

Spring 5-22-2021

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Recommended Citation

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**AN EXPLORATION OF MATH TRAUMA THROUGH ABILITY GROUPING AND
TEACHER LANGUAGE IN ELEMENTARY SCHOOLS**

by

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A project submitted in partial fulfillment of the requirements
for the Bachelor of Arts degree in Honors Liberal Arts
Seattle Pacific University
2021

Presented at the SPU Honors Research Symposium
May 22, 2021

Abstract

This literature review approaches the question of ability grouping and other forms of teacher communication in elementary school math curriculum through the lens of equity and student outcomes. Types of grouping practices in elementary schools are discussed, along with the positives and negatives of each general form of grouping, with special consideration paid to the topic of math trauma and the ways that ability grouping contributes to it. This review concludes that teachers have a profound effect on students and that students have a profound effect on one another, leading to a discussion on the moral and ethical responsibility that exists between a student and various authority figures in their life.

Keywords: Ability grouping, math trauma, responsibility

Which students are the true beneficiaries of the United States Education System? Are there students who are destined for success in our schools before they even step through the door? Alternatively, are there other students who seem to begin their school careers already being blamed for their failures and riddled with math anxiety, when in fact it is the school system that has failed them? It seems intuitive that questions such as these — those seeking to root out the heart of education in this country — would be common, even encouraged. Unfortunately, questions that stem from an intuitive feeling that there is a lack of equity rarely surface easily; this is how inequity begins, and this is how inequity persists.

As a senior in the education program at Seattle Pacific University, I have had the privilege of being a student teacher in a fifth grade classroom at a local elementary school. Even at the young ages of ten and eleven, I have witnessed how some students carry themselves with assurance, asking questions freely and participating boldly, while other students are reluctant to speak or participate in any way. I do not believe that this is a coincidence or that it can be chalked up solely to “personality.” Math itself is an incredibly open subject. Mathematics professor Jo Boaler (2016) writes that “Mathematics is a very broad and multidimensional subject that requires reasoning, creativity, connection making, and interpretation of methods; it is a set of ideas that helps illuminate the world; and it is constantly changing” (p. 20). If math is truly a subject that is open to all and requires a diverse skill set centered on creative thought, why do huge gaps in confidence and achievement exist?

Even as early as second grade I clearly remember my teacher telling me and my parents during a conference that I was “gifted at math, but that I was also very humble about it.” Of course I was humble — I had never been told that I was good at math before! I didn’t know that it was possible to be “better” or “worse” at any subject than my friends. I was not born believing

in the superiority of some over others. Nevertheless, this comment, which came from an adult who I looked up to, stuck with me and built confidence. I went on to participate in local math competitions, to skip eighth grade math, to take calculus, and to attend a university where I decided to major in elementary education with a concentration in math.

I do not share all of this to make the point that I believe that I am somehow predisposed to be better at math than my peers. Far from it! The moment that sparked my journey with math was not a moment of personal enlightenment, it was the moment that my teacher *told me* that I was capable. I believe that I became who I was told that I was. I am not the anomaly here; all students are formed by the verbal and nonverbal communication that they receive from their teachers and other authority figures in their lives. It is only when we begin to believe in this and explore the ramifications of it that we can begin to unpack what it takes to be a positive force in the classroom.

This literature review seeks to make sense of current practices in elementary school math curricula, particularly practices of grouping students in various ways based on ability. It also seeks to uncover the close link between teacher language towards students regarding both student ability and math as a subject at large and the ways that students achieve as a result. In order to be an impactful and equitable teacher in today's classrooms, it is imperative that each teacher understands the power that they hold and how they might best use that power of communication to support student learning and outcomes.

Literature Review

There are countless factors that influence the success that students experience in school in the realm of mathematics. The natural curiosity that young children have towards the world around them is the perfect grounds on which to build a solid foundation of mathematical

reasoning, and yet even at ages as young as five, children may begin to have anxiety that is rooted in math (Boaler, 2015, p. 73). In the following sections, I discuss some factors that may contribute towards the negative associations that are formed by many students regarding the learning and doing of mathematics. I also discuss some ways that teachers can make a positive impact for students, including the elimination of timed testing, thoughtful communication regarding student ability and performance, and choosing tasks that set all students up for success through positive messages and high expectations.

Math Trauma

It is impossible to discuss inequity in math education without addressing the reality of math trauma. Math trauma is a term that encapsulates the mental shutdown and extreme anxiety experienced by some people when they encounter math. Assistant professor of mathematics education at the University of Oregon, Jennifer Ruef (2021) writes that “Math trauma manifests as anxiety or dread, a debilitating fear of being wrong. This fear limits access to life paths for many people, including school and career choices”. Anxiety related to math is all too common, with an estimated 68% of students experiencing math anxiety and about 10% experiencing levels of anxiety high enough to be in need of counseling (Dowker et al., 2016, p. 3). Though there are multiple causes of math anxiety and there is no one change that could cure it, teachers are in a position to make a tremendous positive difference.

Ability and Intelligence

Perhaps some semblance of an answer to the ever-complex question of ability grouping and best teacher practices lies in the very core assumptions of ability grouping, namely how ability is defined by teachers and school systems. The Cambridge English Dictionary defines ability as “the physical or mental power or skill needed to do something” (“Ability,” n.d.).

Teachers and schools generally base their assessment of students' ability in a particular area on a number of data points collected through assignments and tests as well as through their interactions with the students.

I would be remiss to explore ability and ability grouping without first addressing the assumptions which the practice is founded upon. The underlying assumption in the practice of ability grouping is that schools know exactly who has ability and how much of it they have. It is on this measurement of a child that we determine where they fall and what we must do to push them along in the right direction. But, what exactly *is* ability? The longer that I spend in a traditional school setting through my internship, the harder it is to answer this question. I feel the pull of requirements to test and gather data. I feel the pressure of surviving another year, of keeping kids quiet and focused and on task. It is clear that the ability to remain quiet and answer questions quickly and correctly, to speak when spoken to, is what is really being assessed.

