she viewed herself and her mathematical competence in relation to her classmates.

The role of ability grouping and status

I have found that allowing students to work in cooperative mixed ability groups helps expose students to new strategies and ideas. In mixed ability groups, each groupmate was able to provide ideas from their experiences, and students began to appreciate the idea of their peers. In my journal entry from November 17th, I also noted that mixed-ability grouping "gives me more flexibility in which students I work with and how often I can meet with them, in turn removing some of the math 'status' in the classroom."

I found that posing open-ended questions allowed students to utilize a strategy that works for their level of learning and understanding, and also to provide valuable information to their group. For example, some students used manipulatives while others used drawings. But I soon began to see how I also needed to take personality traits into consideration. Some students exhibited more patience than others, and this was playing a significant role in Dana's willingness to contribute in a small group setting. As I wrote in my journal:

> I am also being very careful with who I pull to work with her.… I have some very sweet and patient students who do well working with others who need 'time' to think before answering…and this seems to be beneficial for Dana.

When thinking about who I wanted Dana to work with I knew I needed a peer that would be able to provide "think-time", while still offering a new strategy/idea that could stretch Dana's mathematical thinking.

Dana's increased confidence and mathematical development

Over the course of the year, Dana developed cognitively, socially, and in her identity as a math learner. When the year began, Dana was reluctant to speak in front of others and rarely asked for help. On occasion, she would break down in tears because she was unsure where to start. Over time, I began to see a change in Dana, as noted in my October 20th journal entry: "I have also noticed that Dana is much more willing to ask for help. I feel that this indicates that she feels comfortable and safe to work through problems knowing I am there."

I strategically placed Dana where I could easily monitor her during whole class and small cooperative group formats. I noticed that she more consistently continued working on her own or with her group even when I left to check on another group. She began to take more risks and become more independent, as I described in my November 17th journal entry: "We have talked a lot as a class that it is okay to make mistakes. This has proven very helpful as Dana is raising her hand a lot more and willingly shares her ideas/thoughts/strategies. She also doesn't get upset now when she finds that her idea/answer/strategy is incorrect or inefficient." In January I noted that "...she continues to have a positive outlook on math."

While academic growth was apparent, the growth in Dana's social development and identity development was especially notable. She started to see herself as capable of doing mathematics and saw that her input was valued by all members of our classroom community. In mid-February, I interviewed Dana as part of a project to explore how students viewed working in groups. She reported that she liked math and liked "working with friends during math" because, "I feel good because they are my friends and it makes me learn." These interviews suggested that my students enjoyed working with "friends" and valued exchange of dialogue in small, mixed ability groups.

Challenges

Dana's cognitive growth with regard to math concepts/skills was still slow at times. At the beginning of the year, Dana struggled counting sets of objects to six using one-to-one correspondence. However, she showed perseverance and began to count sets of objects in the tens with minimal errors, and if she lost count would start over without getting frustrated. I also saw how she progressed in her ability to subitise groups of dots when using dice during math games/activities, whereas she originally would count each dot on every roll ("I have observed her being successful when subitising 0-6, particularly when she's using dice"). Although her academic growth was slower than I had hoped for, her increased mathematical self-efficacy and willingness to persist through difficult tasks was an important development.

Ability Grouping at Briar Elementary (Lindaman, Daugherty, and Brown)

When our school first opened, daily differentiated instruction in small groups was a building-wide expectation, with an emphasis on the use of rotating "stations" and little emphasis on whole group instruction. Our small math groups were constructed based on ability, determined by a student's performance on a standardized assessment. These "ability groups" were formed with the intention of tailoring instruction to meet the specific needs of students.

We had always used ability grouping because that was what we knew. But as a team we were unsatisfied with our math teaching; we were simply delivering the lesson to the whole class and then drilling concepts with our predetermined "low", "medium" and "high" small groups. The low students were working on skills and concepts well below grade level, while the high students were completing enrichment projects and activities. Though ability grouping seemed worthwhile during moments where some of the "high" students "got it," we later realized we were failing to do the same for students who were placed in the "low" groups. These students were rarely exposed to new strategies and ways of thinking and were not seeing a lot of growth, while our "high kids" were being pushed to excel. This made us realize that we weren't giving all students equal opportunity and access to the math curriculum we were teaching.

