Spring 5-11-2016

Mindset and Instructional Practices in the Elementary Mathematics Classroom

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MINDSET AND INSTRUCTIONAL PRACTICES

IN THE ELEMENTARY MATHEMATICS CLASSROOM

by

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A capstone submitted in partial fulfillment
of the requirements for the degree of Master of Arts in Teaching.

Hamline University

Saint Paul, Minnesota

Spring 2016

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To my committee, for their keen eyes,
the research participants, for their willingness to collaborate,
my family, for their unending support,
and to Nathan, my dearest friend.
Thank you.

"Education either functions as an instrument which is used to facilitate integration of the younger generation into the logic of the present system and bring about conformity or it becomes the practice of freedom, the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world."

— Paulo Freire, *Pedagogy of the Oppressed*

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Introduction

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? Teachers wield tremendous influence on their students. Teacher beliefs, or mindset, about a student's ability color the student's perception of their own strengths and weaknesses. Additionally, a teacher's mindset may directly affect their instructional practices. A teacher's mindset matters.

Chapter One of this capstone serves as an introduction with an exploration of how educational experiences have shaped my interest in this research topic. The chapter closes with a preview of the research study. Chapter Two explores the current literature related to mindset and instructional practices in mathematics. Chapter Three presents the research methods and theory employed in this study. Chapter Four features an analysis of the research results and Chapter Five concludes the study.

Mindset and Mathematics

In mathematical terminology, equal means the same. What's true on one side of an equation is true on the other. For example, 4 = 3+1. This can be read as four is the same as three and one or four is equal to three plus one. Similarly 5=5 can be read as five is the same as five or five equals five. What is true on one side must be true on the other. School districts striving for equality would award the same funding, materials,

curriculum, and staff to all schools within their community. From this perspective, what is true for one school would be true for all others.

Equality works best, however, when every student or school starts from the same place. Students, teachers, and families know not every student needs the same thing or has the same opportunities and experiences as others. Rather than devaluing or attempting to negate these differences, the richness of this diversity is something for schools to celebrate and triumph.

Because schools are not equal spaces by nature of location, staff training and experience, curriculum resources, and student needs, equality is not the solution for helping all students reach their highest potential. It is the monumental task of public education to provide quality educational experiences for all students regardless of need. Instead of focusing its efforts on equality, the American education system must strive towards equity.

Equity not equality. Equity is the quality of being fair and impartial. Educational equity recognizes the differences in experience, resources, and opportunity students bring to their school setting and makes the bold promise that all students are guaranteed a rigorous, challenging, and transformative education. It is the ideal of educational equity that drove me to teaching and continues to compel my work with students, families, and communities.

Mindset and Instructional Practices. How does teacher mindset affect educational equity and the questions teachers pose to elementary math students? This question was offered by the head of my district's math department to a group of math specialist during

a recent professional development session. At first the question seemed out of place to me. Much of our work as specialists focuses on curriculum development, state and national math standards, challenges our students or co-teachers are facing, or honing our own understanding of math pedagogy. Rarely do we directly discuss issues of social justice or equity. I quickly recognized, however, the power and central role teacher questioning plays in shaping students' opportunity for an equitable education.

Teachers ask as many as 400 questions a day (Levi and Long, 1981). Each of these questions is an opportunity to challenge a student's assumptions, ask them to think critically, or demonstrate how they know. Higher order questions and lines of questioning promote educational equity for all students regardless of class, race, or label. Teachers with a growth mindset (Dweck, 2011) believe all students are capable of responding to and engaging with these higher order questions.

By contrast, low level questions may not adequately challenge a student to their fullest potential. Perhaps teachers are working from an outdated curriculum or have not learned to ask challenging questions of all students. In other instances, teachers may assume certain students are incapable of answering higher order questions or do not want to embarrass these students by asking them to respond to questions perceived to be beyond their ability. These teachers are demonstrating a fixed mindset (Dweck, 2011). Teachers with a fixed mindset may believe their students are not capable of taking on a challenge and may not push their students to grow.

Teachers with a growth mindset are able to challenge all students regardless of their background or perceived ability with rigorous questions in the mathematics classroom. It is within these classrooms where academic educational equity is possible.

Rationale for research. From this study, I hope to learn how a teacher's mindset affects instructional practices within the mathematics classroom. Instructional practices either promote or hinder educational equity. After completing a mindset survey at the beginning of the research cycle, teachers will video record themselves teaching a math lesson, and engage in a personal interview. Through conversation and reflection, research participants will have the opportunity to reflect on their own work and beliefs with an eye towards enhancing student experience, enriching student learning, and promoting greater equity within their classroom.

The state of education in the Midwest is regularly held as an example to the rest of the United States. While there is much to celebrate, there is also much to consider critically. For example, in Minnesota, where this research is being conducted, 39% of students at all grade levels do not meet or partially meet mathematics standards (MN Department of Education). In the district where this study is being held, 56% of students fall into these same categories. 77% of African-American students and 23% of white students in the school district where this study is taking place do not meet or partially meet mathematics standards (See Minnesota Report card for more information http://rc.education.state.mn.us/#). The staggering differences in outcomes between minority groups and white students must change. In order for our region to truly be held up as an example for the nation, our classrooms must be catalysts for change.

The district where this research is being held is one of the largest districts in the region serving approximately 36,200 students each year. Students in this district speak over 200 languages and come from economically, racially, and socially diverse backgrounds. If all students at all sites within this district were receiving an equitable education that was both academically rigorous and fostered a critical mind, this district would make great gains towards addressing the educational debt (Ladson-Billings, 2006) owed these students.

Transformative Educational Experiences

Ghana. Much of my interest in equity began across the Atlantic in Ghana. Though I grew up in a small town in the Upper Midwest, my family has always had a taste for the wider world. Long car trips to the coasts exposed me to new peoples and cultures. When I had the opportunity to travel overseas as a young college student, I leapt at the chance to spend a semester in Ghana. At the University of Ghana, in Legon, I studied, traveled, roomed, dined, and danced with university students from all over the world. It was here I first knew the experience of being a racial minority and experienced the overwhelming privilege of my skin color and nationality. As a white American I had the resources, connections, and historical status my African and African-American peers did not.

During my five month stay in Ghana, much of the Gulf Coast was devastated by Hurricane Katrina. As I returned to the United States from Ghana, a heightened awareness of economic and racial inequity in both countries returned with me. Much of the research, reading, and conversation conducted in my African Studies coursework back in the States focused on the relationships between the inequities in the United

States, Africa, and the African diaspora. My sense of social justice heightened, I felt serving others in making my community a more equitable place was central to my future work.

Small town America. I spent the first three years following graduation serving as an English teacher in Japan. After returning to the States, I spent two years working as an AmeriCorps volunteer with the Minnesota Reading Corps. The community school where I served was rural and blue collar. I was surprised to find issues I had equated with urban America, like the challenges racial minorities face and economic inequality, were relevant in this small town setting. Inspired by the work of my colleagues, I decided to pursue my teaching license and respond to what I now see as my vocational calling; the opportunity to serve and support students by working collaboratively with them towards greater equity in the classroom and community.

Critical theory. In the summer of 2012, I took the first step towards my teaching license at an urban Midwestern university: a prerequisite course called Schools and Society. Though I initially shrugged this class off as introductory, it proved formative in my understanding of what it means to be an educator dedicated to equity, social justice, and change. Critical theory was central to our class discussions and work. As I studied authors, thinkers, and educators, like Paulo Freire, John Dewey, and bell hooks, I grew committed to becoming an educator for change. Through class coursework I was introduced to some of the sweeping disparities in American education including the school to prison pipeline, the history of segregated schools and communities, the disproportional percentage of colored young men in special education programs, and the

challenge of unbalanced district funding. Schools are powerful tools that shape the nation's perceptions of the past, present, and future. This course cemented my commitment to working as a teacher dedicated to equity.

During the summer of 2013, I worked with preschool students preparing for kindergarten in St. Paul. The students had wildly different strengths when they arrived at school. While some students came to class knowing their numbers and letters, others lacked these basic skills. Though most students could communicate comfortably in English, others spoke a different primary language and had trouble communicating verbally with their teachers and peers.

Students' home lives and background knowledge shapes their experience with school. At the age of four, some of these students were already labeled as "behind" compared to their peers. The challenge of public education is to move all students forward and prepare all students for success. Because students begin at unequal places, the challenge in teaching is that much greater. My work with these young students serves as a reminder of the immense power of an equitable education.

In the fall of 2013, I student taught in a fourth grade classroom at a suburban elementary school in Minnesota. The racial and socio-economic makeup of the historically wealthy suburban school was changing. During my brief tenure, the school was grappling with the challenges these changes were bringing and discussing how best to support their newest students. Schools are constantly in flux because our students' needs are always shifting. Because our students' needs are always changing, classrooms and teachers must also be flexible. This research is an opportunity to explore how

teachers can evaluate and reflect on their own mindset or approach to students. It is my hope that this reflection will lead teachers to create safer and more equitable classrooms that meet the needs of all students.

Mathematics as a Tool For Change

As an elementary student, I never was particularly interested in mathematics. As I worked towards my elementary license, however, I was challenged to think differently about the importance of math for a student's success beyond school. Instead of focusing on the rules or algorithms of math, I was encouraged to use numbers in context and consider the broader implications of equity within mathematics education. Though I had not seen math as a place for equity, I came to realize that without mathematical literacy, one is at a great disadvantage. For example, if an individual is not able to use numbers meaningfully in context, they may struggle to understand the finances necessary to navigate a budget, rent, or a mortgage. By withholding a strong and critical mathematical foundation to some of our students, teachers and schools shape individuals underprepared to be successful in our society.

In 2014, I was offered a position with one of the Midwest's largest and most diverse districts as a math interventionist. In this role, I served small groups of students grades K-5 who exhibited some sort of need in math. Additionally, I participated in professional development sessions around math, equity, and the unique needs of students in our district on a bi-monthly basis. Of the 45 elementary schools in my district, the needs and wants of the students vary greatly. I see the math interventionist role as an opportunity to

transform mathematics education at the classroom and school level in order to better prepare all students for success.

Conclusion

My interest in equity runs through multiple and varied experiences spanning continents, counties, and classrooms. *How is teacher mindset reflected in instructional practices within the elementary mathematics classroom?* What can my district do now to work towards greater equity in its schools and communities? Through my research I hope to support teachers by offering tools for active reflection. Enlightened and reflective, these teachers can work to create more equitable classrooms for their students and stronger academic experiences for all. What follows in Chapter Two is a deep dive into the current literature as it relates to equity and social justice in American schools, a study of growth mindset and its effect on teacher and student understanding, and a rich discussion of questioning as an instructional practice and its impact on students in the mathematics classroom.

CHAPTER TWO

Literature Review

Introduction

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? The first section of this literature review focuses on equity within the American school system. The next section focuses on how teacher and student mindset shape teacher and student performance based on the fixed and growth mindset work of Carol Dweck. The final section focuses on the instructional practice of posing questions. It explores different ways of framing question types and addresses the challenges teachers face in posing equitable questions to all students. This chapter concludes with a rationale for proposed research and a summary tying the literature review's findings together.

Equity in American Schools

Defining equity. Equity for the purposes of this study is defined as the quality of being fair and impartial. Equity and equality are closely linked though decidedly different. According to the Great Schools Partnership, equity is the process and equality is the outcome all schools and communities are striving to achieve (Abbott, 2014). Because all schools have different needs, we treat them equitably by allowing them to run, support students, teach, and lead differently. In education circles this may be a shift from the idea of equal opportunity to that of equitable opportunity. In the former case, all

students are treated the same regardless of their circumstances. In an equal classroom all students might receive the same instruction regardless of learning strengths or weaknesses.