In 1998, American developmental psychologist Howard Gardner wrote an article for *Scientific American* about his theory of ability and intelligence in relationship to past theories. Before Gardner, it was widely considered that there was one kind of intelligence (general intelligence), that an individual's intelligence was mostly fixed from birth and rarely changed, and that intelligence could be assessed quickly and easily with an IQ test or by analyzing patterns of brain waves (p. 18). Furthermore, Gardner posited that even in the opposition that existed towards this theory there was a commonality in the fact that all commentators centered their beliefs on the idea that knowledge could be gleaned from tests and data collection (p. 18). Gardner situated himself in stark opposition to this theory, asserting that there are in fact many kinds of intelligence, and that ability and intelligence are not so easily defined as we may think. He proposed a new definition of intelligence: "...an intelligence is a psychobiological potential to

process information so as to solve problems or to fashion products that are valued in at least one cultural context” (p. 19). This definition leaves room for the valuation of many kinds of skills and ways of interacting with the world.

Intelligence exists at least partially outside of the narrow definition that teachers and schools are employing. It exists in a land of creativity and complex problem solving. It exists in developing empathy and communicating well as much as it exists in testing well and being well behaved. There is no way to assess all intelligence with a multiple choice test and we should not try. When we as teachers and schools insist on maintaining ability grouping as a practice, we are sending a clear message that we have decided what success and intelligence look like for our students and that they must fit our narrow definition as determined primarily by data gathered through homework and test scores.

Types of Intelligence. According to Howard Gardner, there are nine distinct types of intelligence: naturalist intelligence, spatial intelligence, linguistic intelligence, intrapersonal intelligence, interpersonal intelligence, existential intelligence, logical-mathematical intelligence, musical intelligence, and bodily-kinesthetic intelligence. Each kind of intelligence is described in Table 1.

Table 1

The Types of Intelligence

Naturalist Intelligence	Understanding living things and reading nature
Spatial Intelligence	Visualizing the world in 3-D
Linguistic Intelligence	Finding the right words to express what you mean
Intrapersonal Intelligence	Understanding yourself, what you feel, and what you want

Interpersonal Intelligence	Sensing people's feelings and motives
Existential Intelligence	Tackling the questions of why we live, and why we die
Logical-Mathematical Intelligence	Quantifying things, making hypotheses, and proving them
Musical Intelligence	Discerning sounds, their pitch, tone, rhythm, and timbre
Bodily-Kinesthetic Intelligence	Coordinating your mind with your body

Note. Adapted from Vital, M. (2014, March 17). *The Types of Intelligence* [Infographic].

Adioma. <https://blog.adioma.com/9-types-of-intelligence-infographic/>

Gardner's (1998) theory of multiple intelligences makes two claims about these nine types of intelligences. The first is that every person has all of these kinds of intelligence — that the possession of these abilities is in fact what it means to be human. The second is that no two humans have the same combination of strengths and weaknesses in regards to the nine intelligences. Gardner's theory of multiple intelligences carries with it a strong hope for the future of education. He writes that “the theory also holds out hope that more students can be reached more effectively, if their favored ways of knowing are taken into account in curriculum, assessment, and instruction” (p. 20). This hope has a special importance in the area of math, where there is a huge emphasis on giftedness and natural ability.

Though logical-mathematical intelligence certainly exists, it is not the only kind of intelligence that is useful to doing math. Doing math takes great spatial awareness, an ability to “recognize and manipulate the patterns of wide space” (Marens, 2020). It also takes linguistic intelligence, the “capacity to use language to accomplish certain goals” (Marens, 2020).

Anyone who has taken a proofs class knows that math requires clear writing and communication. Furthermore, in order to work in groups, share mathematical ideas with one's peers, and to have the courage to speak up and ask good questions, one must have interpersonal intelligence. Group work is a huge priority in elementary math education today because it models the real world, where we must work collaboratively with our colleagues.

Regardless of what one believes about intelligence and ability, the effect that these beliefs have on grouping practices in the classroom deserve consideration. When students are being grouped by ability in mathematics, they are in fact being grouped at least partially by their ability to test well, answer questions quickly, and memorize certain answers and solution pathways (Boaler, 2016). Where there is no freedom to pursue math in a variety of ways, using a variety of skills, it becomes very difficult to teach in heterogeneous groups. It becomes incredibly impractical to set up a classroom that is based on anything other than the narrow definition of ability that is used.

Types of Grouping Practices

A huge form of communication in the classroom is the way that the classroom itself is structured to serve certain students via grouping practices. Grouping is a form of nonverbal communication between teachers and students. Though there are many kinds of grouping practices, some of which will each be explored here, they are all united under the fact that they involve some way of separating students based on ability as a prerequisite for instruction.

Between-Class Ability Grouping. First, between-class and within-class ability grouping must be distinguished. "Curriculum tracking" is a kind of between-class grouping and refers to "broad, programmatic divisions that separate students for all academic subjects" (Gamoran, 1992, p. 11). In this model, students are put in grades not according to age, but according to

ability. This could also be described as the “Non-graded Plan.” In the Non-graded Plan, “...grade-level designations are eliminated. The curriculum for each subject is divided into levels through which students progress at their own rates” (Hollifield, 1987). Another form of curriculum tracking is the “Ability Grouped Class Assignment.” This kind of tracking is similar to the Non-graded Plan in that it places students in classes based on ability rather than age, but is unique in that it aims to create a self-contained class that in some schools may even move as a whole unit through the grades (Hollifield, 1987).

