INSERVICE TEACHERS' ATTRIBUTIONS FOR MATHEMATICAL SUCCESS

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Beliefs teachers hold influence the judgments they make about their students, and opportunities they provide for engaging them in rigorous mathematics. While math-related beliefs have been widely studied, less is known about teachers' attributional beliefs (i.e., beliefs about people's actions or behaviors) for mathematical success. In this study we investigated in-service elementary teachers' stated beliefs about mathematical success. Findings show that teachers attribute mathematical success to factors that are both internal and external to the student. Although teachers explicitly stated that race and gender were not factors, many used descriptors that served as proxies for students' demographic markers.

Keywords: Elementary School Education, Teacher Beliefs, Equity

Teachers play a pivotal role in creating equitable mathematical learning experiences, yet teachers' beliefs about their students' capabilities and what attributes to that success varies, particularly for historically marginalized student groups (Jackson et al., 2017; Wickstrom, 2015). More specifically, beliefs that teachers hold about their students influence the judgments they make about their students (Ernest, 1989; Hoy et al., 2009), how they organize their classrooms (Cross Francis, 2015; Pajares, 1992), and opportunities for engaging in rigorous mathematics (Jackson et al., 2017). Attribution beliefs are individuals' thoughts about the causes of actions or behaviors, and attribution theory assumes that individuals try to determine why people do what they do by attributing behavior to its underlying cause, with either internal or external attributions (Fiske & Taylor, 1991; Graham, 2020). For example, Jackson et al. (2017) found that in-service middle school teachers attributed students' lack of mathematical success to various kinds of deficit-oriented beliefs connected to innate traits and families' funds of knowledge, resulting in lowering the cognitive demand of the mathematics activity.

Cognitive bias assumes that what a person says or does is dependent on the "kind" of person they are (Ross, 1977). Research suggests teachers often hold attributional biases and attribute student failure to factors internal to students (e.g., lack of effort) and external to themselves (Gosling, 1994; Jackson et al., 2017; Kulinna, 2007). Teachers' attributions relate to student demographic markers with gender and race being the most prominent (Espinoza, 2014; Fennema and Leder, 1990; Teidemann, 2002). Research has shown the strong relationship between teachers' math-related beliefs and their practices, suggesting that teachers' attributions about students' mathematical success or failure may influence how they architect and support students' opportunities to learn. Interestingly, despite the abundance of research on teachers' math-related beliefs, very few studies focus on teachers' attribution beliefs about mathematical success in elementary contexts. In this study, we

investigated teachers' stated beliefs about reasons for mathematical success.

Attributional Beliefs

Three kinds of attribution beliefs closely inform our work: belief in genetic determinism (Keller, 2005), belief in social determinism (Rangel & Keller, 2011), and belief in school meritocracy (Wiederkehr et al., 2015). Belief in Genetic Determinism (BGD) holds that innate biological or genetically determined traits play the largest role in molding an individual (Keller, 2005). Statements aligned to BGD communicate underlying beliefs such as, "People can do things differently, but the important parts of who they are cannot really be changed" (Keller, 2005, p. 691). In relation to mathematical success, BDG is expressed by the belief that some people are naturally good at math. This physiological essentialism is correlated with race, gender, stereotyping, and prejudice (Hoffman & Hurst, 1990; Keller, 2005; Martin & Parker, 1995). The foundation these beliefs is connected to an individual's understanding, and contribute to the formation and endorsement of stereotypes (Keller, 2005) that perpetuate deficit narratives about who is considered good at math (Adiredja, 2019).

Belief in Social Determinism (BSD) is the understanding that an individual's fundamental essence is shaped permanently by social factors (e.g., upbringing, social background) (Rangel & Keller, 2011). Statements grounded in BSD communicate underlying beliefs like, "…[T]he social background a person comes from is strongly reflected in the person's character" (ibid, p. 8). An example of BSD in mathematics contexts communicate faultiness in Black students' capabilities based on their family's background and socioeconomic status (Martin, 2012). BSD is strongly linked with negative stereotyping, prejudice, and discriminatory tendencies, along with in-group favoritism (ibid), which can contribute to out-group bias and racism (Brewer, 2001).