By contrast, in an equitable classroom all students are offered what they need when they need it. Equity in education recognizes not all students come from the same background, have the same needs, or have the same strengths. Equitable education is differentiated to meet the needs of students and is grounded in the belief that all students can succeed at the highest levels. The following section considers the consequences of various inequities inherent within the American school system and how they contribute to achievement gaps and perhaps in the larger view, the education debt. This section closes with an introduction to culturally responsive teaching as an option for addressing these challenges.

The achievement gap. In educational circles, there is much discussion about academic achievement gaps. The term achievement gap refers to discrepancies in academic success between subgroups and could refer to scores on standardized assessments, high school dropout rates, students in advanced placement courses, students participating in advanced learning classes, or students admitted to and graduating from college or advanced degree programs (Ladson-Billings, 2006). Typically comparisons are drawn along racial lines, comparing white students with their black, Native American, or Latino peers. Comparisons are also often made between girls and boys particularly in the areas of math, literacy and science. What follows is a look at different inequities that contribute to these achievement gaps.

Social, cultural, linguistic, and assessment inequity. There are several ways inequity manifests itself in the American school system. Societal inequity may cause minority students to be discriminated against because of preexisting bias in society (Abbott, 2014). These biases are historical and have long affected groups of people because of race, class, gender, or ability. Societal inequity also disproportionally affects teachers of color. Because of inequitable hiring practices, students may not have teachers who look like, sound like, or come from similar cultural backgrounds as themselves. This can put students of color at a further disadvantage, particularly when the teachers they do have are unable to address cultural gaps.

Social inequity is tied closely to cultural inequity, where students from diverse cultures or backgrounds may be disadvantaged because customs, beliefs, or practices in American schools are different than those from their home culture (Abbott, 2014). Lisa Delpit notes teachers must be willing to explore their own beliefs and attitudes about non-white people and non-middle-class people in order to begin to connect with their students (1995).

Additionally, students may face linguistic inequity if they come from a household where English is not the primary language. Because English is typically the language of instruction, not having this background this may affect how teachers interact with or challenge these students. Standardized assessments, which American schools increasingly rely on as measures of success, may also be cause for inequity. Students may be disadvantaged because assessment content, design, or language choices are different from their cultural norm.

Familial and socioeconomic inequity. Students may suffer not only from inequities tied directly to their social status, cultural background or native language, but may suffer under indirect inequity that affects their caregivers and family. According to legal scholar and author Michelle Alexander (2009), America has not moved away from the racial caste system of slavery and Jim Crow, but instead redesigned this system as mass incarceration. According to Alexander, more African Americans are under correctional control today than were enslaved in 1850. The inequity tied to incarceration affects not only adults within the system, but families including children, remaining at home. This familial inequity (Abbott, 2014) can also affect children who are raised in dysfunctional or abusive homes, are first generation to complete high school or college, or have little educational support from family members.

Familial inequity is often tied to socioeconomic inequity. Evidence suggests students from lower-income families underperform compared to their wealthier peers on standardized assessments (Abbott, 2014). This socioeconomic inequity is tied to the inequality of opportunities among children. Robert Putnam (2015) found that the children of more affluent and less affluent families are raised in different ways and have different opportunities. This opportunity gap directly influences students' experiences in school and extracurricular activities. To compound the challenge, students from low-income situations may attend schools with fewer financial resources, less experienced teachers (instructional inequity), and less rigorous academic opportunities (programmatic inequity).

These multiple and varied inequities have direct connections to our nations' students and their academic success. According to 2014 data in Minnesota, the difference in graduation rates between African-American students and their white peers was 26 points. (See http://rc.education.state.mn.us/# for more statewide statistics). Though the numbers in this particular state are drastic, they align with national trends. Similarly disparaging are the large gaps between minority and white students' performance on national achievement tests. In Minnesota, 33% of African-American, 37% of Hispanic, and 68% of white students tested proficient on national math assessments in 2014. While these assessments have their own biases and are far from perfect measures of academic accomplishment, they point to larger national trends of inequity.

Education debt. Gloria Ladson-Billings argues that rather than focusing on achievement gaps and working towards short term solutions to close these gaps, the United Sates must first address its education debt (2006). According to Ladson-Billings (2006), historical, economic, sociopolitical, and moral decisions and policies that characterize our American society have created an education debt. When we are able to see the complexities of this debt and recognize its roots, we are better able to address it for the good of our students, the future of our country, and because it is simply the right thing to do. How do we begin to address this debt?

Expectations, questions, and curriculum. As Gutstien and Peterson (2006) assert, teaching is not a neutral activity. Teaching is a political act in that everything teachers do is embedded in social, cultural, and political contexts that shape the way our students experience schooling (Koestler, 2010). Mathematics, too, is not a neutral subject. The

expectations we set for students and beliefs we hold about their abilities, questions we ask or do not ask our students, and curricula we include or exclude all send messages to students about what is important, valued, and valuable in the classroom and the wider world.

The expectations of teachers about their students matters. According to Jorgensen, et al. (2008), when teachers have certain expectations of their students, such as they will not do their homework or the student is not able to learn because of cultural or linguistic differences, these expectations may prove true. Understanding and acknowledging the value of cultural beliefs and behaviors different from their own can be challenging for teachers (Colombo, 2005). It is in this self-reflection, however, where teachers can move towards a broader mindset.

The questions teachers pose to students matters. All students must be challenged to engage in critical thinking and respond to higher order questions. Without this challenge some students may not fully engage in the material or assume they lack the knowledge and skills to participate at more rigorous levels. Questioning practices can look very different at school than they do at a student's home (Jorgensen, 2008) and subsequently put some students at a disadvantage.

The content of mathematics instruction also matters. Every curriculum sends messages to students about what is important. According to Jorgensen, et al. (2008), school and classroom practices recognize some feature of a culture while denying others. School curricula often favor middle-class values and norms because they are created by individuals from the middle-class. This can create a great disadvantage and disconnect for

students from differing socioeconomic groups. As educators concerned about equity, culturally responsive teaching is one approach to better aligning school with students' lives.

Culturally responsive teaching is a pedagogy grounded in teachers' showing cultural competency by connecting students' home lives with the classroom. According to Lunenburg and Irby (2011), effective culturally responsive teachers are able to show empathy, describe student behavior without judging, express respect for students' cultures and experiences, and praise, give feedback, and pay equal attention to all students. Colombo (2005) asserts teachers who do not share their students' cultures can provide culturally compatible instruction if they understand and acknowledge children's ways of knowing, communicating, and doing as valid.

If teachers are able to make connections between their students' lives and the classroom curriculum, students may also come to see mathematics as a central part of daily life and a critical tool for addressing issues of injustice. Jackson (2013) argues that teachers who practice an equity centered pedagogy create real opportunities for minority students to grow. In particular, these teachers build relations with students, have high expectations for them, and help students maintain their own unique cultural identifies. In our increasingly diverse schools and communities, both culturally responsive teaching is essential to addressing both the academic and social needs of all students.

Summary. "Equity cannot be fully realized if the classroom environment limits any child's access to challenging mathematics instruction" (1997, Campbell and Rowan, p. 60). In order for all children to participate in mathematical discourse, they must feel that

their input is valuable and valued, and know their participation is expected. The mathematics must not be trivial or boring, but relevant and accessible. Academic gaps must be acknowledged within the larger context of a national education debt, and addressed as such. Teachers must be willing to examine themselves and their prejudices and hold all students to the highest expectations.

According to Campbell, et al. (1997), an equitable environment for learning is one where, "thoughts are accepted, ideas are investigated, and meaningful problems are solved" (p 60). This chapter next turns to the literature as it relates to thoughts (teacher and student mindset) and investigated ideas (teacher questions and lines of questioning). The next section focuses on teacher and student mindset.

Teacher and Student Mindset

Equity in education can focus on tangible things like equal access to facilities or resources. However important, these factors are relatively easy to assess. The beliefs that teachers and students hold about their own work and ability may be harder to quantify, but are equally important.

Research has shown that a teacher's mindset influences how the teacher engages students during class (Boaler, 2014, Dweck, 2010, Olson and Knott 2013). This engagement has profound effects on student learning and outcomes. Both the beliefs students hold about their own ability and the beliefs teachers hold about students' abilities matter a great deal and can have a significant impact on student achievement (Dweck, 2010). This next section focuses on mindset and the power it holds to shape academic outcomes in the classroom.

Fixed mindset vs. growth mindset. Researcher Carol Dweck (2010) has identified two sets of beliefs that people hold about students' intelligence. One is a fixed mindset, the other a growth mindset. People with a fixed mindset believe that intelligence is a static trait. As Dweck (2007) states, the cardinal rule of a fixed mindset is to look smart at all costs. Students with a fixed mindset may believe it is not okay to make mistakes, do not want to work hard for fear of seeming to try too hard, and believe it is not worth it to fix mistakes they do make (Dweck, 2007).

By contrast, those that hold a growth mindset believe that intelligence can be developed and that they have the ability to learn. A growth mindset does not imply that everyone is the same or that anyone could be Einstein, but does believe that everyone's intellectual ability can grow (Dweck, 2010). Students with a growth mindset take on challenges, work hard, and confront areas of personal weakness (Dweck, 2007). The difference in these mental mindsets often makes a key difference for student learning and growth.

According to Dweck (2010) the brain is like a muscle: the more someone uses it, the stronger it becomes. When students develop a growth mindset they believe intelligence can be learned and the brain can grow from exercise (Dweck, 2006). The idea of brain plasticity has been corroborated by neuroscience as individuals with traumatic brain injury have gone on to learn skills that require the brain to grow in response to learning (Boaler, 2013). A key growth mindset message is that effort changes the brain by forming new connections, a process controlled by the individual. This understanding of the brain

is empowering and has important implications for teachers pursuing an equitable classroom.

Student mindset. When students with a growth mindset face academic challenges, they see opportunities for learning. Additionally, students with a growth mindset develop a resiliency that assures greater success in school and life (Yeager, et al., 2012). Dweck (2010) found that students with a fixed mindset can be taught to develop a growth mindset. The switch from a fixed to a growth mindset had significant effects on these students' academic outcomes.

Ricci (2013) surveyed kindergarten, first, second, and third grade students about their beliefs about intelligence. While 100 percent of kindergartners had a growth mindset, only 90 percent of first graders, 82 percent of second graders, 58 percent of third graders did (Ricci, 2013). This data suggests that current teaching practices play a role in shifting student's beliefs about themselves and their abilities.

When students possess a growth mindset, they see themselves as capable. Though they may face academic challenges, they have the motivation to overcome difficult work. Despite their level of performance these students may seem more confident or curious in the classroom. Teachers may see this confidence and encourage students to continue their growth. By contrast, students with a fixed mindset may be timid in their classroom because they are worried about looking smart or not making mistakes (Dweck, 2010). Teachers may see this timidity and assume a student is not capable of producing rigorous work. Though student mindset matters a great deal to their own success, teachers are

charged with the responsibility of providing an equitable education. An equitable education can begin with a teacher's mindset.

Teacher mindset. Research has shown that teachers' mindset about their students has a powerful effect on student outcomes (Rheinberg, as cited in Dweck, 2007). In this study, when teachers had a fixed mindset, students who began the year as low achievers finished the year as low achievers. When teachers had a growth mindset, however, these same students finished the year as mid-level or high achievers. This study shows the power of teacher's beliefs about students on student outcomes.

