How Can You Tell?: Unpacking Evidence in Teachers' Stories of Math Students

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Abstract: When teachers describe their students as math learners, they likely draw on a diverse set of data, but how they do so and what data they use is not known. This study explores the evidence that K-3 teachers use to support their perceptions of students. Analysis revealed that teachers relied on a variety of evidence, used different types of evidence for different students, and used certain types of evidence more often when they perceived a misalignment between students' performance in math class and aptitude for math. While this highlights potential for teachers to think deeply and in complex ways about their students, it also raises concerns that teachers may tend to characterize students as being certain types of math learners. Expanding the sources of evidence that teachers draw upon when describing students may open up the possibility for more students to be seen by their teachers as developing mathematicians.

Introduction and background

> "[Colleen] just would strike me as like, if you looked around the class and said who of these kids might end up going into some field of math someday, I would definitely say her."

When asked to describe her students as math learners, second-grade teacher Ms. Sullivan talked about Colleen's potential. To her, Colleen stood out as having a positive math trajectory, as someone who had what it takes to be successful in math. But what does that mean for a 7-year-old? And how could Ms. Sullivan tell? This study aimed to unpack the evidence that primary grade teachers use when describing their students' relationships with math.

It would not be surprising for Ms. Sullivan to select only a few students as having a future in mathematics because there is a pervasive, cultural perception that math is for some and not for all. Advanced math is often seen as particularly difficult with success attainable by only a select few (Boaler & Greeno, 2000). Relatedly, research has shown that when students reject math, their reasons span beyond their own abilities and affinities. Rather, students often reject math because they feel that math is not intended for them, is not a part of who they are as students now, and is not a part of the people they hope to become (Boaler & Greeno).

To push against the perception of math for some and not for all, and to expand access to positive math experiences, it is important to understand how students take on mathematical identities—dispositions and beliefs about their relationships to mathematics (Aguirre, Mayfield-Ingram & Martin, 2013). One way math identities develop is through the stories that relevant people tell about who students are as math learners (Sfard & Prusak, 2005). Stories from teachers, parents, peers, and students shape students' interest in, commitment to, and success in math (Langer-Osuna & Esmonde, 2016). Students' math identities are also constructed through social interactions that position students in relation to others (Harré, 2015). In math classrooms, learners are constantly interacting with and being positioned by their peers, teachers, and the discipline (Gutiérrez, 2013).

Like storytelling and positioning, *noticing* is another mechanism by which teachers influence students' math identities. Noticing is the ability of teachers to sift through information coming from students and the classroom environment in order to hone in on what is important (Sherin, Jacobs, & Philipp, 2011). When teachers act on what they notice, their actions affect what students notice, and this relationship continues cyclically, shaping the teacher's and the students' experiences of each other, their classroom, and the discipline of math at large (Erickson, 2011).

Unpacking the mechanisms for how teachers influence students' math identities is important for understanding how we can support students in forming positive relationships with math. One way researchers have done this is by studying the impact of teachers' talk about students, curriculum, and assessments on students' opportunities for learning (Horn, 2007; Bertrand & Marsh, 2015). This study took a different approach; it looked at the evidence that teachers used in their descriptions of students as a lens into what teachers notice. By prompting teachers to answer the question, "How can you tell?," this study explored what stands out to teachers about the students in math. Specifically, this study asked: What evidence do K-3 teachers draw upon when describing their young students as math learners?

Study design

Sites, participants, and data sources

This qualitative interview study took place in a Midwestern, suburban school district with significant racial, ethnic, economic, and linguistic diversity. Eleven Kindergarten through 3rd grade teachers with 6 to 23 years of experience across two elementary schools. Ten of the teachers were female.

Between February and April of 2019, I conducted one-on-one semi-structured interviews with each teacher, which lasted between 45 minutes and 1 hr. During the interviews, I asked teachers to move through their class rosters in an order of their choosing, describing each student as a math learner. Within the available time, teachers discussed between 8 and 25 students each. Using pseudonyms, I transcribed the interviews in full.

Data analysis

In order to engage with an equal number of student stories per teacher and to capture a cross-section of the students teachers discussed, I analyzed six student stories per teacher- the first, middle, and last two of each interview (total n=66). In previous work, I found that teachers described students as math learners by discussing their perceptions of students' personalities, effort, development, family context, performance, and aptitude. The latter two categories—performance and aptitude—emerged in 63 out of 66 stories, and in turn were used for continued analysis. Descriptions of students were coded as *performance* if they described completion of classroom tasks and were coded as *aptitude* if they described teachers' perceptions of students' overall abilities in math. Teachers' perceptions of performance and aptitude were further coded as high, average, or low.

This project specifically examined the evidence that teachers used in their descriptions of students to support their perceptions of students' performance in math class and aptitude for math. I began with in-vivo coding in order to highlight what was salient in the voices of the teachers. I then clustered the in-vivo codes into emergent code categories. Table 1 offers definitions of and examples from each emergent coding category.

Table 1: Teachers' evidence for their descriptions of students: Emergent codes and examples

Code	Definition: Teachers' phrases that relate to…	Examples
Speed	The rate at which students understand concepts or complete classroom tasks	she's faster; took almost two full class periods to finish
Classwork	The quality or quantity of students' assigned work in math class	shows every way to solve the problem; work is all incorrect
Assessments	Students' performance or scores on curriculum-based or standardized assessments	acing every test; got a 92%; MAP test scores
Behavior and engagement	Students' participation, work habits, peer collaboration, and enthusiasm during math	does that on her own without me having to say; ready to work; always eager
Specific skills	Specific skills, tasks, standards, or objectives important to math class or math curriculum	computation with basic addition and subtraction-he got it; can count 1-20
Comparison to other subjects	Students' perceived performance in other parts of the school day	a good reader; a Tier 2 reading student; hates writing

After coding, I compared the use of evidence within clusters of students who were described as having similar performance or aptitude. My goal was to understand whether the ways in which teachers were thinking about students as math learners related to the types of evidence that they used to support their perceptions.