Belief in School Meritocracy (BSM) describes an individual's belief that school success can be explained in terms of effort (Wiederkehr et al., 2015). It specifies the general meritocratic belief that social institutions reward individual ability and effort (Young, 1961; Jost et al., 2003). Individuals expressing this belief may state, "To succeed at school, one only has to work hard." For mathematics teachers, a student's motivation and growth mindset toward learning are direct indicators of their mathematical outcomes. However, Zavala and Hand (2019) warn against the guise of growth-mindset beliefs because those do "not take into account institutional forces and historical patterns of marginalization and trauma" (p.850). Thus, belief in meritocracy is associated with out-group favoritism for members of low status groups, and in-group favoritism for members of high-status groups (Jost & Hunyady, 2005). In this study we attempt to develop a better understanding of teachers' attributional beliefs by answering the following questions: *(i) What do elementary, in-service teachers believe about students' success in mathematics? (ii) Are there commonalities across teachers' demographics in relation to their beliefs about students' success in mathematics?*

Methods

Participants

This study is situated within a larger project called *Attributions of Mathematical Excellence in Teaching and Learning* focused on understanding teachers' attributions for mathematical success. The participants included ten, female, elementary in-service teachers who teach math in grades K-5 in the United States. Of these teachers, five held Master's degrees, four held Bachelor's degrees, and one teacher indicated their education level as "other". Years of experience ranged from one year to twenty or more years. Four teachers were still in their first five years of teaching, five teachers in the 6-10 year range, and one teacher had taught for more than twenty years. Three teachers identified as Black or African American, three identified as White, three identified as Hispanic or Latino, and one teacher identified as Asian.

Data Sources and Analysis

All participants completed a Zoom-recorded, semi-structured interview that lasted approximately 60-minutes. The interview consisted of a range of questions focused on understanding

participants' beliefs about the factors that contribute to mathematical success. For this study, we focused on three questions that targeted their beliefs about why some students do well in mathematics and the attributes of students who succeed in mathematics. After the interviews were completed, we listened to the recording and identified the location of the participants' responses to the three questions. We wrote detailed notes that described each participant's beliefs about the factors that contributed to mathematical success and transcribed specific statements that captured these beliefs. All authors read and re-read these descriptions and wrote statements or phrases that reflected the meaning underlying the teachers' statements. Then we met to collectively discuss our observations and identified statements/phrases that cohered. We summarized these statements into themes which are described next.

Findings

Teachers' responses converged around five themes in relation to the reasons for students' success in mathematics. In what follows, we describe teachers' responses under each theme.

Innate abilities and dispositions. Participants indicated that there was some inborn traits responsible for students' mathematical success. Some alluded to innate cognitive abilities while others described more dispositional traits. Participants stated that some students were born with high mathematical aptitude, or their brains were designed to be proficient at math. Connie and Abby's statements reflected these perspectives, stating respectively "Some people are just born with a high skill in math…[they] think mathematically" and "…that's just how their brain is made up". Others described traits of students who are successful at math in ways that would suggest they were inborn and not developed through experience. Some of these traits included "well-behaved" (Eva), "creative (Elizabeth)", "takes initiative (Kimber)", "has a growth mindset (Pablo)", "resilient" (Joanna). These traits were described as the students' natural inclinations in how to act or behave.

Parental influence. The majority of teachers attributed mathematical expertise to parental influences to some degree in both positive and negative ways. However, the nature of the influence that teachers described varied. Influences that were regarded as positive included parental support and encouragement to do well, providing opportunities to support brain development, and creating access to resources that support mathematical thinking. One of the three factors supporting mathematical expertise that Connie stated was the student's homelife. In particular, "whether there are clear expectations and encouragement at home". Negative influences included parents projecting their own experiences with math onto their children, and lack of encouragement to do well mathematically. Karen recalled parents making statements like "math was hard for me so it will be hard for them".