Additionally, teachers with a growth mindset are committed to the equitable objective of ensuring all students are learning and making growth. Teachers with a growth mindset do not put their students in categories and expect them to stay there. According to Crespo and Feathersone (2012), changing the language of how we talk about our students can be powerful. For example when children who have been described as "low" kids, become "low status" kids, a teacher's perception of the student's growth and learning struggle may shift. As "low" kids, students are not expected to grow. This is a fixed mindset. As "low status" kids, however, the student's academic struggles are framed as temporary and within a larger context. This framework allows both teachers and students to see students as capable. This is the essence of a growth mindset.

A teacher with a growth mindset sees the strengths of all students rather than their deficits. By contrast, a teacher with a fixed mindset may decide a certain student is not able to succeed academically, socially, or emotionally, and may choose not to focus their time and energy on that student (Dweck, 2010). This can lead to larger issues of inequity

in the classroom as some students are no longer pushed to develop their full potential. Rather than focusing on student deficits, teachers with a growth mindset are able to celebrate students' assets and build a more equitable classroom in the process.

Teachers with a growth mindset may differentiate their instruction by working with small groups of students. These groups must be flexible to respond to ever dynamic student needs, learnings, misconceptions, and understandings. If groups remain static, research has shown ability grouping harms the achievement of students in low and middle groups and does not improve the achievement of high-attaining students (Boaler, 2013). According to the research, a growth mindset from both teachers and students coupled with heterogeneous classrooms and dynamic student groupings seems a good way to help all students reach their fullest potential.

Messages that motivate. According to Dweck, it is essential for educators to communicate to their students and their students' families that the teachers themselves hold a growth mindset. Any time teachers offer feedback to their students, it is an opportunity to communicate mindset messages. Dweck (2010) found that students who were praised for their intelligence (a fixed mindset approach) lose their confidence and motivation when faced with a challenge. For example, teachers with a fixed mindset might praise a student's smarts. By contrast, students who were praised for their effort (a growth mindset approach) often seemed unfazed by future challenges and continue to improve. Teachers with a growth mindset might say, "great thinking" or "excellent effort" to a student. Teachers are constantly sending messages that shape students' mindsets

(Dweck, 2007). In order to provide an equitable space for all students to learn and grow, teachers must strive to send growth mindset messages that motivate.

Making mistakes. Dweck (2012) proposes that every time a student makes a mistake in mathematics, new synapses are formed in the brain. Thus, an important and powerful element of a teacher's practice is how they respond to student mistakes in the classroom (Boaler, 2013). If students are scolded for making mistakes or not challenged to think through why or how they made an error, they may develop a fixed mindset. When students are challenged to consider why they made a mistake, they are giving the brain an opportunity to grow. In this light, mistakes are central to learning. When teachers and students hold a growth mindset, mistakes are celebrated and learning is deepened.

Mathematics and mindset. Teachers' mindset influences not only how they interact with students, but how they teach content. Olson and Knott (2012) found that teachers with a growth mindset focus on the process of understanding mathematics rather than the end product. Additionally, Olson, et al., assert students in the classroom of teachers with a growth mindset come to see math as a dynamic subject that values differing interpretations and perspectives rather than a static subject riddled with tricks or memorization. A teacher's mindset influences not only their students but also their practice. This is particularly true for students who society stereotypically assumes may not be good at math.

An equitable math education may be a challenge for traditionally stereotyped groups including girls, racial minorities, students who come from poor socio-economic backgrounds, and students identified as having special needs. Stereotype threat is defined

as a situational predicament in which people are or perceive themselves to be at risk of conforming to stereotypes about their social group. Psychologist Claude Steele argues that such stereotype threats contribute to academic achievement gaps (1999). According to Dweck (2010), teaching a growth mindset seems to decrease or even close academic achievement gaps for these groups. This finding has profound implications for teachers working to promote equity in the mathematics classroom.

Summary. According to Yeager, et al. (2012), while many mathematics reform efforts focus on increased rigor in instruction, if they do not also address mindset and student resilience they prove less effective. When teachers hold and act on a growth mindset, they send messages to students that they can succeed. Empowered by their teacher's beliefs in them, students recognize they have the freedom to make mistakes and try again. Believing that though they may not have the ability to solve a particular problem now, the promise of yet drives teachers and students forward.

Students from stereotyped groups in particular stand to make strong gains as they shift from the fixed mindset of a negative stereotype, to the belief that they can achieve with the support of others. Equitable classrooms are those where students and teachers alike possess growth mindsets, ask and respond to high level questions, and challenge themselves and their peers to achieve at their highest potential. The next section focuses on the instructional practice of asking questions.

Instructional Practices: Questioning in the Mathematics Classroom

Teaching is a dynamic process that involves dozens of moving parts. Individual students' needs, wants, understandings, thoughts, feelings, and fears are jumbled together

with those of twenty or more of their peers' as a teacher seeks to support all students' in their learning and development. Teachers have a variety of tools or teaching strategies at their disposal at any given moment to gain insight into student understanding, misconceptions, and thinking. Classroom discourse and specifically types and lines of questioning are one of these key instructional practices.

In a traditional mathematics classroom, a teacher might present a problem, work with an algorithm to find the solution and practice the said algorithm with students to ensure procedural understanding (McConney and Perry, 2011). As mathematical standards have shifted in recent years from procedural understanding to an emphasis on reasoning, logic, and process, so too the questions teachers pose in the classroom must change. It is this shift from basic to more complex lines of questioning that poses both a challenge for teachers and a great opportunity for student learning. The following section focuses on different lines and types of questions teachers use in the classroom before turning to discourse practices. The section finishes by exploring the literature for questioning tools teachers might use to best support student learning and development.

Categorizing questions. In education circles, Bloom's taxonomy (1956) is often the first exposure young teachers have to different types of questions. According to Blooms, questions can be categorized into one of three domains, the first of which is cognitive. Within this domain, questions are categorized by their level of rigor. Questions build from the most basic (lower order questions) and build to questions that challenge students to analyze or evaluate information (higher order questions).

A delineation between higher order and lower order questions remains consistent throughout the literature. Tienken, Goldberg and DiRocco (2009) categorize questions into two main categories based on Bloom's work: productive and reproductive. Productive questions relate to Bloom's higher order questions which challenge students to analyze, synthesize and evaluate. Reproductive questions relate to Bloom's lower order categories by asking students to recall, comprehend and apply information. Though all levels of questions have value, for students to grow to their fullest potential, they must have the opportunity to respond to and wrestle with higher order questions.

Lunenberg and Irby (2011) developed four key categories of questions: initiating, probing, higher order, and divergent. Initiating questions begin the conversation between teacher and student and, once the conversation has begun, may be followed by probing questions. Probing questions may be classified as higher order as they challenge students to make inferences, comparisons, or evaluations (2011). Divergent questions have no right or wrong answer and may challenge students to think more deeply or independently.

According to Laursen (2015) for students to be successful beyond school, they not only need access rigorous academics but the opportunity to develop metacognitive skills. These metacognitive skills include grit, problem-solving skills, perseverance, self-control, collaboration, and tenacity (2015). Each of these skills involves and relies on higher forms of thinking (Conley, 2013). In order for students to be successful both academically and socially, exposure to higher order thinking and forms of thinking is a must.

While Herbel-Eisemann and Breyfogle (2005) agree on the importance of planning questions for their students, they argue it is equally important for teachers to think about the patterns of questions they pose. Wood (1998) identifies two types of questioning patterns or interactions between teachers and students. These categories are funneling, which limits students' responses and is often driven by teachers seeking a correct answer, and focusing, which develops students' thinking by asking more abstract or open-ended questions.

The heavy lifting of learning. Funneling questions (Wood, 1998) align neatly with Bloom's lower order, Tienken's reproductive, and Lunnenberg's initiating questions. In all of these instances the questions posed typically have one correct answer and offer little insight into a student's thought process or reasoning. Focusing questions (Wood, 1998) align well with Bloom's higher order, Tienken's productive and Lunnenberg's probing and divergent questions. When funneling questions are utilized, teachers more often do the heavy lifting of learning. Because teachers know the answer before they ask the question in this context, students are not necessarily challenged to think outside the box or really, think at all.

By contrast, when students are offered focusing questions they are challenged to make connections and address misconceptions for themselves. In these instances students are doing the "heavy lifting" of learning; challenging themselves to understand, articulate, respond to their peers, and find solutions that make sense to them. While there may be instances where both types of questions are appropriate, an equitable classroom is a space

where all students engage in and are challenged by focus type questions on a consistent basis.

Discourse rituals and routines. Focus questions align with open questions. Open questions allow for dialogue, discussion, and interpretation. These questions can be launching points for engagement and challenge students to think divergently. According to Parks (2009), because open questions lack the structure that might otherwise guide students forward, however, some may stay silent. She suggests using published lists of recommended questions as a starting point for creating content specific questions that both direct student thinking and allow for students' to express their own creativity and thought. Questions like "Why do you think that?" can be revised to direct students attention to the mathematics, "Why do you think it is important that the number was even or odd?", while still allowing for student thought and reasoning. With support, Parks argues teachers who are able to make open-ended questions more explicit and content rich were able to engage all children in rich mathematical discussion. Students are also challenged to make their thinking explicit, thereby honing their skills and refining their beliefs.

The National Council for Teaching Mathematics (NCTM) encourages open ended lines of questioning in their 2000 guide, Professional Standards for Teaching Mathematics. However, according to Stein (2007) the use of discourse in the mathematics classroom can be difficult to implement and manage. For example, some of the same students may volunteer to participate in every discussion while others stay silent. Stein encourages teachers to foster classroom discourse by providing a welcoming community,

establishing norms, using supportive discourse, and pressing for conceptual understanding. As all students are challenged to participate in mathematical discourse, the classroom becomes a space for equitable learning.

Power dynamics. Power dynamics between teachers and students directly affect the educational experiences of both students and teachers in the classroom (Reinsvold and Cochran 2012). According to Lemke (1990), teachers and students have unequal power in the classroom. As the key power holder in the classroom, teachers have the ability to shape classroom discourse by redirecting, responding to, and even ignoring select students' responses. This power can also be used to provide questions and questioning strategies that allow students to evaluate their own understandings, justify their work, and reason at a higher level (Lemke). The challenge is using this power in an equitable way so that all students are challenged to grow and learn.

Teaching Strategies. Students in every classroom come with rich and varied experiences and understandings. While this diversity can and should be celebrated, it can also create great challenges to effective instruction. When faced with the challenge of differentiating a curriculum to support all students, some teachers find it easiest to "teach to the middle", reaching neither their strongest nor weakest students. In response, some schools choose to group students by ability despite research that has shown such groups can amplify differences among students and lead to large differences in student achievement (Gamoran, 1992). Teachers may wonder how they can differentiate classroom discourse when faced with a variety of student strengths and needs.

One response to this challenge is to work with in-class, flexible groupings (Campbell, 1997). While all students work towards the same standards-based objective, the differentiated small groups may work with different number choices within the same problem, be challenged by different questions, or be asked to perform different tasks. Differentiation in this instance is equitable because all students are held to the same academic objectives.

Many schools throughout America are facing increasing numbers of students who are classified as English Language Learners, or those learning English in addition their native language. One may argue that engaging in mathematical discourse may be too challenging for these students or that they should first develop English language proficiency. In a study featuring diverse urban schools, Campbell (1997) states that once students become accustomed to using language in mathematics, they seem to enjoy it regardless of their fluency level with English. As teachers differentiate to meet the needs of these learners, they must be mindful of the need to challenge these students to their fullest abilities as well.