Between-class grouping is perhaps the more radical form of grouping, if only for the fact that it deviates from the norm of public schools in our area. Public School Review states that “For the 2021 school year, there are 313 alternative public schools in Washington, serving 39,202 students” (“Top Washington,” n.d.). Though all 313 of these schools deviate in some way, usually it is to provide a tailored experience to a particular group of students rather than to provide a truly nongraded experience to all students. One school in the area that takes one of the closest approaches to non-graded instruction is Madrona, a school in Edmonds, WA. At Madrona, students learn in centers that span up to three grade levels. This allows students to have increased flexibility in their progression through the grades.

There are a number of benefits associated with nongraded educational plans. In her report titled “Nongraded Primary Education,” Kathleen Cotton writes that “Today, there is a strong movement-involving many child development specialists...calling for a return to a developmentally oriented curriculum which includes nongraded learning arrangements for primary children” (Cotton, 1993, p. 3). This return is fueled by a number of factors researched by Cotton. Some primary reasons are that chronological age does not always correlate predictably to mental age, children do not experience as much hardship because they do not have to get used to

a new teacher each year, validated practices like cross age tutoring and group work are more commonplace and easily accessible, and that students perform as well or better in a more relaxed and community-centered environment (Cotton, 1993).

This return to nongraded education has only increased in the years since, with many schools throughout our area opting for nontraditional structures. Clearly, there are many opinions on how best to structure school. Amongst both traditional and alternative schools, there is great variety to be found. Though it is good to have a variety of options in schooling to match the variety of learners that exist, the wide variety of school models that exist also bring up questions of equity.

Within-Class Ability Grouping. Within-class ability grouping refers to the general format of creating small groups consisting of students of “like ability” within the context of a mixed-ability classroom. In the “Joplin Plan” students spend most the day in heterogeneous classes and regroup across the grade levels for reading instruction (Hollifield, 1987). This Plan of regrouping for limited subjects is popular and is also seen in other subjects, with students spending varying portions of the day outside of the mixed-ability classroom. The school that I teach at loosely follows this model, using within-class ability grouping in reading, writing, and math. This form of grouping is so widespread that its effectiveness is based mostly on speculation and comparison to other kinds of grouping. Hollifield points out that “...it is difficult to conduct research that includes a control group *not* using the practice...” as virtually all traditional schools use some form of within-class ability grouping (Hollifield, 1987, emphasis added).

Though each school and each teacher approaches grouping differently, it is helpful to distinguish between-class grouping from within-class grouping for the purpose of discussing the

literature surrounding each. In fact, The Brown Center Report on American Education writes that “Ability grouping and tracking are inversely related,” which leads to a system in which “It is rare for students, once grouped between classes by tracking, to be grouped again within classes by ability grouping” (Loveless, 2013, p. 14). In other words, once students are tracked, they rarely return and it is highly unlikely that those same students will also experience the within-class grouping that is so prevalent today.

It is also crucial to acknowledge that although both between-class and within-class grouping are forms of grouping, there is substantial debate as to which form of grouping is superior. This debate further complicates the controversy of grouping practices as a whole, as not all grouping practices may actually fall under a particular critic’s definition of “grouping.” In an attempt to simplify this disorganized conglomeration that is education in the United States: there is the “traditional” school and there is the “alternative” school, and then there is perhaps a third camp that disapproves of grouping altogether. For the sake of clarity, and because the vast majority of schools in the United States group students by age, the pervasive and often subtle act of within-class grouping will be my focus here.

Due to the transition towards teaching to the Common Core State Standards in Washington and to standardized tests, focus in the classroom has shifted almost entirely to be on English Language Arts (ELA) and mathematics. For example, in a week of online instruction in my fifth grade class, subjects such as social studies or science are only taught for about an hour each every week or every other week. That means that there are four days out of every school week where all of the direct instruction time goes towards ELA and math. The ramifications of losing these other subject areas is another topic entirely, but my point here is that if a teacher chooses to use within-class grouping for ELA and math, students will rarely *not* be separated into

groups based on their ability. Along with the growing influence of the Common Core and widespread standardized testing comes an increased occurrence of ability grouping in the general classroom.

Support for Within-Class Ability Grouping

Parent and Guardian Expectations. A 2010 study conducted by George Ansalone and Frank A. Biafora looked into the views held by parents whose children have been tracked. Ansalone and Biafora hoped to investigate the beliefs held by parents as a factor influencing the prominence of ability grouping despite extensive evidence that it has a negative impact on student outcomes. The study found that parents from all sample groups in the study generally favored the use of tracking for their children (Ansalone & Biafora, 2010). The conclusion of this study speaks to the tendency of parents to look out for the good of their child above all else, even if that good is heavily rooted in their own perception and/or personal experience as children.

Unsurprisingly, “Parents with gifted children...appeared to be more likely to desire homogeneous ability groupings than parents of special education children” (Ansalone & Biafora, 2010, p. 239). What comes as more of a shock is the fact that the study found that parents from *all* sample groups generally favored the use of tracking for their children (Ansalone & Biafora, 2010). The conclusion of this study speaks to the tendency of parents to look out for the good of their child above all else, even if that good is heavily rooted in their own perception and/or personal experience as children. Ultimately, ability grouping seems to find its practicality in tradition, stemming from parental experiences in the education system and the belief that students are better served when they are given attention specifically geared toward their strengths or weaknesses.