Attending the MEMLI Summer Institute motivated us to change the structure of our math instruction. We hoped that by switching to mixed ability or random groups all students would get opportunities to engage in rich mathematical tasks, no matter what "level" they were according to standardized tests. We were also hoping that implementing mixed ability groups would create a more positive, rich, and equitable experience and support all students to develop a love of math.

Lindaman's story

After the Summer Institute, I (Lindaman) started the year by incorporating mixed ability grouping into my math instruction. Before doing mixed ability grouping my approach to teaching mathematics was very different. Generally, I would start with a whole group lesson using a direct instruction model ("I do, we do, you do") and then I would move into ability-based math groups to go over the content with each group. When I made the switch to mixed ability grouping as part of our team Action Plan, I began to see an increased confidence and willingness to share ideas and strategies. This was particularly evident in the student I selected for my Target Student assignment, an African American boy named Gavin (a pseudonym).

At the beginning of the year Gavin was very reserved and seemed to lack confidence in his mathematical ability. He began the year using mostly direct modelling strategies to solve story problems (e.g., acting out the problems with objects), and had received relatively low scores on our beginning of the year assessments. Gavin also found himself being pulled from class as a result of school disciplinary policies, and this was a concern I noted in my first journal entry:

> I believe the time he spent out of the classroom caused him to have missed opportunities to be supported with high quality mathematics instruction. I think the kids around him saw the behaviour issue and began to devalue his opinion in math. I even see this starting to happen this year. I want him to see himself as a mathematician and I want others to see him that way, too!

I was concerned about Gavin's status among his peers and that he seemed to have a "very negative view of himself as a mathematician" (Journal #1). I also wondered if opportunities to develop a positive disposition towards mathematics had been limited in his previous school experiences due to perceptions regarding his socioeconomic background and race.

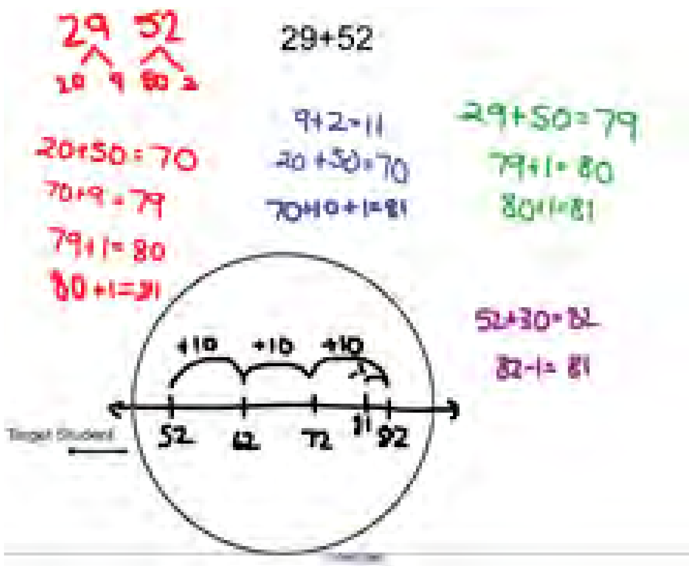

Figure 4: Gavin's solution for 29 + 52.

When I had previously used ability grouping, a student like Gavin would not be exposed to multiple strategies because in our ability group structure, we would focus on a specific skill that they needed to work on and limit the number of group members to a few, all of whom tended to use similar strategies. When I decided not to use ability grouping, I adopted some new practices to promote broader sharing of ideas. For example, we did number talks to begin math most days, which allowed my students to share strategies and connect ideas across the entire class (Parrish, 2010). During a whole class number talk towards the end of the year, Gavin shared the strategy circled in Figure 4 for 29 +52. Several students had shared the other strategies, which involved various decompositions, place value reasoning, and compensation. Gavin's number line solution showed 3 jumps of 10 from 52 (landing on 82), and then a single jump back to 81. This was not only significant academic growth from the beginning of the year, where he primarily directly modelled operations using ones, but also showed substantial growth in my target student's mathematical confidence. Doing mixed ability grouping allowed our class to be accepting of and exposed to different math strategies.

Daugherty's story

Like my colleagues above, when I (Daugherty) began to use mixed ability and random grouping, I noticed that all my students, not just those with strong mathematical identities, were engaged in rich learning. Utilizing this strategy also freed me as a teacher, as I no longer had to plan different activities for each group of students, as I had been doing in previous years. Instead of having students rotate into my "Meet with the Teacher" station to engage in levelled content, all of my groups received a low floor, high ceiling task[1] that was grade-level appropriate. This gave me the chance to conference with each group about the same task. I was also able to ask questions to extend student thinking and problem-solving, which helped me determine what we needed to discuss when we came back as a whole class.