Despite years of research encouraging the use of focusing questions, teachers more frequently ask funneling questions (Tienken, 2009). This is true across all levels of teaching experience and school settings. Shifting practice from teaching procedures to asking questions to promote student thought takes practice, patience, and self-discipline (Campbell, 1997). Tienken suggests that teachers and administrators look to the law profession for advice and support in implementing stronger questioning techniques in the classroom.

Tienken (2009) encourages teachers to prepare their lines of questioning prior to asking them in the classroom. Just as many teachers use backward design to structure their curriculum or unit work, teachers could prepare questions ahead of time that are tied to specific learning objectives. Preparing these questions before class would ensure that a more substantive percentage of questions will foster productive thought (Tienken, 2009). Additionally, scripting focusing questions ahead of time will support teachers in their efforts to challenge all students with questions that develop critical thinking skills.

In an effort to engage more students in critical thought, Tienken (2009) offers several teaching strategies. These include using choral response, think-pair-share, and a voting system to show if students agree, disagree or have something to add to a peer's comment. According to Tienken (2009) these strategies taken together with focused questions prepared for the class ahead of time, can enhance the cognitive environment in the classroom.

Teacher reflection. In order to realign practice, McConney and Perry (2011) suggest engaging teachers in conversation about their beliefs about classroom discourse. Additionally, McConney -and Perry, suggest teachers have the opportunity to watch videotaped lessons that showcase discourse best practice. Reflecting on ones own beliefs, assumptions, and practice can be a powerful tool for change. All students have the right to high quality education that is both rigorous and equitable. Strengthened with the tools of scripting questions, teaching strategies, and self-reflection, teachers are better empowered to provide instruction and educational opportunities to make that right a reality.

Summary. Levin and Long (1981) report that teachers may ask as many as 300-400 questions per day. Each of these questions is an opportunity to move students forward by engaging them in critical thought, challenging misconceptions, or building upon current understanding. Despite minor differences in classification, the literature suggests focusing on higher order questions do more than lower order questions to develop student understanding. In order to shift practice from funneling to focusing questions, teachers must be willing to reflect on the lines of questioning they use in the classroom and adapt their questions accordingly in an effort to better engage students in critical thinking.

In an equitable classroom all students should have the opportunity to be challenged with focusing questions in an effort to provide a rigorous academic curriculum for all. While there may be a time when funneling questions may be most appropriate, in an equitable classroom all students should have the opportunity to respond to and be challenged by focusing questions. Cognitively Guided Instruction (CGI) is a research-based approach toward implementing curriculum designed to draw out student thought and understanding in mathematics (Carpenter, et al., 1999). The CGI approach does not, however in and of itself, ensure all students are receiving an equitable opportunity to engage in meaningful lines of questioning. It is the teachers' responsibility to prepare lines of questioning that encourage all students to engage in critical thought.

Rationale for Research

This study explores the connection between teacher's mindset and instructional practices within the mathematics classroom. Instructional practices either promote or hinder educational equity. After completing a mindset survey at the beginning of the

research cycle, teachers will video record themselves teaching a math lesson, and engage in a personal interview. Through conversation and reflection, research participants will have the opportunity to reflect on their own work and beliefs with an eye towards enhancing student experience, enriching student learning, and promoting greater equity within their classroom. Current literature suggests that a teacher's mindset directly affects student learning (Dweck, Boaler, et al.). This study considers the connections between a teachers' beliefs and practice.

Conclusion

Education in America is riddled with historical, economic, political, and moral inequities. This education debt has led to achievement and opportunity gaps between many minority and low-income students and their more affluent peers. To address this debt and these gaps is our moral obligation as educators. Teachers can address these gaps in part by being mindful of how they think about their students. Teachers with a growth mindset believe all students can grow to succeed. Because teachers ask as many as 400 questions of their students every day, this interaction can be used as a tool for equity in the classroom. The next chapter focuses on the research setting, participants, and methodologies including a description of the research tools and data analysis techniques used in this study.

CHAPTER THREE

Research Methods

Introduction

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? The purpose of this chapter is to describe the methodology and methods used in this research study. A teacher's mindset affects both student performance and the ways in which teachers engage with students. Teachers largely engage their students in classroom conversation through the instructional practice of posing questions. How is mindset reflected in practice? The juncture of mindset and practice is the crux of this research.

The chapter opens with a description of the research methodology followed by a description of the research setting and participants. Next the chapter includes a description of the research tools and data analysis techniques employed. This is followed by a discussion of the ethical implications of doing research in schools and an explanation of the consent documents sought and received prior to conducting the research.

Research Paradigm

Action research in an educational setting is an opportunity to improve the lives of children and to learn about the craft of teaching (Mills, 2007). Research can both enhance the lives of students, but also enhance the lives of professionals. My work does the latter

with the aim of improving educational opportunity for the former. Osterman and Kottkamp (1993) provide a strong rationale for research as a professional development tool. They state that all professionals need growth opportunities, have the desire to improve, have the capacity to learn, need, and want feedback about their own performance, and develop through collaboration with colleagues (1993). Action research is an opportunity for teachers to reflect meaningfully on their practice (Mills, 2007). This reflection than translates to changed practice and richer experiences for students.

Mixed methods. This research pulls from both quantitative and qualitative methodologies in a mixed methods approach. According to Creswell (2014), a mixed methods approach can provide a stronger understanding of the question and research at hand than either qualitative or quantitative research alone. Methods in this study include a mindset survey, classroom video recordings, and a personal interview. The mindset survey serves as a piece of quantitative data while the interview and the video recordings serve as qualitative data. Rather than focusing on only one data source, this research works from three areas. This triangulation of the data ensures greater reliability and validity in the results and strengthens the research as a whole (Mills, 2007).

Research Setting and Participants

Student demographics. Teacher participants in this research come from various sites of the same large, urban district. The following statistics were pulled from the Minnesota Department of Education Report Card website in the spring of 2014 pertaining to the district as a whole (http://rc.education.state.mn.us/#). The school district serves approximately 36,000 students. The student population is 37% Black, 7% Asian, 34%

white, 18% Hispanic, and 4% American Indian. The designation of "Black" includes African-Americans, Somali-Americans, and immigrant students from other areas of Africa and the African diaspora. Approximately 62% of students throughout the district receive free or reduced price meals.

Staff demographics. The staff participating in the research serve in various schools within the same large urban district. The participants all serve as math specialists who work exclusively in this subject area across various grade levels. Of the eight individuals who took the mindset survey, 62% hold an advanced degree. 50% have taught for 10 years or more and the other 50% have taught 3-10 years. Half of the participants in this study are women and half are men. All of the participants identify as white. Within the larger district where this research took place, approximately 49% of teachers hold a higher degree and roughly 48% have taught for 10 or more years.

Two women and one man were selected to continue the research study beyond the mindset survey. They all agreed to participate in the personal interview and submit video recordings of themselves teaching. Of these three, two have an advanced degree and have taught for 10 years or more. One of these individuals teaches an on-line math class for fourth grade students and the other two serve as math specialists at different sites within the district.

Research Tools and Data Analysis Techniques

Mindset survey. The research tools in this particular study include a mindset survey modeled after the work of Carol Dweck, a personal interview, and classroom video recordings. The survey (see Appendix *B*) is a quantitative tool that select teachers took at

the beginning of the research cycle. Designed by Mindset Works, a company dedicated to growth mindset training in educators and students (mindsetworks.com), the survey closely aligns with the work of Dweck and is a simple tool teachers could self-administer and use for reflection.

Before any research in this study took place, approval from both the school district and the University's Human Subject Committee (HSC) was sought and received. After receiving this approval, colleagues within the math specialist community were contacted by email requesting their participation. The teachers who volunteered in this study all came from this pool of math specialists within the district.

Survey Analysis. The data collected from this tool was coded along a mindset/beliefs continuum. This survey, as a piece of quantitative data, was analyzed using descriptive statistics. According to Mills (2007) descriptive statistics can offer a good deal of information about a range of numbers using only one or two numbers. Each response in the survey (Disagree A Lot, Disagree, Disagree a Little, Agree a Little, Agree, Agree A Lot) is assigned a numerical value. Disagree A Lot was assigned 1, Disagree assigned a 2 and so on for a range running from 1-6.

After participants completed the eight question survey, they then self scored the survey using the provided mindset/beliefs continuum. For odd number questions, participants were to give themselves the score from their answer choice. For even numbered questions, they used the rubric provided where answer choice 1 was worth 6, 2 worth 5 and so on. After calculating their total score, teachers identified their mindset profile number. This number fell into one of five categories ranging from a strong fixed mindset

to a strong growth mindset. Participants also had the option to respond in writing to their suggested profile designation. Only four out of eight participants chose to respond in this way. Using the mindset profile number, I was able to analyze the data for several measures of central tendency (Mills, 2007) including mean, median, and mode.

Personal Interview. The results from the mindset survey were compared within the sample size. From these responses, I invited three individuals to continue the study. These participants were selected because their responses to the survey were diverse; one exhibited a mindset exhibiting fixed and growth mindset elements, one a strong growth mindset, and one a mindset that fell between these two categories. All three of these individuals agreed to continue the study by taking part in a personal interview. The interview (Appendix C) serves as a qualitative research tool and was designed to gain an understanding of how individual's perceive their own mindset, perceive students in their classroom, and consider the power of questioning techniques in their classrooms. Teachers were given the option of conducting this interview in person or responding to set questions as a written response. All three of the teachers answered the questions in a written format.

Interview Analysis. According to Agar (1980), information from interviews can serve as the methodological core against which observational data can be compared. Using a structured formal interview (Mills, 2007) ensured that all participants received and had the opportunity to respond to the interview same questions. The interview was limited to four questions and ranged from convergent to divergent question types to encourage diverse participant response. This data was analyzed by first identifying overarching

themes and patterns. Following Mills (2007) "four commonsense guidelines" for coding data, I first read through each of the interviews multiple times and attached labels to sections of text. This text was then drawn from its original context and written on post-it notes. Next these notes were grouped by type. These groupings were revisited and reshuffled as needed.

Video recordings. Wolcott (1992) outlines three primary fieldwork strategies teachers can employ when researching within the classroom; experiencing, enquiring and examining. While the mindset survey and interview fall into the enquiring category, the classroom recordings are a piece of "experiencing" data. "Experiencing" data is important because it allows the teachers' voice to speak. In contrast to the interview and survey, the video recordings provide an opportunity to hear and see the participants practicing what they profess. This data gives a first hand look at a teachers' practice.

Teachers were asked to submit one math related video recorded lesson. The video could cover any aspect of math, across any elementary grade. One teacher submitted an on-line lesson featuring two short videos for fourth graders, another a recording of a one-on-one lesson with a second grader, and the third a recording of a full second grade class. Each of these videos provided the opportunity to both see and hear the teacher's interactions with his or her students.

Video analysis. Data analysis is an attempt by the researcher to summarize and collect data in a dependable and accurate manner (Mills, 2007). Similarly to the interview data, the data from the video recordings was first analyzed by identifying overarching themes and patterns.

Following Mills (2007) "four commonsense guidelines" for coding data, I watched each of the recordings multiple times. While I did this, I took general notes of what I noticed. The second time I watched the video, I took notes related to the kinds of questions the teacher (and students) were asking. The third time I watched the video, I listened for mindset messages the teacher might be sending to his or her students. After watching and responding to each of these videos, I pulled out major themes from my notes and recorded them on post-it notes. Next these notes were grouped by type. These groupings were revisited and reshuffled as needed.