Flexibility. There is indeed a great deal of support for maintaining grouping practices. In “The Resurgence of Ability Grouping and Persistence of Tracking,” Tom Loveless (2013) writes about another potential reason for teacher support of ability grouping, stating that “Because the groupings are within-class (and often decided by a single teacher), ability grouping is more flexible than tracking. Groups may be reshuffled periodically to reflect changes in student performance” (p. 14). This fluidity makes ability grouping appear very attractive. It is seen as less restrictive because students are always a small teacher decision away from moving into a higher group. Unlike tracking, ability groups are not restricted by all the details and paperwork of switching classes. Unlike a lack of grouping, ability groups provide students with work at their level and a clear place to rise to when the objectives and goals of their current group have been met.

Teaching to the Needs of all Levels. In addition to being flexible, within class ability grouping allows teachers to stop “teaching to the middle,” a term used to describe how, when forced to teach to a broad range of abilities, educators are often put in a position where they must ignore the needs of students at the top and bottom of the class, favoring the average student in the middle. In “Ability Grouping is on the Rise, but Should It Be?” Kristina N. Bolick and Beth A. Rogowsky (2016) write that a benefit of ability grouping is that “Teachers are able to more effectively engage students in small groups rather than completely group classroom instruction because there are fewer students; this grouping allows teachers to efficiently make adaptations to the instructional materials and methods provided in homogenous ability groups” (p. 43). This point is often made in conjunction with the assertion that gifted students deserve to be challenged and, although it may be rightfully critiqued to some regard, is truly a compelling force for

grouping practices. This is especially the case when outside resources are scarce for supporting students who fall outside of the middle ability range.

Evidence Against Within-Class Ability Grouping

Damaging Messages are Sent to all Students. Despite the prevalence of within-class ability grouping, there remain a number of strong voices that do not agree with the practice. Jo Boaler is a British author and the co-founder and faculty director of a Stanford center called youcubed that provides math education resources to teachers, students, and guardians. Boaler is a huge proponent of moving away from tracking (especially in the middle school and high school years) and ability grouping practices. Boaler (2016) writes that “The strong messages associated with tracking are harmful to students whether they go into the lowest or highest groups” (p. 175). This belief strikes a stark contrast to the commonly-heard concerns from parents that their gifted children need to be pushed — that they are being unfairly held back and disadvantaged by the other students in the class.

Perpetuates Fixed-Mindset Messages. Within-class ability grouping also perpetuates harmful fixed-mindset messages. When students are only given access to math problems within a set range of difficulty, they are being limited in what they can learn and are being sent the message that they are incapable of doing any work beyond what they have been given. Ultimately students lose the confidence necessary to attempt new and higher level problems. Fixed-mindset messages also intersect in a powerful and destructive way with stereotypes and inequality related to factors like race, gender, culture, and socioeconomic status, where biases held by teachers, staff, community members, and other students create a negative environment and a lack of belief in those students.

In “Math and the Growth Mindset,” Susanna Miller writes that “When students believe that the odds are stacked against them, they underperform. A growth mindset helps students understand that their abilities in math can improve and are not limited due to things out of their control such as their genes, gender, or socioeconomic status” (Miller, 2020). When grouping practices are used in a way that do not give students confidence or a clear path onward to harder concepts, students feel limited and stuck. There is no real push to move on. Miller writes that these students are less likely to take risks in math or to work hard on something they do not immediately understand. This is the classic case of believing that the only way to be good at math is to understand everything easily and quickly. We perpetuate this harmful attitude in schools through our focus on speed and quantity of problems solved above creative problem solving and reasoning.

A huge cause of fixed mindsets in math are beliefs regarding one's ability towards math. It is stated all too often that some people have a sort of math gene and are naturally destined for success. Boaler is staunchly opposed to this belief in innate math ability, asserting that it damages *all* students — both those seen as gifted and those who are not. Just like with students put in lower groups based on perceived ability, students who are labeled as gifted are also set on a track to having a fixed-mindset due to the pressure put on them to continue succeeding and the stress of having one's identity tied to their performance in math. Many types of praise can damage in this way and create fixed-mindsets in students. Some praise is verbal; Boaler (2016) writes that “When students are given fixed praise — for example, being told they are smart when they do something well — they may feel good at first, but when they fail later (and everyone does) they think that means they are not so smart after all (p. 31). I believe there is another way that students experience this negative praise, through ability grouping. Putting students in a

“high” math group is like giving a complement and telling them that you think they are smart. It’s no surprise that these become students held back by a fear of failure. There is enormous social pressure tied to the idea of being “demoted” or seen as “less smart” than you used to be in your classroom community.

Negative Psychological Effect on the Teacher. Within-class ability grouping also becomes damaging through the psychological effect it has on the teacher. A striking study by Robert Rosenthal makes a strong case for the effects of teacher communication on student outcomes in regards to grouping practices. Rosenthal’s research centered on the idea of experimenter expectancy effects, the way that what a researcher expects to see in an experiment has an effect on the outcome of the experiment itself. Interestingly, Rosenthal’s work took off in 1963 through his work with Kermit Fode, studying not students, but rats (Blake et al., 2013). The experiment consisted of taking a group of rats and separating them into groups labeled “maze bright” and “maze dull” although in reality there was no such difference between them.

Rosenthal and Fode witnessed “that the students [assigned to conduct the experiment] unconsciously influenced the performance of the rats in order to fit the expected results between the “maze bright” and “maze dull” rats” (Blake et al., 2013). Amazingly, the belief of the “authority figures” in the experiment, in this case the lab students, was enough to cause real, tangible outcomes. Belief was strong enough to change behavior in the rats, and Rosenthal reasoned that the same would be true between other “authority figures” and “test subjects,” namely teachers and their students.