One particularly powerful learning experience involved the following task: "How many squares, hexagons, and pentagons can you make if you had 55 popsicle sticks? Each popsicle stick represents one side of the shape. List every combination you can come up with." For this problem, I randomly put students into groups of 3 or 4. While students worked on this problem, I went around facilitating conversations with guiding questions. One group started by drawing every shape and labelling how many sides it had, while another looked at their resource book. During the next part of the problem, students began experimenting with the "55 popsicle sticks." Some students drew out each shape as they were counting so they could then count the total number of "popsicle sticks" for all of the shapes. Some groups represented each shape with just its number of sides and tried adding up until they counted 55, while others began finding multiples of the sides, adding them together to get 55. I tailored some of my questions to each group, but often I simply asked students to, "Tell me more," or "Can you explain what you did here?" These questions guided the students without directly telling them which strategy to use. Even for the students that were able to calculate more quickly, we discussed if there was a way to create an algebraic sentence to know how many shapes and combinations you could always create. Once students were done, they discussed their ideas, challenging each other with questions and responding with detailed explanations. I had not observed these kinds of conversations in my previous years using stations and ability-based groups.

Another assignment also highlighted the changes in how students experienced my mathematics teaching. At the beginning of the school year I had asked students to show me what a mathematician is to them by filling in an outline of a body. The first time they did this, they drew a lot of symbols and wrote statements such as, "Someone who can do math fast," or, "Someone who knows all their facts." The following year (I "looped" to fourth grade and stayed with my same students) I was quite pleased to see that students answered with some of the same symbols, but this time drew hearts on their illustration of a mathematician and wrote statements such as, "A mathematical (mathematician) can help someone with math if they want help," and "...is someone that can explain math even if it is hard to explain to other people … can find an

[1] A "low floor, high ceiling" task refers to an open-ended task with multiple entry points, so that students with a variety of incoming knowledge can all engage and learn from the task.

answer to a problem they don't know if they can't move on." I was happy to see that one of my students, who would have been deemed as "low achieving," because of his math scores on a standardized test, articulated that all mathematicians come in contact with difficult problems but they work through them. This, to me, indicated a positive mathematical disposition that was connected to the ways I had been positioning him, and all of my students, over the course of the previous year.

In my previous stations-based approach to teaching, my "lower" ability math students would not have had access to the kinds of extensions and connections that I saw as a result of our Action Plan, and I believe they came to see themselves as capable learners of mathematics. I believe this new structure also created a more comfortable learning environment for my students.

Brown's story

When I (Brown) first began teaching at my current school, I used a similar structure as described above. I began my math block by teaching a whole group lesson which focused on a particular standard, then transitioned to differentiated small group instruction, and often felt as if I was creating 5 or 6 different lessons for each math block. I also noticed that there was never much movement between my groups throughout the year. If a student was sorted into the "low group" at the beginning of the year, they typically stayed in the "low group" as the year continued. When I started implementing mixed ability groups and partnerships in my classroom, I began to see real growth in how my students were thinking about math. I have learned that listening to strategies used by their peers gives students who would have normally been placed in the "low group" exposure to hearing new ideas and strategies to solve problems, which rarely happened in my classroom in previous years.

One example of how my students' thinking changed occurred during a lesson focused on solving "fraction of" problems. My class was shown a problem, ⅕ of 25, and then asked to talk with their math partner about how they would solve it. Then, I gave the students time to solve. This was the first time my students had been exposed to "fraction of" problems so they were required to invent their own strategies to solve the given problem. During the time they talked with their partners, I observed two students, who I will refer to as Cade and Gemma, engage in a very productive conversation. Gemma is a student who would have been sorted into the "low group" in years prior. As a result, she had developed low confidence in her mathematical capabilities and sometimes struggled to find an entry point into math tasks. Gemma saw this particular problem and said, "25 is too big. I can't do that." Cade, her assigned math partner, took Gemma's idea of 25 being too big and invented a strategy to help her. Cade shared a strategy of partitioning the number 25 into smaller numbers first (10, 10, and 5), finding ⅕ of those parts (2, 2, and 1), and then adding those parts together at the end to get the answer (see Figure 5). This strategy was unique, and provided an entry point for Gemma, who had initially resisted engaging in the task. If grouped by ability, this partnership would not have occurred, and the sharing of ideas would have been limited.