Together these three research tools work to support the research question. By collecting multiple data points, the research is strengthened. Taking this triangulated approach (Creswell, 2014), the research tools will work to cover each tools' individual weaknesses and strengthen the action research as a whole.

Ethical Considerations

Any research involves ethical implications and concerns. According to Mills (2007), research studies are built on trust between the researcher and participants and researchers have the responsibility to uphold that trust and act with the participants' well-being in mind at all times. This is particularly true when the research involves vulnerable populations including children. In accordance with legal regulations and guidelines, this research upholds participant confidentiality. Pseudonyms are used when appropriate to conceal the identity of the participants. Participants agreed to join the study of their own volition with the option of exiting the study at any time. Potential risks to the participants include time spent on surveys, interviews, and observations, the possibility of distracted

students during classroom observations, and findings contrary to the participants' views or beliefs about their own practice. Consent was sought and received from all active participants prior to the research taking place. See Appendix A for copies of relevant consent and approval forms. As the participants in this study are colleagues, professionalism and confidentiality are essential to conducting an ethical study.

Conclusion

This chapter introduces the action research methodology and methods followed by a description of the research setting and participants. It also includes a description of the research tools and data analysis techniques and closes with a section on the ethical implications of doing action research in schools.

This study is an opportunity for teachers to intentionally consider how their beliefs, attitudes, and mindset affect their students' growth and development. As the district where this research will take place faces daunting inequities, segregated schools and communities, and stagnant results on national assessments, a basic belief in the capacity of all children is central to a more equitable future. The next chapter looks at the results of the research and presents major findings.

CHAPTER FOUR

Results

Introduction

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? The purpose of this chapter is to describe the research results. A teacher's mindset affects both student performance and the ways in which teachers engage with students (Boaler, 2014, Dweck, 2010, Olson and Knott, 2013). Teachers largely engage their students in classroom conversation through the instructional practice of posing questions. How is mindset reflected in practice?

The juncture of mindset and practice is the crux of this research. This chapter includes a description of the data results from the three research tools: the mindset survey, interview, and video recordings. The chapter closes with an overview of the major findings from the research.

Findings: Mindset Survey

The mindset survey is a quantitative tool that select teachers took at the beginning of the research cycle. The survey was selected from an Educator Kit designed by Mindset Works, a company co-founded by Dweck. Though the survey is designed for students, I felt it also could be used with adults as a simple tool teachers could self-administer and use for reflection. Often the demands of teaching are such that time for reflection is limited and perhaps pushed aside.

The survey, as a piece of quantitative data, was analyzed using descriptive statistics. According to Mills (2007) descriptive statistics can offer a good deal of information about a range of numbers using only one or two other numbers. For example, each response in the survey (Disagree A Lot, Disagree, Disagree a Little, Agree a Little, Agree, Agree A Lot) was assigned a numerical value. Disagree A Lot was assigned a 1, Disagree assigned a 2 and so on, for a range running from 1-6. After participants completed the eight question survey, they self scored it using the provided mindset/beliefs continuum. For odd number questions, participants were to give themselves the score from their answer choice. For even numbered questions, they used the rubric provided where answer choice 1 was worth 6, 2 was worth 5, and so on.

After calculating their total score, teachers identified their mindset profile number. This number fell into one of five categories ranging from a strong fixed mindset to a strong growth mindset. Scores from 8-16 fell into the strong fixed mindset category, 17-24 in the fixed mindset category, 25-32 in the mixed mindset category, a blend of fixed and growth mindsets, 33-40 in the growth mindset category, and 41-48 in the strong growth mindset category.

Of the eight teachers who completed the mindset survey, three fell into the strong growth mindset category (scores 41-48, See Figure One.) The category was described in this way: “You really feel sure that you can increase your intelligence by learning and you like a challenge. You believe that the best way to learn is to work hard and you don’t mind making mistakes while you do it” (See Appendix B). Of the teachers who fell into this category, one chose to respond with written comments. When asked if this survey

category matches the way he thinks and feels about teaching, he simply said, “Yes, it matches very well.”

Three teachers fell into the growth mindset category (scores 33-40). This category is described as follows: “You believe that your intelligence is something that you can increase. You care about learning and you’re willing to work hard. You do want to do well, but you think it’s more important to learn than to always perform well.” Though one participant didn’t comment on her survey regarding her mindset profile designation, her ideas about mindset seem to align with her profile score as noted on her school’s webpage where she writes, “…every person can develop their math understanding. Young or old, it is never too late.”

Two teachers fell into the middle category which was a blend of fixed and growth mindsets (scores 25-32). This category is described as follows, “You are unsure about whether you can change your intelligence. You care about your performance and you also want to learn, but you don’t really want to have to work too hard for it.” Teachers who fell in this category noted, “I am very mixed if one can increase their basic intelligence significantly…I believe hard work and reflective practice leads to higher growth potential!” Another teacher noted that though she identifies with a growth mindset, her score reflected somewhat differently. She found herself agreeing with questions related to “enjoying ease in learning” and wondered what more she can do to be open to “true learning”.

Figure One

As noted in Figure One above, 37% of teachers fell into both the strong growth mindset and growth mindset categories respectively. 25% of participants fell into the mixed mindset category. No teachers fell into the fixed mindset and strong fixed mindset categories.

From this data, several simple measures of central tendency were calculated. The mean score on this measure for the eight teacher participants is 37.75. This score falls squarely into the growth mindset category. The median score for this data set is 37 and shows close alignment with the mean. There is no mode for this small set of data. The range of scores in this data set is17, running from 30 to 47. Of the total points possible, the range of scores is 40 and the midpoint score is 28. All of the participants scored in the upper half of this range.

The standard deviation is a measure of variability that tells us how spread out a group of scores are (Mills, 2007). The standard deviation is a measure of distance from the mean and can help with the interpretation of data. In particular it can note how much a particular score deviates from the average. Accordingly, the standard deviation for this set

of data is 5.96. Of the eight scores, all but three (37%) fall within this standard deviation range. The two lowest scores (30, 31) and highest score (47) fall just outside this range.

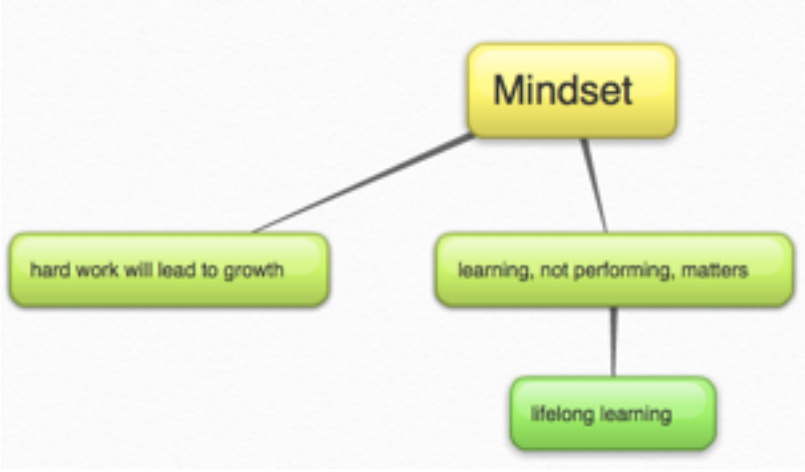
With the caveat that descriptive statistics can be misleading if interpreted too broadly (Mills, 2007) or without context, what follows are findings from this survey data. Within such a limited sample size it is unwise to generalize this information for a larger community. This group of math specialists has had training on equity practices and growth mindset as part of their math related professional development. It may be safe to assume this group scored higher on this survey than the larger teaching community might because of this training and exposure to growth mindset ideas. In order to truly get a clear picture of how teachers throughout the district might approach growth and fixed mindsets, a more diverse sample size is advised. The mean score for this group of individuals on the mindset survey was fairly high at 37.75. This shows all individuals from this data set, even those with a mixed mindset assessment profile, express strong growth mindset tendencies.

Hard work will lead to growth. From the four written responses I received on the survey all teachers showed growth mindset tendencies regardless of their score. From these responses I pulled out two common themes and one subcategory. The first is the belief that *hard work will lead to growth*. As one teacher noted, "I will puzzle through it," until solutions are found. Another teacher who scored lower on the mindset profile said, "hard work and reflective practice leads to higher growth potential." This comment reflects the basic belief that individuals can grow and change with work.

Learning, not performing, matters. The second theme is the idea that *learning, not performing, matters*. One teacher noted simply, "I love learning!" while another noted, "Mistakes are important. They encourage brain growth and learning." Another teacher commented that this line pulled from the mindset survey, was where she most closely identified as a learner.

Lifelong learning. Under this category, the subcategory *lifelong learning* also emerged from the survey data. One participant noted, "I got [an advanced] degree… because I love the language, I published an article because it was a challenge. I present at conferences because it is hard and good for me…I LOVE learning." These themes will be considered again as we move to analyzing the interview and video recordings data. These three categories are depicted in the mind map in Figure Two.

Figure Two



Findings: Personal Interview

The results from the mindset survey were compared within the sample size. From these responses, I invited three individuals to continue the study. These participants were selected because their responses to the survey were diverse; one exhibited a mixed fixed and growth mindset, one a strong growth mindset, and one a mindset that fell between these two categories. These participants included two women and one man. Of these three, two have an advanced degree and have taught for 10 years or more. One of these individuals teaches an on-line math class for advanced learners and the other two serve as math specialists at different sites within the district. From this point on, pseudonyms will be used for each of these individuals.

The interview (Appendix C) serves as a qualitative research tool and was designed to gain an understanding of how individuals perceive their own mindset, perceive students in their classroom, and consider the power of questioning techniques in their classrooms. Teachers were given the option of conducting this interview in person or responding to set questions as a written response. All three of the participants responded to the questions in a written format.

According to Agar (1980), information from interviews can serve as the methodological core against which observational data can be compared. Using a structured formal interview (Mills, 2007) ensured that all participants received and had the opportunity to respond to the same interview questions. The survey was limited to four questions ranging from convergent to divergent to encourage diverse participant responses.

The interview data was analyzed by first identifying overarching themes and patterns. Following Mills (2007) "four commonsense guidelines" for coding data, I first read through each of the interviews multiple times and attached labels to sections of text. This text was then drawn from its original context and written on post-it notes. Next these notes were grouped by type. These groupings were revisited and reshuffled as needed.

Building off of the three identified themes from the mindset survey, another was added to better reflect participant's thoughts and reflections from the personal interview. The new category, *high expectations,* explores the value of holding all students, including those that struggle, to the same rigorous academic standards. The other categories (*hard work will lead to growth* and *learning, not performing, matters)* expand with new subcategories as we consider the interview data.

Learning implies change. The first question on the personal interview was, "Why did you pursue a career in education? Why do you continue to teach?" Laurie notes she was drawn to a career in education because she wanted to be a hopeful voice in the development of our society. Her belief in the power of education to transform people's lives for good falls under the category *learning implies change.* She continues, "I want to be a great teacher who accelerates all students'…growth," while acknowledging this skill "cannot be achieved without hard work…". This belief that *hard work will lead to growth* is an element of growth mindset.