Nature of the subject. Teachers also remarked that developing expertise in math is difficult because understanding concepts in the discipline is generally challenging. Elizabeth stated that developing knowledge of math requires initial interaction with concrete objects and learning how to talk about and describe what you are making sense of. She stated that "students generally struggle with explaining" and that does not bode well for developing expertise. Similarly, Joanna mentioned "Students don't have an opportunity to concretely understand what numbers are, what is happening if you're adding, subtracting something and have that concrete hands-on experience". While Joanna and Elizabeth referred to difficulties in developing a strong conceptual foundation, Eva described the role of practice, stating "math is a matter of practice so if you are more active then you will succeed".

Good mathematics teaching. Four teachers identified high-quality teaching as playing an important role in students' mathematical success. Joanna described how the role of the educator and teaching became most salient for her when she taught kindergarten after teaching third grade. She reflected "Teaching kindergarten was really humbling. I didn't realize how much teaching had to happen in kindergarten for my third graders to know what they know". Similarly, Smith foregrounded the role of the educator in unearthing students' abilities to engage meaningfully in mathematics. She stated, "It's the educator's responsibility to ensure that all students feel heard, that

create a space where students feel that they can participate and contribute". Smith made it clear that distinctions along race and gender lines tend to be imposed by adults and that when students are placed in classrooms with educators who know their value, they will do well mathematically.

Race but not race. Unlike Smith who consistently explained why mathematical expertise should not be attributed to gender and/or race, some teachers would state the race and/or gender were not factors but in their descriptions of reasons would include proxies for race. For example, Abby talked about language being a barrier to success, "Schools in the US, white students (advantaged) do better, and this is due to students being accustomed to English and learning connected to their real-life contexts". Others ascribed racialized and gendered dispositional traits to students although rejecting this idea in other parts of the interview. Connie described that Black and Latino boys often have a "smart mouth" and that often correlated with success, while girls tended to be more reserved. Further, Abby stated that "lower-level" and Hispanic students do not put forth effort, resulting in negative mathematical outcomes.

With respect to commonalities across teachers' demographics, there were no distinct patterns by race across the responses that fell within the abovementioned themes, except for *good mathematics teaching*. We noted that both teachers of color and white teachers described innate characteristics (i.e., ability, dispositions) and external factors (i.e., parents, resources) as reasons for students' mathematical success. However, only teachers of color provided reasons for mathematical success that reflected the belief that high-quality teaching played a role in students' mathematics success. It may be that while white teachers recognized the factors external to the student support or hinder students' mathematical outcomes, they may not consider teaching as significant enough to outweigh other factors or they do not position themselves as having a critical role to play in students' success.

Discussion

The teachers' responses in the study indicate a wide range of beliefs around mathematical success. Although some teachers highlighted and centered teachers as being partially responsible for inspiring students to engage with mathematics (i.e., contextual factors external to the student), there were other teachers who centered students as being solely responsible for how successfully they relate and connect to mathematics. In this regard, teachers referred to innate characteristics and dispositions as the reason for students' success, which aligns with the tenets of genetic determinism (Keller, 2005). Thus, success in mathematics is connected to students' abilities to use their own "creativity", "focused nature", "initiative", and/or "resilience" to deal with challenging mathematics concepts. Teachers also described students' effort (growth mindset), the role of parents, and resources accessible within the home, as responsible for mathematical success. These reflect attributions aligned social determinism and school meritocracy (cf., Jost et al., 2005; Rangal & Keller, 2011). Interestingly, some teachers suggested that the mathematics was itself a challenging discipline, thus lack of success was not person-related.

The variety of responses from in-service teachers suggests the need to further research how attributional beliefs about students' mathematical success are developed and sustained. However, the real danger lies in within-service teachers' beliefs in one sole factor that determines success. This leads to the further perpetuation of beliefs such as social determinism, genetic determinism, and school meritocracy which largely emphasize one factor without considering contextual aspects, social identities (e.g., race), stereotyping, and equal access and opportunity. By considering the social, political, racialized and gendered contexts that impact student success, educators consider factors that influence students' mathematical success beyond personal attributions and characteristics. Teachers that consider many different factors can aid in pushing back against both positive and negative stereotypes about students who succeed in math and those who do not while also being more culturally responsive to the needs of all of their students.

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