Rosenthal promptly went on to conduct his most famous experiment later that year, collaborating with Lenore Jacobson, the principal of an elementary school just south of San Francisco, California. At the beginning of a school year, Rosenthal gave a Test of General

Ability to students. He then randomly selected some students to be identified as “academic bloomers” to their teachers at the start of the year. The results of Rosenthal and Jacobson’s study supported their hypothesis that there would be a positive difference in the academic outcomes of those students identified as “academic bloomers.” They found that “Especially in younger children like those in grades 1 and 2, there was a remarkable difference in the increases of IQ between the students chosen to be academic bloomers and those that were not” (Blake et al., 2013). Rosenthal and Jacobsen’s results demonstrate the Pygmalion effect, that greater expectations result in greater outcomes. When a teacher expects better quality and more work out of a student, they will often pay that student more attention and praise them more, even if they do not mean to show bias. The truth of this study is gut-wrenching. It means that success in school is almost certainly not what it seems.

Inequity. Finally, The prevalence of within-class ability grouping compounds the effects of social inequalities. Adam Gamoran writes that “...students are typically divided according to measured or perceived performance in school. Because school performance is related to social inequality outside the school, such divisions contribute to the separation of students from different racial, ethnic, and social backgrounds” (Hollifield, 1987). For example, in *Mathematical Mindsets*, Boaler (2016) writes that “...math teachers may not be intentionally discriminating by race or ethnicity, but if they use other criteria [to decide on class and group placements], such as homework completion, that impacts students of color more than other students, they are breaking the law” (p. 153). Due to long-standing societal inequalities in the United States, grouping and tracking practices often have the effect (whether intentional or not) of also separating students along racial lines.

Towards Diverse Students and Students of Color. In *Culturally Responsive Teaching and the Brain*, Zaretta Hammond (2015) makes bold claims about the sociopolitical impact on academic mindset. She writes that “In addition to policies and practices that limit opportunities, culturally and linguistically diverse students encounter subtle and not so subtle negative messages about their capabilities, the importance of their contributions, and their expected life outcomes” (p. 112). Hammond’s book reveals the viewpoint that due to the structural inequities of schools, it is all too easy to predict which students will achieve. These devastating inequities lie not only with the structure of the school, but also with teachers and other students. Hammond writes that “When teachers frame student differences as deficits rather than as assets, a microaggression is ignited for the student” (p. 113). When a teacher misinterprets a student’s actions, responding in a way that is racist, the student’s negativity bias is activated, causing school to become an unsafe environment and often leading to decreased student outcomes.

Towards Those Identifying as Female. Grouping practices and the communicated values they stem from also tend to have a highly negative impact on girls and women. In 2010, Sian L. Beilock, Elizabeth A. Gunderson, Gerardo Ramirez, and Susan C. Levine found that the math anxiety of female teachers (female first and second grade teachers were the subjects of their study) disproportionately affected the outcomes of their female students.

There was no relation between a teacher’s math anxiety and her students’ math achievement at the beginning of the school year. By the school year’s end, however, the more anxious teachers were about math, the more likely girls (but not boys) were to endorse the commonly held stereotype that “boys are good at math, and girls are good at reading” and the lower these girls’ math achievement. Indeed, by the end of the school

year, girls who endorsed this stereotype had significantly worse math achievement than girls who did not and than boys overall. (p. 1860)

A likely cause of this finding comes from the fact that young female students are more likely to identify with their female teachers. The study reasoned that due to the high percentage of female elementary school teachers (at over 90% in elementary school and even higher in early grades) and due to the fact that “gender is a highly salient feature to children at the early elementary school age,” that girls may be more likely than boys to pick up on their teachers fears and negative views towards math (Beilock et al., 2009, p. 1860). For all groups of students that are underrepresented in the highest levels of math, and particularly for women and people of color, teachers need to be especially thoughtful of the kinds of messages that they send, less they perpetuate stereotypes or allow their own negative experiences with math to seep into the mindsets of their students.

Steps to Combat Math Trauma

So then, what is the modern elementary school teacher to do? How are we to communicate with our students through the structure of our classrooms and the things we say to them in a way that makes a positive and equitable impact? Is it possible to do away with math trauma? I believe that changes need to be made on many levels. Seeing as how schools are vitally connected to the communities that support them, it stands to reason that students will be affected in their learning not only by their teachers and family, but also by the larger community around them in their city, state, and country. Teachers in their microcosm of a classroom need the support of those outside of the classroom — like their principal, superintendent, and local leaders — to bring positive change.

For someone who may not have children or who is not connected in some way to an elementary school, it can be easy to turn a blind eye to the issues that are arising emotionally and psychologically for our students. If this is you, I beg of you to reconsider your viewpoint and to turn your attention to the elementary schools in your area. The state of our nation's children is a direct reflection of who we are and what we value. If the children in our community are traumatized by school and live with a fear of failure that poisons their hopes for a future, that is on us. Through the way that we interact with one another in our workplaces, universities, churches, and communities, we communicate our values and the children around us pick it up.

The Elimination of Timed-Testing. Through our communication we can either send the message that we think anyone who cannot do math quickly and perfectly will not succeed *or* that we believe there are multiple kinds of intelligence that leave us each with something unique to contribute. There are many ways that each teacher can embrace the latter and begin to undo the effects of math trauma through their communication. One huge tangible step a teacher can take is to eliminate timed testing to the best of their ability, as this is one of the factors leading to harmful grouping practices.

Authors Morton Ann Gernsbacher, Raechel N. Soicher, and Kathryn A. Becker-Blease advocate for an end to timed testing on the grounds that time-limited tests are less valid, less reliable, less inclusive, and less equitable than untimed tests. Time-limited tests are less valid than untimed tests as there is no correlation between pace and accuracy in student responses. Gernsbacher, Soicher, and Becker-Blease advocate for an end to timed tests "...because more knowledgeable students do not take less time on time-limited tests and time-limited tests become less valid as they tap more intellectual content" (Gernsbacher et al., 2020, p. 4). In regards to reliability, they write that "Although some statistical corrections for computing the reliability of

time-limited tests have been suggested, we have known for decades that the best way to improve a time-limited test's reliability is simply to remove its time limits" (p. 4).