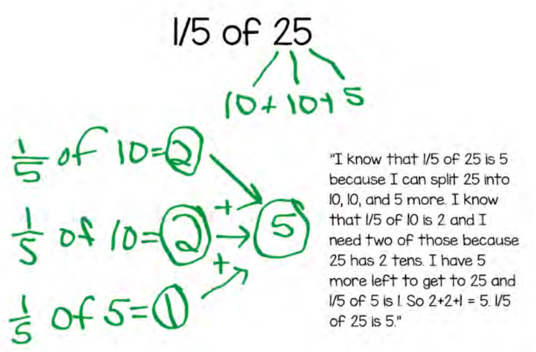

Figure 5. Cade's strategy for ⅕ of 25.

In other instances, students who would have been sorted into the "low group" made substantial contributions to their mixed ability group. One example of this occurred when I was introducing the topic of multi-digit multiplication to the class. I posed a 2-digit by 2-digit multiplication word problem to each small group and asked them to solve the problem using any strategy they wanted. When it was time to share, a student who would have been considered "low" confidently shared her way of solving the problem using repeated addition. Some of the other students in the group were confused on how she arrived at the same answer that they did using a completely different strategy. This allowed for some powerful conversations and connections to be made between repeated addition and multiplication.

Influence within Briar Elementary School.

After we (Lindaman, Daugherty, and Brown) had received support for eliminating ability grouping from our school administrators, they gave us opportunities to share some of the instructional strategies and discoveries we had learned with our fellow teachers. They allowed us to take the lead of our math curriculum team, which gave us an opportunity to share some of the mathematical practices that we were observing in our classroom. Along with that, I (Brown) found that I became a leader on my team for others to ask questions about math instruction. One specific team member even began to mirror his instruction after my own. He asked to meet to discuss the structure of my math block and wanted advice on how to implement mixed ability groups and partners with his own class. We met regularly to discuss how things were going and he saw positive changes not only in the way his students were performing academically, but also in his students' attitudes toward math.

Once our principals had a chance to observe our classrooms during math instruction, they asked if multiple leaders in our district could do a "walkthrough" to observe what we were doing. Afterwards, we debriefed the observations, and the district leaders were enthusiastic about us teaching math in a seemingly more equitable way. Most recently, we were asked by our principals to lead a discussion with new teachers to our building, focusing primarily on their questions about effective math strategies in our classrooms. As we learn more in our program, we continue to apply what we are learning in our classroom and inform other teachers in our building about our experiences using alternatives to ability grouping.

Summary of Cases

Across the cases, we found that using alternate grouping strategies reduced the stigma that ability grouping had seemed to perpetuate. Students like Dana, Gavin, and Gemma, who might have previously been assigned to a "low" group, were able to make important contributions to class discussions, and exhibited increased confidence over the course of the year. We found that by using open tasks and facilitating conversations about a variety of solution strategies, students with a variety of incoming levels of understanding were able to engage with each other's ideas and deepen their thinking (Sullivan et al., 2009). The mathematical conversations in our classes were richer, deeper, and more connected across mathematical concepts, and we also found planning easier because we did not have to plan different lessons for different groups. In addition, we were encouraged that colleagues at Briar Elementary became increasingly interested in learning from our experiences.

Discussion: Our Experiences Reducing Ability Grouping

Each of us experienced some success with moving away from ability grouping in class. Woldruff, Lindaman, Daugherty, and Brown saw low-status students make important contributions and exhibit increased confidence over the course of the school year. Webel and Dames saw teachers changing their practice in important and potentially risky ways, such as incorporating an approach to grouping that deviated from sanctioned school practices and using class time to engage students in rich mathematical tasks and discussions instead of prioritising content coverage or test preparation. We witnessed many reports of improved positivity towards mathematics and more inclusive participation from potentially marginalized students.

However, challenges still remain. We recognize that some challenges are bigger than the math classroom, such as poverty, discrimination, and lack of access to resources (e.g., Rooks, 2017). Some school structures work against equity, such as school suspensions, which pull students out of learning environments (as Lindaman described with Gavin), and school policies that endorse or mandate ability grouping (Park & Datnow, 2017).