Tom notes he did not like school as a child because, "teachers treated me as if I couldn't think for myself" and, once he became a teacher, vowed to create a classroom in which he would enjoy being a student. This quote about Tom's past implies his childhood

teachers did the hard work of learning for him because they didn't believe him capable. A new subcategory, *students are capable,* fits under the broader category, *high expectations.* According to Tom, when students are not inspired, they sink to low expectations, completing a self-fulfilling prophecy. Teachers don't think students are capable, students don't perform, and teachers are reaffirmed in their beliefs.

Emily notes a similar idea when she writes, "all children can learn, but our classes and curriculum are narrowly focused to reward "smarts" and correctness." In this statement Emily shows though she believes *students are capable,* she sees the larger school system as working against this kind of thinking. "There is little room to just explore ideas and follow where our common curiosity leads," she writes. This concern points to the larger idea that *learning, not performing, matters*.

Tom notes he continues to teach because he gets to, "learn and teach mathematics every day (which I love)." Notably, Tom doesn't say he simply enjoys teaching every day, but also finds enjoyment in learning. As a veteran teacher of 25 years, Tom notes learning is something he does every day. Laurie notes she continues to teach because she loves it and believes there is, "still so much to learn about how students learn." Emily also notes that she stays in teaching because she loves her work and loves that there is, "always more to learn. If I ever think I know it all," she continues, "then I will know it is time to quit." Tom, Laurie, and Emily's words about their passion for learning fall under the subcategory, *lifelong learning.*

The second interview question asks participants to consider barriers to achievement and equity in the classroom. In response to question two, Tom argues that the greatest

obstacle to student achievement is a one-size fits all approach to teaching and learning. He believes rather than expecting students to "learn exactly the same thing at exactly the same time at exactly the same pace," we need to remake schools so there is choice for students and families. The subcategory *learning is dynamic* falls under the larger heading of *learning, not performing, matters.* Emily addresses this issue from a slightly different angle. She notes the narrow focus of both curriculum and the classroom structure reward "smarts" and "correctness" over exploration and curiosity, the opposite of which would reward curiosity and divergent paths to learning.

Emily writes that barriers to equity in the classroom are many. She reflects that, "sometimes the thinking level [in the classroom] stays low in order to keep the stress level [of teachers and students] lower." When this happens, students are not challenged to their fullest potential, but classrooms might be able to stay calm. In this example, Emily reflects on the broader need for *high expectations* for all students, while recognizing the barriers to such practice.

Laurie writes that in her view, one obstacle to student achievement is the belief that effort and hard work with lead to frustration. In this comment, she implies she believes instead that *hard work will lead to growth.* She also notes that an obstacle to equity in school settings is the value some place on certain students' experience over others. This inequity points to the larger underlying growth mindset belief that *all students are capable.*

In response to question three, which asks participants to explain the kinds of questions they often find themselves asking students during math class, Tom notes he, "tries to

respond to student questions with questions" in an effort to focus student understanding. Emily notes something very similar when she writes, "I try to ask questions that I know will require some thinking on the part of most students." She also writes, "understanding how students learn" and putting that understanding into practice is, "incredibly rewarding." Laurie simply wrote she often asks students to explain their thinking by asking them, "how do you know?". In these reflections Tom, Emily, and Laurie each show they value encouraging students to examine and articulate their own thinking. This subcategory, *making thinking explicit,* falls under the broader category of *high expectations.*

The fourth question from the personal interview asks teachers to consider whether math is a learning or performance subject. This question did not provide context for these terms in an effort to elicit diverse participant response. Laurie defined math as a learning subject, by noting, "performance suggests there is memorized and rehearsed work…" while "learning…leaves room for mistakes and retrials." In this way, Laurie shows she believes *learning, not performing, matters.*

Tom chose to define each of these terms for himself before responding to the question. He labeled a learning subject as, "one where ideas are presented to the student and the student is expected to understand…and apply it to novel situations." He defined a performance subject as where one is, "given a tool and expected to perform." From these working definitions, Tom defines mathematics as a learning subject and states, "*learning implies change."* This subcategory falls under the larger category of *learning, not performing, matters.* While the subcategory *learning is dynamic,* addresses the

misconception that learning is one-size fits all*, learning implies change* hints at value of learning for growth and enrichment.

Emily says something similar when she writes students should, "want to learn about the connections between known and new mathematical ideas." Here learning is the opportunity to make connections and change. She also balances this emphasis on learning with a need for performing. "I need to see what my students can do, in order to know what my next moves will be." In her view, both learning and performing are important parts of the learning process.

After analyzing the interviews and survey data, three major themes related to mindset emerged. These categories and subcategories are organized in Figure Three below; *hard work will lead to growth*, *learning, not performing, matters*, and *high expectations.* Three subcategories also developed. Many of these themes are direct quotations from participants and align with growth mindset messages. These themes will be considered again as the video recordings are analyzed.

Figure Three

Findings: Video Recordings

One lesson from each participant was video recorded and then analyzed for the study. Following Mills (2007) "four commonsense guidelines" for coding data, I watched each of the recordings multiple times. While I did this, I took general notes of what I noticed. The second time I watched the video, I took notes related to the kinds of questions the teacher (and students) were asking. The third time I watched the video, I listened for mindset messages the teacher might be sending to his or her students. After watching and responding to each of these videos, I pulled out major themes from my notes and recorded them on post-it notes. Next these notes were grouped by type. These groupings were revisited and reshuffled as needed.

Each of the three videos proved unique in setting, student grouping, and subject. Tom, as an online math teacher, routinely creates videos to interact with his students. Laurie, as a math specialist, largely works with students in Tier III situations (in the range of academic or social need, Tier III is the most intensive services). Emily serves in a similar role to Laurie, but focuses much of her work on co-teaching in the mainstream math classroom. Though each of these settings is different, there are common themes among their work. Building off of the four identified themes from the mindset survey and personal interview, I identified two new subcategories, *open and closed questions* under *making thinking explicit* and *persistence* under *hard work will lead to growth*.

Persistence. Laurie's video showed a Tier III math intervention with a second grade student. A Tier III situation is the most intensive service option for students and is typically conducted one-one-one. In this video I noticed Laurie validating student

thinking with statements like, “Yeah, you’re absolutely right”. She also occasionally showed she was listening and responding to the student by saying things like, “So, what you’re saying is…”. This validation of student thinking falls under the subcategory, *students are capable.* When teachers send strong messages of affirmation to their students, students may recognize they have the skills to be successful in math.

Laurie also probes student thought early and often in the lesson by asking open questions like, “What did you do to change 7 to 2?” and, “Could you solve this problem a different way?” By *making thinking explicit,* Laurie is challenging the student to articulate their own thinking and reasoning. Though she doesn’t consistently use this technique throughout the lesson, the student seems accustomed to the routine of explaining his thinking in the lesson warm-up with both words and tools.

In addition to open questions that give the student more flexibility in his answer, Laurie also asks closed questions intended to narrow the student’s focus. There are times when both *open and closed questions* seem appropriate. For example, when the student does not respond to an open question and appears confused, Laurie follows up with two shorter closed questions that help guide the student’s thinking. As Hufferd-Ackles, et al. (2004) notes, the development of math-talk in a classroom community provides opportunities for students to reason, defend and prove their conceptions to one another. All three participants encourage this kind of reasoning in their students in each of their unique contexts.

In Laurie’s Tier III lesson, the student works on one particular word problem for approximately six and a half minutes. Neither Laurie nor the student show signs of giving

up on the problem, but rather both keep asking questions and manipulating tools until they find an agreed upon solution. I categorized both the student and teacher's *persistence* in learning under *hard work will lead to growth.* This example of persistence also points to the value of learning itself and the idea of lifelong learning. This student seems to know giving up, even when faced with a challenge, is not an option.

After the student was able to find a solution to the math story problem that took up the bulk of the lesson, Laurie challenged the student to solve the problem a different way. Building off of background knowledge, she guides him to solve the same problem using ten rods and ones instead of just ones. This episode shows learning, not a solution, matters. Because *learning implies change* Laurie and the student engage in connecting previous learning with today's lesson.

Making thinking explicit. Emily shared a video of her teaching an introduction to equal sharing in a second grade math class. Students at this school study in both English and Spanish as part of the school's Dual Development program. Throughout the video, English language use and development is central to Emily's teaching. This video, different from what Laurie shared, is not raw video footage but had been edited to highlight certain elements of a math workshop lesson[1]. In this video Emily works with a group of 15-20 students.

Throughout the video, Emily asks her students to *make their thinking explicit* with questions like, "Can you say more about that?" and "Can anyone build off what Jesus

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[1] The participant states, "I made the video to demonstrate that children younger than 3rd grade could and should work with rational numbers. After we made the video, I wanted to share the process and results with other teachers, and I edited it to show the important teaching actions and student responses…".

said?" These open questions challenge her students to think more deeply about their conceptions and work to clarify both their own and their classmates' ideas. When working one on one with students later in the video, she asks a series of *open and closed questions* that challenge the student to articulate verbally what he had already depicted visually. By asking her students to make their thinking explicit, Emily is supporting their understanding of the material while allowing them to do the heavy lifting of learning.

By asking her students repeatedly to voice their thoughts about the work at hand, she also shows she believes each of her *students are capable.* In more than one instance, Emily takes pains to ensure all student opinions are voiced in response to a math problem. She asked, "does anyone have [an answer] I haven't put up [on the board] yet?" while looking around the circle of students. By ensuring each student's voice is heard, she sends a strong message to her students that their thinking matters.

Later in the lesson when students are wrapping up a particular problem, Emily asks the group to articulate their answer as a full sentence. When a student responds correctly, Emily doesn't respond herself, but asks the group if they agree with what the student had said. By affirming student thought in this way, she shows *students are capable* and have a voice in the classroom. Answers in this case, don't come from the teacher, but the students themselves.

At one point a student struggles to articulate her thinking accurately using the language of whole and half. Emily shows great *persistence* in her line of questioning as she pushes the student to develop her thinking. The student is ready to give up and states, "I don't know that." Emily challenges her to continue her thinking and eventually leads

the student to a more accurate response. When students are routinely asked to be persistent in their work and are held to *high expectations,* they may learn that hard work leads to personal growth.

High expectations. Tom teaches an on-line math course for fourth graders identified as advanced learners. Each on-line lesson typically has several activities. The lesson he shared for this research has five parts. The first activity asks students to check their work from the day before. The second is a video where Tom teaches how to use inverse operations to balance equations. The third activity is a "not-quiz" where students were asked to practice their arithmetic, specifically multiplication and division. Activity four is a video about solving algebraically, and activity five is a chance for students to practice solving algebraic expressions. For the purposes of this research, I've analyzed the two videos (activities two and four) and the written directions from all five of the activities.

Tom uses many videos to teach his on-line classes and uses both *open and closed questions* to guide student understanding. Often times closed questions serve the purpose of *making thinking explicit.* For example, Tom reads aloud a problem written on the screen multiple ways, teasing out the idea that x+16 is the same as x plus 16 more. By making his thinking explicit and expecting his students to do the same, Tom sets high expectations.

In activity three, students are asked to show their understanding of multi-digit multiplication and division problems. Though Tom reminds them, "while this is not a quiz, it is important that you know how to do these things for yourself…be sure you understand." By setting *high expectations*, students know Tom believes they are capable.

In a different video Tom affirms student thinking by using phrases like, "…just what you thought" and "of course you know…". These small comments may work to build student confidence and belief in themselves.

When introducing a more complex mathematical idea, Tom advises his students, "Watch [this video] twice if it doesn't make sense the first time." This advice encourages students to develop their *persistence* in the face of challenges. For students who may not have struggled in a general education math class, this recognition that struggle and hard work are is important to learning may be important to hear.