Timed tests are not only less valid and reliable, but also less inclusive and equitable. Their lack of inclusivity is demonstrated clearly through the example of accommodations made for disabled students through Section 309 of the Americans with Disabilities Act of 1990. Due to this Act, students may be given reasonable testing accommodations such as "...Braille, sign language interpretation, large print, auditory presentation and description, and extended time on time-limited tests" (Gernsbacher et al., 2020, p. 5). The key thing to recognize here is that in order for something to be considered an accommodation rather than a modification, the data collected from the test must be considered equally valid to a test taken by a student not receiving the accommodation. Due to the fact that timed-testing creates stress in students that impacts their performance, it can clearly be seen that extending time limits does much more than provide an accommodation — it radically alters the culture of the testing atmosphere itself. In fact, when given extra time, students rarely even use it. It is the stress of time that they need taken away, not the addition of time itself. Gernsbacher, Soicher, and Becker-Blease (2020) write that in a study of "...50 students with a variety of learning disabilities taking the SAT, no student used more than 14% extra time" (p. 6).

Timed testing increases math anxiety and trauma in students by unfairly creating a link between math ability and speed when in reality there is no such link. Just last week I administered a test to my fifth graders on adding and subtracting decimals. Some of the last tests to be turned in were the most accurate and scored highest because they represented the work of the students who took the time to read instructions carefully and double check their work. Students with the wisdom to approach their education with such care should be rewarded and

honored for their efforts, not chided because they do not finish their work before the students who scribble down nonsense so that they can go out to recess sooner. Equally of note ought to be the students who are perfectly capable of reaching solutions to math problems, but can become paralyzed by stress when they know that there is a time limit that they cannot meet. If schools persist in using timed testing, they need to be upfront about the fact that they are not primarily measuring math ability, but speed.

Most teachers would likely agree that timed tests are unfair, but the practice continues for one simple reason: that school exists within a time frame. Class periods have lengths and teachers' hands are tied by all that they must accomplish within them. In a situation like this where teachers seem to be caught between a rock and a hard place, there is one saving grace. The way that a teacher communicates their values is everything. Teachers choose if they send a message that values speed over depth of learning or if they instead value creativity and effort. As authority figures and role models, teachers are in a unique place where they can alleviate stress through their demeanor alone.

Thoughtful Teacher Communication. Though communication exists in many forms within a classroom, not all of them verbal as we have seen, thoughtful verbal communication *is* an important second way that I believe a teacher can make a positive change for their students. Through the way that they talk about math as a subject and the way that they make clear what they value in their students as learners, teachers can help to change the mindset of their entire classroom. In *The Power of Our Words*, Paula Denton (2018) writes that “When our words and tone convey faith in students' desire and ability to do well, students are more likely to live up to our expectations of them” (p. 17). Through communicating positively, clearly, and calmly, teachers can successfully communicate their belief in their students' abilities and desires to

listen, cooperate, and do good work (Denton, 2018). This kind of classroom talk promotes a growth mindset, as the teacher is effectively modeling a growth mindset towards their beliefs about student outcomes. It is also important that teachers communicate positively about math as a subject. Looking back to the effect that negative teacher talk towards math had on female students in the 2010 Beilock study, it becomes clear that students tend to pick up and reflect their teacher's ideas.

“Low Floor, High Ceiling Tasks.” A third way that teachers can affect their classroom to decrease math trauma is to change the way that they teach math, from lessons centered on ability-grouped assignments to whole class tasks and discussions. By “opening up” math in this way, students no longer have a limit that is impressed upon them by their teachers' expectations of how much they can do or their own personal beliefs in themselves as doers of math. In a classroom where there are no ability groups, each student is both held to a high standard and given the freedom to choose to extend a task as far as they are comfortable with.

Tasks that work best for a whole class setting are known as being “low floor, high ceiling” (Boaler, 2016, p. 137). This means that they are tasks with multiple entry points; one does not need to know much about math to get started and get something out of the task. The tasks are also extendable; they ask questions that do not have one simple answer. These tasks provide an opportunity to think deeply and apply the mathematics of the task to increasingly complex situations. Thus, they are “low floor” because the whole class can get started and participate *and* “high ceiling” because every student will find a challenge.

Tasks that are rich in their ability to be altered for and by each student work perfectly with the idea of differentiation. Differentiation is a term that essentially means giving each student what they need to be able to accomplish a goal. Anything can be differentiated in a

classroom, from the wording of a task, to the way that instruction occurs, to the final product that is completed and turned in by a student. Differentiation is equitable because it recognizes that differences are not the same as weaknesses and that each student is a unique person with unique giftings and needs.

Low floor, high ceiling tasks that allow for differentiation are a wonderful way for teachers to break away from traditional ability groups. Not only do they do a superior job of meeting all students' needs simultaneously, but they also communicate positive messages to students by giving them choices in how deeply they go into math topics, opportunities to discuss with the entire class in a way that allows for the sharing and interplay of multiple kinds of intelligence, and the assurance that their teacher believes in them.

Responsibility in Education

Through the way that teachers and other authority figures communicate, they show students what they value and set a goal for students to try to attain. By taking the focus in math from speed and accuracy to creative thinking, more students are given access to success in the eyes of the classroom community. All throughout my honors education I have been asked to ponder what it means to be human. Though I have left with more questions than answers, one thing remains clear to me — that humans have an effect on other humans. In ways great and small, positive and negative, we shape the lives of one another. Herein lies the apex of education: that there is responsibility. *Because* we each affect the other, there is a moral and ethical responsibility that a teacher takes on to educate their students well. As teachers, we are called to wrestle with our biases and worldview until it encompasses and expects great things from all learners. We are called to challenge and affirm and push and love in a transformative way.