We also recognize we are on a trajectory in our pursuit of equitable mathematics teaching. As providers of experiences for practicing elementary teachers, we (Webel and Dames) are experimenting with assignments that we have never used before. We are challenging groups of predominantly white teachers to examine assumptions about systems of education that, for the most part, "worked" for them. We are asking them to wrestle with questions of identity and to critically examine their own practice for implicit bias (Copur-Gencturk et al, 2020) and reproduction of societal hierarchies (e.g., Oakes, 2005). These approaches are relatively new for us, and we are sure that future iterations of the program will provide opportunities for improvements. For example, we see too many divisions between aspects of our program that are focused on mathematics and aspects that are focused on equity. Also, as white men, we are becoming increasingly aware of the systems that have advantaged us and provided the platform to inquire into teachers' experiences. We hope to become more sensitive to the ways in which we use our privilege in professional development or teacher education settings.

As a teacher, working with Dana has helped me (Woldruff) to reflect on my pedagogy and recognize where I need to make adjustments to better meet the needs of my students as mathematical thinkers and valued members of a classroom community. Often, there is pressure to track student progress cognitively, but cognitive development is only a small part of helping a student progress in their overall mathematical development. This project helped me see how all aspects of a child are important, including social, physical, and identity development. For marginalized students in particular, one way to foster growth in all of these areas is through forming mixed ability groups where students' academic strengths, interpersonal strengths, and life experiences are considered. Throughout the year, Dana's math identity benefited in areas of self-confidence and perseverance to work through productive struggles because the mixed ability groups provided her a safe space to ask questions and try new strategies that she might not have otherwise attempted. As my next steps I am hoping to have open, honest conversations with fellow teachers to reflect on our pedagogies. These conversations become personal and make us vulnerable, but it is often through reflection that we discover practices that we thought were "right," might be flawed.

As teachers, we (Lindaman, Daugherty, and Brown) have developed many strategies for using mixed ability and random grouping to support mathematics learning and positive mathematics dispositions. We found that, in comparison to our previous practice of grouping by ability, our students were more engaged and motivated, more confident, and had more access to a variety of strategies and ways of thinking (Sullivan et al., 2009). We also found value in sharing with each other these efforts, especially in terms of encouragement and solidarity regarding the adoption of new practices. Because ability grouping was so ingrained in our school culture, these changes felt risky. Having partners to share experience with made us feel more less exposed, and also bolder in explaining our ideas to our administration.

In addition, we were surprised by the willingness we found in our colleagues to consider new approaches to mathematics instruction, and we want to build on opportunities to share more of our experiences and continue to learn from each other. This aligns with Hunter and colleagues' (2020) observation that teachers are looking for alternatives to ability grouping but desire more support and advice for how to implement these alternatives. In the future, we want to experiment with the difference between grouping students *randomly* versus strategically putting them in *mixed ability* groups. In general, we want to continue developing strategies to support marginalized students, and to increase awareness of alternatives to ability grouping.

Conclusion

In this paper we have shared experiences from the perspectives of designers of a program aimed at developing leaders in mathematics teaching at the elementary level, as well as from some of those leaders-in-training as they worked to make significant changes to their practice. These experiences add to the research literature by providing cases of how teachers might work to reduce ability grouping and how students with a variety of incoming knowledge might benefit from approaches to teaching that emphasize sharing, discussing, and revising different strategies for solving open ended tasks. Our work also provides a case for how teacher development programs can encourage teams of teachers to identify problems of practice related to equity and work together to understand and address these problems (Scribner et al., 2007). Our collaborative action research approach (Miller & Pine, 1990) allowed us insights into aspects of our work that are unique; it is rare for researchers to co-author papers with teachers, and we hope that readers will be encouraged to engage in this kind of generative, collaborative, and practical work.

We also note that this study speaks to our experiences, which may have limited application to the experiences that other teachers and teacher developers might have in other contexts. We hope that readers will take what is useful and relevant to their contexts, build upon those aspects, and continue to study the implementation of alternatives to ability grouping.

We believe that addressing ability grouping is critical to creating more equitable mathematics instruction at the elementary level (NCTM, 2020). Our experiences show that there are alternatives to ability grouping that can, in fact, meet the needs of students with different levels of incoming knowledge. By creating environments where multiple forms of competence are valued, where thinking and talking about math counts for more than answers, and where multiple strategies and representations are the expectation, students from many backgrounds can thrive. We have found that not only can teachers create these environments, some are actively looking for a more equitable way of teaching mathematics (Anthony & Hunter, 2017). We look forward to future research exploring more possibilities for supporting teachers and teacher leaders in adopting, sharing, and continuing to develop equitable teaching practices.

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