Summary

Data analysis is an attempt by the researcher to summarize collected data in a dependable and accurate manner (Mills, 2007). I first immersed myself in all three data sets, multiple times. While I did this, I took general notes of what I noticed. Next I pulled out major themes from my notes and recorded them on post-it notes. Next these notes were grouped by type. These groupings were revisited and reshuffled multiple times as needed. Recognizing this is simply one way to interpret this set of data, three major themes related to growth mindset emerged. These themes include *hard work will lead to growth, learning, not performing, matters,* and *high expectations.* The three major categories and their subcategories are listed in Figure Four below.

As a math specialist, I have the opportunity to collaborate with colleagues at my site across grade levels on a semi-regular basis. Conversations around classroom content and student needs often give a glimpse into teachers' mindsets. In moments when teachers show a fixed mindset about themselves or their students, I am able to engage in

scaffolded conversations that move teacher understanding about themselves or their students towards growth mindset.

As an academic lead in the building, I also have the opportunity to push for change on a systems level. Every school site has an Instructional Leadership Team (ILT) that works collaboratively with site administration to make decisions for the school. The ILT is a great place to push for site level change and an opportunity to engage colleagues and administration around ideas of equity on a larger scale. Additionally, as a math lead I have access to the elementary math department on a district level. Collaborating with the elementary math department, I'm able to offer resources and opportunities for math leads district-wide to consider the confluence of mindset, equity, and teacher practice.

Figure Four

The next and final chapter of this capstone reflects on major learnings from the research, revisits the literature review, considers implications and limitations of the study, suggests further research, and presents a plan for communicating with stakeholders.

CHAPTER FIVE

Conclusion

Introduction

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? After collecting, organizing, and analyzing the data, clear themes related to growth mindset emerged. This final chapter of the capstone reflects on major learnings from the research and connects these learnings back to the literature. It also considers implications and limitations of the study and offers suggestions for further research. The chapter closes with a plan for communicating findings with stakeholders.

Major Learnings

After immersing myself in the data and coding the research content, three themes emerged. Each of these themes reflect the actions or words of the participants. The themes from the research – *hard work will lead to growth, learning, not performing, matters,* and *high expectations* – connect to the growth mindset messages that mindset is malleable, teaching and learning are lifelong pursuits, and all people are capable. The next sections connect the insights of the three teachers in this case study, Laurie, Emily and Tom, with the themes that have emerged from the research, categorized around central growth mindset ideas.

Malleable mindset. Research has shown that a teacher's mindset influences how the teacher engages students during class (Boaler, 2014, Dweck, 2010, Olson and Knott

2013). If a teacher holds a growth mindset about her students, she believes all students are capable no matter what challenges they might face. The belief that *hard work will lead to growth*, comes through in the work of all three of the research participants, but is strongest in Laurie's one-on-one lesson with a struggling student. When Laurie pushes this student to *persevere* in the face of a challenging problem, she shows great confidence in his abilities to achieve despite the struggles he faces.

Though Laurie fell between a mixed growth and fixed mindset on the survey, she sends strong growth mindset messages to her student in the work they do together. She doesn't allow the student to give up and encourages him to persevere. This disconnect between the survey findings (a mixed mindset) and Laurie's practice (strong growth mindset) suggests mindset is a malleable and contextual. Mindset may shift from day to day, student to student, or from one subject area to another, an idea corroborated by Dweck (2012).

In her survey response, Emily notes a bit of discord in her stated beliefs and her practice. Emily's score on the mindset survey landed her between Laurie (mixed mindset) and Tom (strong growth mindset). "When I don't know something," she wrote, "I feel like a failure, or not smart enough. I need to work to challenge myself in these situations." In this statement Emily recognizes that mindset may be malleable and something she can actively work to change for herself. When teachers believe they can work to change their own beliefs and values, they may believe the same about their students. We must celebrate the struggle and be patient with the process of developing a growth mindset both for our students and ourselves.

Teaching and learning. Olson and Knott (2012) found that teachers with a growth mindset focus on the process of understanding mathematics rather than the end product. This ties directly to the second theme from the data; *learning, not performing, matters.* Within this category are several subcategories including *learning implies change*, *learning is dynamic*, and *lifelong learning*. These themes came through most strongly in the survey response questions and interview data. This may be in part, because these tools were more personal and individualized in nature than the classroom recordings.

In his interview response, Tom notes that one of the biggest obstacles to student achievement is a one-size fits all approach to teaching and learning. He believes rather than expecting students to "learn exactly the same thing at exactly the same time at exactly the same pace", we need to remake schools so there is choice for students and families. In other words, he believes *learning is dynamic*. Much of what drives this one-size fits all approach to teaching and learning is the current focus on standardized assessment scores and results. Tom suggests shifting our focus from these performance measures to learning itself will lead to better outcomes for students.

While the subcategory *learning is dynamic* may not seem to directly correlate to growth mindset work, the belief does influence teacher practice. It is implied from Tom's interview responses that he approaches his students with differentiated tools in recognition of their varied abilities and readiness for class content. At the heart of this subcategory is the understanding that students have the capacity to learn, regardless of their current ability; a central theme of growth mindset.

Tom's own words reflect the next subcategory, *learning implies change.* In the fourth and final interview question, Tom defines a learning subject as one where, "ideas are presented to the student and the student is expected to understand…and apply [this learning] to novel situations." The belief that learning is an opportunity to grow is also an important element of a growth mindset. This belief connects to the celebration and joy found in *lifelong learning.*

In several of the survey response questions, teachers noted their passion for teaching and learning. "I LOVE learning!" noted one enthusiastic participant. Individuals with a growth mindset not only celebrate learning, but are able to celebrate challenges as well. Dweck (2012) proposes that every time a student makes a mistake in mathematics, new synapses are formed in the brain. Thus, an important and powerful element of a teacher's practice is how they respond to student mistakes in the classroom (Boaler, 2013). Teachers who celebrate students' learning, over their performance, send growth mindset messages. Each of the participants cited a passion for learning as part of their interest in the field of teaching. This connection between learning and teaching suggests teachers passionate about learning may be more open to growth mindset messages and beliefs.

All are capable. Teachers' expectations about their students matter. According to Jorgensen, et al. (2008), when teachers have certain expectations of their students, such as they will not do their homework or the student is not able to learn because of cultural or linguistic differences, these expectations may prove true. Understanding and acknowledging the value of cultural beliefs and behaviors different from their own can be challenging for teachers (Colombo, 2005). It is in this self-reflection, however, where

teachers can move towards a broader mindset. Each of the three participants show they hold high expectations for their students in the ways they give feedback, ask questions, or challenge students to persevere in the face of challenge.

Tom addresses a lack of *high expectations* in the classrooms of his childhood. Though he felt capable, he felt his teachers didn't see him as such. According to Tom, when students are not inspired, they sink to low expectations, completing a self-fulfilling prophecy. Teachers don't think students are capable, students don't perform, and teachers are reaffirmed in their beliefs. Emily also shows high expectations for her students as well as her colleagues when she notes, "I made the video to demonstrate that children younger than 3rd grade could and should work with rational numbers." Laurie shows the same high expectations when she pushes her struggling student to make sense of his work and do the heavy lifting of learning for himself.

Both Laurie and Emily note that they occasionally struggle to hold onto a growth mindset for themselves in the face of challenge. Their insistence on high expectations for themselves despite this challenge, mirrors their high expectations for students. This correlation suggests when teachers hold high expectations for themselves, they may do the same for their students.

Implications of the Study

How is teacher mindset reflected in instructional practices within the elementary mathematics classroom? The data collected from the mindset survey, personal interview, and classroom recordings reflects strong growth mindset messages. Though each of the participants scored differently on the mindset survey (one each in the strong growth

mindset, growth mindset, and mixed mindset categories), each reflected growth mindset messages in their interactions with students. These interactions took the form of feedback, questions, and other teacher moves.

Teacher feedback. Culturally responsive teaching (CRT) is a pedagogy grounded in teachers' showing cultural competency by connecting students' home lives with the classroom. According to Lunenburg and Irby (2011), effective culturally responsive teachers are able to show empathy, describe student behavior without judging, express respect for students' cultures and experiences, and praise, give feedback, and pay equal attention to all students. Colombo (2005) asserts teachers who do not share their students' cultures can provide culturally compatible instruction if they understand and acknowledge children's ways of knowing, communicating, and doing as valid.

Each research participant offered feedback to their students; this is a huge part of teaching and learning. Because Tom teaches an on-line course, I was able to access the written feedback he gave to students. I was also able to analyze Emily and Laurie's verbal feedback in their video recordings. In each of these data sets, teachers showed they valued their students' thinking, believed students were capable, and valued the learning process over the end product. These practices align with both CRT equity practices and growth mindset ideas. This suggests CRT and growth mindset messages may blend well as a classroom or school wide approach.

Questioning. Levin and Long (1981) report that teachers may ask as many as 400 questions per day. Each of these questions is an opportunity to move students forward by engaging them in critical thought, challenging student misconceptions, or building upon

current understanding. Despite minor differences in classification, the literature suggests higher order questions do more than lower order questions to develop student understanding.

All three of the participants asked both open (higher order) and closed (lower order) questions of their students throughout each lesson. Though the research suggests high order questions do more to develop student thinking, in practice teachers asked just as many lower order as higher order questions. Further analysis of these teachers' questions may clarify whether the closed questions are a reflection of lower expectations of the students (fix mindset) intermingled with higher order questions, or if the mix of questions reflects a natural contextual range needed to scaffold a child's thinking. More evidence is needed to clarify which of these two possible scenarios are motivating these teachers.

Other teacher moves. Hufferd-Ackles, et al. (2004), developed a framework for classifying math classrooms using four categories: questioning, explaining mathematical thinking, source of mathematical thinking, responsibility for learning. This framework moves through four levels. Level Zero classrooms are traditional teacher-directed classrooms with brief answer response from students. At this level there is little student-to-student math talk. None of the three research participants fell into this area. In Level One classrooms, the teacher still plays a central-role in the math talk community, but begins to pursue student thinking through direct questioning. Emily's classroom sometimes fell into this level as students responded to her questions. Though student thought was sought universally, justification was often brief.

Level Two classrooms are those where co-teaching and co-learning are happening as students take a more central role in explaining their ideas and exploring work collaboratively. When Emily's students listen and respond to other's thinking during the full group lesson, her classroom fits neatly into this category. Though Laurie's class was one-on-one and missed the student-to-student element, on more than one occasion the student's ideas guided the conversation and direction of the lesson, another hallmark of this level.

In Level Three classrooms, the teacher is equally a learner and a teacher. Though fully engaged in the lesson, the teacher is largely assisting as a "coach". In this classroom, students justify their work and challenge others to do the same. Student ideas guide lessons and take responsibility for their learning. Level Three is ultimate goal for math classrooms within this framework. Though none of the classrooms I observed demonstrated this level within the limited data set drawn for this study, the growth mindset ideas pulled from this research connect in many ways to Hufferd-Ackles's Level Two and Level Three classrooms. For example, the idea teachers are also students connects to *lifelong learning*, students are also teachers connects to *students are capable*, and explaining mathematical thinking connects to *making thinking explicit*.

The research implies that mindset is a not a static or cleanly defined trait, but instead is malleable depending on setting, context, and experience. As schools, communities, and educational organizations look towards closing academic and opportunity gaps between various groups of students, mindset may play an important role in shifting teacher practice. If teachers truly believe, as these research participants do, that all students are

capable, feedback given and questions posed to students may change. The research and literature suggest growth mindset is a tool teachers, students, communities, and other vested parties can use in the work towards more equitable classrooms.