Perhaps, even more moving to me than the responsibility between teacher and student is the responsibility that I believe students have to each other. The culture of the United States, in all of its rugged individualism and competitive “carve out your own place and hang on tight” atmosphere, is not conducive to the notion of mutual responsibility. Actually, it seems radically opposed. It is no wonder that students, and the guardians of those students, do not want to be mixed in with those who learn at slower speeds. What if I lose my edge? What if I fail as a result of bending down to help someone else up? There is fear here. There is fear that there is not enough time to learn how to work with those we are not naturally similar to. There is fear that we are not living up to our full potential if we are not constantly pushing forward and moving on.

I would like to offer a final thought here, to the one fearful of falling behind: that it is a very wise learner who has the courage to dive deeper before they push on. Who dares to encounter the views of others in all of their depth and complexity. Who recognizes the value of the multiple kinds of intelligence that their peers possess and wants to reason together rather than apart. They are wise for their understanding that there is endless depth to learning.

As a Christian, I feel called towards being an educator who helps students to see that the study of our world is a form of worship. When we solve math problems creatively and communicate our ideas about the way that the world works to one another, we are participating in a restoration of community and an acceptance of the importance of togetherness as we marvel at the beauty of the natural world. I affirm Jo Boaler (2016) in her statement that “When we ask students to use intuition and think freely, they develop not only a new perspective on mathematics, themselves, and the world but also an intellectual freedom that transforms their relationship with learning” (p. 289). It is this feeling of freedom that will finally open up the subject of math, making it a place of joy and exploration rather than of trauma and fear.

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Appendix

Which students are the true beneficiaries of the United States Education System? Are there students who are destined for success in our schools before they even step through the door? Alternatively, are there other students who seem to begin their school careers already being blamed for their failures and riddled with anxiety, when in fact it is the school system that has failed them?

As a senior in the education program at Seattle Pacific University, I have had the privilege of being a student teacher in a fifth grade classroom at a local elementary school. Even at the young ages of ten and eleven, I have witnessed how some students carry themselves with assurance, asking questions freely and participating boldly, while other students are reluctant to speak or participate in any way. I do not believe that this is a coincidence or that it can be chalked up solely to “personality.” Math itself is an incredibly open subject. Mathematics professor Jo Boaler (2016) writes that “Mathematics is a very broad and multidimensional subject that requires reasoning, creativity, connection making, and interpretation of methods; it is a set of ideas that helps illuminate the world; and it is constantly changing” (p. 20). If math is truly a subject that is open to all and requires a diverse skill set centered on creative thought, why do huge gaps in confidence and achievement exist?

It is impossible to discuss inequity in math education without addressing the reality of math trauma. Math trauma is a term that encapsulates the mental shutdown and extreme anxiety experienced by some people when they encounter math. Anxiety related to math is all too common, with an estimated 68% of students experiencing math anxiety and about 10% experiencing levels of anxiety high enough to be in need of counseling (Dowker et al., 2016).

Though there are multiple causes of math anxiety and there is no one change that could cure it, teachers are in a position to make a tremendous positive difference.

In an effort to unearth the key forces affecting educational outcomes for our students, I was drawn to the topic of ability grouping in my literature review. I believe that one cause of math trauma is the use of ability grouping in general education classrooms. Within-class ability grouping is the most common kind of ability grouping. It refers to the general format of creating small groups consisting of students of “like ability” within the context of a mixed-ability classroom. This form of grouping is so widespread that its effectiveness is based mostly on speculation and comparison to other kinds of grouping. Virtually all traditional schools, including the public school that I taught at, use some form of within-class ability grouping. Ability grouping is a huge form of nonverbal communication embedded in the very structure of a classroom.

I would be remiss to explore ability and ability grouping without first addressing the assumptions which the practice is founded upon. The underlying assumption in the practice of ability grouping is that schools know exactly who has ability and how much of it they have. It is on this measurement of a child that we determine where they fall and what we must do to push them along in the right direction. But, what exactly *is* ability? The longer that I spend in traditional school settings through my internship, the harder it is to answer this question.

In 1998, American developmental psychologist Howard Gardner wrote an article for *Scientific American* about his theory of ability and intelligence in relationship to past theories. Before Gardner, it was widely considered that there was one kind of intelligence (general intelligence), that an individual’s intelligence was mostly fixed from birth and rarely changed, and that intelligence could be assessed quickly and easily with an IQ test or by analyzing patterns

of brain waves (p. 18). Gardner posited that even in the opposition that existed towards this theory there was a commonality in the fact that all commentators centered their beliefs on the idea that knowledge could be gleaned from tests and data collection (p. 18). Gardner situated himself in stark opposition to this theory, asserting that there are in fact many kinds of intelligence, and that ability and intelligence are not so easily defined as we may think. He proposed a new definition of intelligence: "...an intelligence is a psychobiological potential to process information so as to solve problems or to fashion products that are valued in at least one cultural context" (p. 19). This definition leaves room for the valuation of many kinds of skills and ways of interacting with the world.

According to Howard Gardner, there are nine distinct types of intelligence: naturalist intelligence, spatial intelligence, linguistic intelligence, intrapersonal intelligence, interpersonal intelligence, existential intelligence, logical-mathematical intelligence, musical intelligence, and bodily-kinesthetic intelligence. Gardner's (1998) theory of multiple intelligences makes two claims about these nine types of intelligences. The first is that every person has all of these kinds of intelligence — that the possession of these abilities is in fact what it means to be human. The second is that no two humans have the same combination of strengths and weaknesses in regards to the nine intelligences.