Limitations and Further Research

Research findings can be misleading if interpreted too broadly (Mills, 2007) or without context. With a critical eye towards the research process, what follows is an exploration of the limitations of this research followed by suggestions for further investigation.

All said, there were eight participants in this research study. With such a limited sample size it is unwise to generalize any conclusions from the data over a larger context. Additionally, though these individuals scored in different categories on the survey tool, all three showed signs of holding a growth mindset. A more diverse sample size with participants ranging from a fixed to growth mindset, would presumably yield different results. This is an area for further research.

All of the participants at each level of the study held the title of Math Specialist within one school district. This group of math specialists has had training on equity practices and growth mindset as part of their math related professional development. It may be safe to assume this group scored higher on this survey than the larger teaching community might because of this training and exposure to growth mindset ideas. In order to truly get a clear picture of how teachers throughout the district might approach growth and fixed mindsets, a more ethnically and vocationally diverse sample size is recommended.

Additionally, to gain a larger view of teacher perspectives, further research might invite a wider range of teachers from urban, suburban, and rural areas of the state to participate.

Though the original plan was to include three video recordings from each participant, the final study included just one video recording from each participant. To get a truer picture of teacher practices over time, a broader sample size spanning a larger block of days and subject areas would prove beneficial. Because Emily's video was submitted as edited piece of data, my interpretation and analysis of this data was influenced by what parts of the episode I was allowed to see. In the future, full, unedited videos from all participants would keep this data collection technique consistent.

The interview was originally designed to be conducted in person. Because of time constraints however, each of the three participants recorded their responses in a written format. Though the written responses make the interview process easier to record in some respects, they lose the body language, follow up responses, and ad lib conversations that are possible in live interview settings. Further research might hone in on one of these areas (survey, interview, or video recording data) more deeply to get an extensive understanding of participant's mindset beliefs in context.

Next Steps

As a math specialist, I have the opportunity to collaborate with colleagues at my site on a semi-regular basis. Conversations around classroom content and student needs often give a glimpse into teachers' mindsets. In moments when teachers show a fixed mindset about themselves or their students, I am able to engage in scaffolded conversations that move teacher understanding about themselves or their students towards a growth mindset.

Often times when teachers lack confidence in their own math ability, they pass that fear or dislike of math on to their students. A teacher's fixed mindset about their own abilities can lead students to develop fixed mindsets, too. In order to change students' mindset, teachers also must change.

As an academic lead in the building, I also have the opportunity to push for change on a systems level. Every school site in this large urban district where the research took place, has an Instructional Leadership Team (ILT) that works collaboratively with site administration to make decisions for the school. Working with the ILT is an opportunity to engage colleagues and administration around ideas of equity on a larger scale.

Additionally, as a math lead, I have access to the elementary math department on a district level. Collaborating with the elementary math department, I'm able to offer resources and opportunities for math leads district-wide to consider the confluence of mindset, equity, and teacher practice. By sharing my work and raising questions about equity at the site, system, and district levels, I hope to move towards positive change for students.

At the close of the study, paper or electronic copies of this capstone will be shared with relevant stakeholders. These include the district's research team, district co-sponsors, interested principals, and participants. In addition to conversations with colleagues, the research has pushed me to be more mindful of my own interactions with students. It is my hope this study has also provided the participants space to reflect on and develop their own understanding of growth mindset and their practice.

Conclusion

Teacher mindset can work to support or hinder student growth (Dweck, 2007). Though each of the participants varied in their response to a survey about their own mindset, each exhibited strong growth traits in their work with students. This finding suggests mindset is a malleable element that may vary depending on context, setting, or discipline. It also suggests that although an individual may not hold a growth mindset about their own abilities, they are capable of holding a growth mindset about others. The research also suggests educators who are passionate about learning themselves, may be more open to a growth mindset messages. When teachers hold high expectations for themselves, they may do the same for their students.

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Appendix A

Participant Consent Forms

Letter of Consent-Phase I

January 7, 2015

Dear colleague,

Background Information: I am a graduate student working on my Master of Arts in Teaching at Hamline University, in St. Paul. As part of my graduate work, I plan to conduct research with math teachers throughout MPS for six to eight weeks from January-March 2016. The purpose of this letter is to request your participation in an eight point survey.

The topic of my master's capstone is mindset and questioning in the mathematics classroom. My research is three fold. A team of teachers will participate in the initial mindset survey. After results are tallied, I will select a small group of teachers to continue the study at which further permission will be sought.

Procedures: Teachers continuing the study will audio record their math classrooms for five days, complete a simple check list to help me understand the days' lessons, and engage in a personal interview lasting approximately 30 minutes. After completing the capstone, I will summarize the findings in a report to be distributed to participants and relevant school administrators.

Risks: There is little to no risk if you choose to participate. Pseudonyms for the district, schools, and participants will be used. The individual survey responses, audio recordings, and interview data will be destroyed after completion of the study.

Confidentiality: If you agree to participate, you are agreeing to participate in the initial survey with the knowledge that you may be asked to continue with the full study. Participation in the study is voluntary, and you may decide to withdraw from the study at any time without negative consequences.

I have received approval from the School of Education at Hamline University and from MPS's district office to conduct this study. This capstone will be catalogued with Hamline's Bush Library Digital Commons, a searchable electronic repository and that it may be published or used in other ways.

If you agree to participate, keep this page. Fill out the agreement to participate on the following page and return it to me by mail or fax by January 19. Please contact me with any questions.

Sincerely, Charity Hall

Informed Consent to Participate in Mindset Survey

Return this page to Charity Hall

I have received Charity Hall's letter about the proposed research study and agree to participate in the eight point mindset survey. After results have been tallied, I may be asked to continue participating in the study at which point further permission will be sought. I understand participating in this study poses little to no risk for me, my identity will be protected, and I may withdraw from the project at any time without negative consequences.

_____ Signature _____ Date

_____ Printed Name

_____ Preferred email address

Letter of Consent-Phase II

Spring, 2016

Dear Colleague,

I am a graduate student working on my Master of Arts in Teaching at Hamline University, in St. Paul. As part of my graduate work, I plan to conduct research with math teachers throughout MPS this spring. Earlier this year you took mindset survey. Of the larger pool of candidates, you have been selected to continue the study. The purpose of this letter is to request your participation in classroom audio recordings and a personal interview.

I'm asking participants to audio record your math classrooms for five consecutive days during the month of March. Recording equipment will be provided if needed. Select lessons will be randomly analyzed as they relate to growth mindset in the mathematics classroom.

Participants will also join a personal interview. The interview will last about 30 minutes and questions will be provided ahead of time. After completing the capstone, I will summarize my findings in a report to be distributed to participants and relevant school administrators.

There is little to no risk if you choose to move forward with this study. Pseudonyms for the district, schools, and participants will be used. Audio recordings and interview data will be destroyed after completion of the study.

If you agree to participate, you are agreeing to participate in the audio recordings and personal interview. Participation in the study is voluntary, and you may decide to withdraw fro the study at any time without consequences. I have received approval from the School of Education at Hamline University and from our district office to conduct this study. This capstone will be catalogued with Hamline's Bush Library Digital Commons, a searchable electronic repository and that it may be published or used in other ways.

If you agree to participate, keep this page. Fill out the agreement to participate on the next page and return it to me. Please contact me with any questions.

Sincerely,
Charity Hall @Bryn Mawr Elementary
252 Upton Ave, Minneapolis, MN 55405

fax: 612.668.2510
charity.hall@mpls.k12.mn.us

Informed Consent to Participate in the Audio Recordings and Personal Interview

Return this page to Charity Hall.

I have received Charity Hall's letter about the proposed research study and agree to participate in the audio recordings and personal interview. I understand participating in this study poses little to no risk for me, my identity will be protected, and I may withdraw from the project at any time without negative consequences.

_____ Signature _____ Date

_____ Printed Name

_____ School, Title

Appendix B

Mindset Survey and Rubric

MINDSET ASSESSMENT PROFILE **Name:** _____

This is NOT a test! It is an opinion survey about beliefs and goals regarding ability and performance. It is very important that you give your honest opinion, not what you believe someone else would think best. Read each statement, decide how much you agree or disagree with the statement, and circle your answer.

Do you Agree or Disagree?	Disagree A Lot	Disagree	Disagree A Little	Agree A Little	Agree	Agree A Lot	Profile Number
1. No matter how much intelligence you have, you can always change it a good deal.	1	2	3	4	5	6	
2. You can learn new things, but you cannot really change your basic level of intelligence.	1	2	3	4	5	6	
3. I like my work best when it makes me think hard.	1	2	3	4	5	6	
4. I like my work best when I can do it really well without too much trouble.	1	2	3	4	5	6	
5. I like work that I'll learn from even if I make a lot of mistakes.	1	2	3	4	5	6	
6. I like my work best when I can do it perfectly without any mistakes.	1	2	3	4	5	6	
7. When something is hard, it just makes me want to work more on it, not less.	1	2	3	4	5	6	
8. To tell the truth, when I work hard, it makes me feel as though I'm not very smart.	1	2	3	4	5	6	
MINDSET ASSESSMENT PROFILE NUMBER							

Creating Your Mindset Assessment Profile

1. **First, determine your Profile Number for each question.**

- **For questions with odd numbers (1, 3, 5, 7)**, write the number of your answer into the boxes in the right column.
- **For questions with even numbers (2, 4, 6, 8)**, use the table below to fill in the gray boxes in the right column.

If you chose this answer:	Then write this number in the gray box on the right (Profile Number).
Disagree A Lot (1)	6
Disagree (2)	5
Disagree A Little (3)	4
Agree A Little (4)	3
Agree (5)	2
Agree A Lot (6)	1

2. **Now, add up all your Profile numbers.**

- Add up all the numbers in the Profile column on the right, and write the total in the last box in the bottom right corner.

3. **What does your Mindset Profile Number mean?**

- Find the group that includes your number in the chart below and circle it.
- Now, read what it says about your MAP group.

If your profile number falls into this range:	Then your MAP (Mindset Assessment Profile) group is:	People in this MAP group usually believe the following things:
8-12	F5	You strongly believe that your intelligence is fixed—it doesn't change much. If you can't perform perfectly you would rather not do something. You think smart people don't have to work hard.
13-16	F4	
17-20	F3	You lean toward thinking that your intelligence doesn't change much. You prefer not to make mistakes if you can help it and you also don't really like to put in a lot of work. You may think that learning should be easy.
21-24	F2	
25-28	F1	You are unsure about whether you can change your intelligence. You care about your performance and you also want to learn, but you don't really want to have to work too hard for it.
29-32	G1	
33-36	G2	You believe that your intelligence is something that you can increase. You care about learning and you're willing to work hard. You do want to do well, but you think it's more important to learn than to always perform well.
37-40	G3	
41-44	G4	You really feel sure that you can increase your intelligence by learning and you like a challenge. You believe that the best way to learn is to work hard, and you don't mind making mistakes while you do it.
45-48	G5	

4. **Do you think the description under your MAP group matches the way you think and feel about your school work? Which parts are true for you and which are not?**

Appendix C

Personal Interview Questions

Personal Interview Questions

1. Why did you pursue a career in education? Why do you continue to teach?
2. What in your view are the greatest obstacles to student achievement? What are the greatest obstacles to equity in your classroom, the school or the larger community?
3. What kinds of questions do you notice yourself asking your students during math class?
4. Do you see mathematics as a learning subject or a performance subject? Why?