Though logical-mathematical intelligence certainly exists, it is not the only kind of intelligence that is useful to doing math. Doing math takes great spatial awareness, an ability to "recognize and manipulate the patterns of wide space" (Marens, 2020). It also takes linguistic intelligence, the "capacity to use language to accomplish certain goals" (Marens, 2020). Anyone who has taken a proofs class knows that math requires clear writing and communication. Furthermore, in order to work in groups, share mathematical ideas with one's peers, and to have

the courage to speak up and ask good questions, one must have interpersonal intelligence. Group work is a huge priority in elementary math education today because it models the real world, where we must work collaboratively with our colleagues.

Regardless of what one believes about intelligence and ability, the effect that these beliefs have on grouping practices in the classroom deserve consideration. When students are being grouped by ability in mathematics, they are in fact being grouped at least partially by their ability to test well, answer questions quickly, and memorize certain answers and solution pathways (Boaler, 2016). Where there is no freedom to pursue math in a variety of ways, using a variety of skills, it becomes very difficult to teach in heterogeneous groups. It becomes incredibly impractical to set up a classroom that is based on anything other than the narrow definition of ability that is used by schools.

There are many factors that have led to the prominence of within-class ability grouping in math. The desire of parents and teachers to challenge each student in a way that is more individualized than whole-class instruction could offer, the flexibility of shuffling groupings of students, and the ability to stop “teaching to the middle” in order to engage all students in learning are some prominent reasons for the resurgence of ability grouping.

However, for every bit of evidence or emotion supporting ability grouping, there is evidence that points towards the damage that can be caused to students through these practices. Ability grouping sends damaging messages to students regarding their own ability and their perception of themselves as being capable of growth by perpetuating a fixed-mindset message. It also distorts teacher perceptions of students leading to unequal outcomes. Furthermore, ability grouping also leads to increased inequity for linguistically and culturally diverse students.

In “Math and the Growth Mindset,” Susanna Miller writes that “When students believe that the odds are stacked against them, they underperform. A growth mindset helps students understand that their abilities in math can improve and are not limited due to things out of their control such as their genes, gender, or socioeconomic status” (Miller, 2020). When grouping practices are used in a way that do not give students confidence or a clear path onward to harder concepts, students feel limited and stuck. There is no real push to move on. Miller writes that these students are less likely to take risks in math or to work hard on something they do not immediately understand. This is the classic case of believing that the only way to be good at math is to understand everything easily and quickly. We perpetuate this harmful attitude in schools through our focus on speed and quantity of problems solved above creative problem solving and reasoning.

Within-class ability grouping also becomes damaging through the psychological effect it has on the teacher. A striking study by Robert Rosenthal makes a strong case for the effects of teacher communication on student outcomes in regards to grouping practices. Rosenthal’s research centered on the idea of experimenter expectancy effects, the way that what a researcher expects to see in an experiment has an effect on the outcome of the experiment itself. He worked with elementary school principal Lenore Jacobson to demonstrate this by randomly selecting students to be identified as “academic bloomers” to their teachers at the start of the year. The study found that “Especially in younger children like those in grades 1 and 2, there was a remarkable difference in the increases of IQ between the students chosen to be academic bloomers and those that were not” (Blake et al., 2013). Rosenthal and Jacobsen’s results demonstrate that when a teacher expects better quality and more work out of a student, they will often pay that student more attention and praise them more, even if they do not mean to show

bias, resulting in better outcomes for that student. Ability grouping creates a similar situation to the one in the Rosenthal and Jacobson study, with some students receiving an identifying mark of ability at the onset of the year.

In regards to the inequity of ability grouping, there is substantial evidence to support that the deficit approach of ability grouping has a tremendously negative effect on students who are already at risk of mistreatment in school systems. In *Culturally Responsive Teaching and the Brain*, Zaretta Hammond (2015) makes bold claims about the sociopolitical impact on academic mindset. She writes that “In addition to policies and practices that limit opportunities, culturally and linguistically diverse students encounter subtle and not so subtle negative messages about their capabilities, the importance of their contributions, and their expected life outcomes” (p. 112). Hammond’s book reveals the viewpoint that due to the structural inequities of schools, it is all too easy to predict which students will achieve. These devastating inequities lie not only with the structure of the school, but also with teachers and other students. Hammond writes that “When teachers frame student differences as deficits rather than as assets, a microaggression is ignited for the student” (p. 113). In ability grouped math classrooms, by dividing students along lines of perceived ability, differences are set up to be easily viewed through a deficit lens, with students in the lower grouping levels receiving messages that they are not successful unless they are moving up to higher levels.

So then, what is the modern elementary school teacher to do? How are we to communicate with our students through the structure of our classrooms and the things we say to them in a way that makes a positive and equitable impact? Is it possible to do away with math trauma? I believe that changes need to be made on many levels. In the classroom, teachers can take steps such as doing away with timed tests, carefully choosing the words that they use when

they speak about math as a subject and achievement in math in their classroom, and by ceasing to use ability grouping in favor of rich mathematical tasks that all students can take part in and extend as far as they would like.

For someone who may not have children or who is not connected in some way to an elementary school, it can be easy to turn a blind eye to the issues that are arising emotionally and psychologically for our students. If this is you, I beg of you to reconsider your viewpoint and to turn your attention to the elementary schools in your area. The state of our nation's children is a direct reflection of who we are and what we value. If the children in our community are traumatized by school and live with a fear of failure that poisons their hopes for a future, that is on us. Through the way that we interact with one another in our workplaces, universities, churches, and communities, we communicate our values and the children around us pick it up. Through the way that teachers and other authority figures communicate, they show students what they value and set a goal for students to try to attain. By taking the focus in math from speed and accuracy to creative thinking, more students are given access to success in the eyes of the classroom community.

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