Findings

This study had three primary findings. First, teachers used a variety of evidence when describing their students as math learners. Second, teachers used different sources of evidence more or less frequently in relation to their perceptions of students' performance in math class and aptitude for math. And finally, teachers used certain sources of evidence more frequently when their perceptions of performance and aptitude did not match.

The variety of teachers' evidence for their descriptions of students

When teachers explained how they determined students' performance or aptitude, they relied on a variety of types of evidence. Teachers discussed students' speed for understanding concepts and accomplishing tasks, the quality of their classwork, their curriculum-based and standardized assessments, their behavior and engagement during class, their mastery of mathematical skills, and their achievement in math compared to other school subjects. Table 2 shows the percentage of student stories in which each type of evidence appeared.

As the table shows, certain types of evidence were used more frequently than others. Teachers most often supported their descriptions of students' performance and aptitude by talking about their behavior and engagement in math class. This resonates with research that shows teachers often note students' behaviors even though behaviors can be misleading cues for considering students' math thinking and understanding (Ball, 2011).

Table 2: Teachers' use of evidence in student stories

	Speed	Classwork	Assessments	Behavior/ Engagement	Specific skills	Comparison to other subjects
# of stories (total n=66)	17 (26%)	36 (55%)	21 (32%)	49 (74%)	30 (45%)	29 (44%)

Evidence in relation to perceptions of performance and aptitude

Table 3 shows how frequently each source of evidence was used for students who teachers perceived as having high, average, or low performance (P) and aptitude (A). In looking across students who were perceived differently, several patterns emerged. For one, teachers mentioned how fast students understood concepts or completed classroom tasks more often with students who they perceived as having high performance in math or high aptitude for math than they did with students who they perceived as having low or average performance or aptitude (Table 3, shaded). It is not surprising that teachers supported their perceptions of high achieving students by discussing speed because despite research that shows speed to be irrelevant to mathematical thinking and ability, it continues to be lauded in many classrooms (Boaler, 2014). However, teachers did often mention lack of speed for students who they perceived as having lower math achievement.

A second pattern emerged in teachers' descriptions of students with low perceived performance or aptitude. In these descriptions, teachers frequently named specific math skills (Table 3, bolded). One reason for this could be that their skills were seen as out-of-the-ordinary and therefore more worthy of mention. For this same set of students, teachers also frequently compared achievement in math to achievement in other subjects (Table 3, bolded + italics). These statements often suggested that students' academic challenges extended beyond the math classroom by paralleling what the teacher perceived as a struggle in math to a relatable struggle in, for example, literacy. It seems possible that by highlighting students' challenges in other academic areas, teachers were attempting to give credence to their perceptions of students in math.

Table 3. Teachers' use of evidence in student stories sorted by performance codes

	Speed		Classwork		Assessments		Behavior/ Engagement		Specific skills		Comparison to other subjects	
	P	A	P	A	P	A	P	A	P	A	P	A
High (n=22)	50%	39%	64%	55%	32%	42%	77%	85%	41%	36%	36%	45%
Avg (n=26)	19%	18%	50%	64%	38%	18%	73%	23%	38%	45%	46%	41%
Low (n=15)	7%	0%	60%	50%	27%	38%	87%	75%	**73%**	**100%**	***60%***	***63%***

Evidence in relation to alignment between performance and aptitude

Though it was common for teachers to describe students' performance and aptitude in alignment with each other, in approximately one third of the student stories, there was misalignment between how teachers perceived students' performance in math class and their aptitude for math. In the majority of these cases, teachers described students as having greater aptitude for math than their performance in math class would suggest. For these students, teachers were more likely than average (Table 2) to use assessments (here 45% vs avg 32%) and students' engagement (here 91% vs avg 74%) as evidence for their perceptions (Table 4, shaded). It may be that for teachers, assessments act as a proxy for aptitude and can hold up even when they perceive that students' behaviors impact their performance. Table 4 shows the use of evidence sorted by whether there was alignment between perceived performance and aptitude.

Table 4. Teachers' use of evidence in student stories with and without alignment of performance and aptitude

	Speed	Classwork	Assessments	Behavior/ Engagement	Specific skills	Comparison to other subjects
Aligned (n=41)	12 (29%)	26 (63%)	11 (27%)	29 (71%)	22 (54%)	19 (46%)

Not aligned (n=22)	5 (23%)	10 (45%)	10 (45%)	20 (91%)	8 (36%)	10 (45%)

Discussion and implications

The findings from this study—that teachers relied on a variety of types of evidence to support their perceptions, used different types of evidence for different students, and used certain types of evidence more often when they perceived a misalignment between performance in math class and aptitude for math—together suggest that teachers conceptualize students' relationships to math in complex ways. This complexity signals a strong potential for teachers to continue to think deeply about how they understand and evaluate their students in math.

However, despite this complexity, participating teachers used evidence in repeated, patterned ways. Teachers seemed to use some sources of evidence more frequently with certain categories of students—those who they perceived as performing in certain ways in math class or as having certain levels of aptitude for math. This differential use of evidence suggests that teachers attended to different characteristics for students they perceived differently. It may be that teachers' perceptions of students and the evidence that teachers use to support those perceptions are in a feedback loop with each other. Research on teacher noticing explains that on the one hand, teachers' orientations toward students impact what teachers notice about students (Shoenfeld, 2011). On the other hand, what teachers notice can lead them to make assumptions about students, and these assumptions can be misconstrued. For example, a fidgeting student may still be paying close attention, a messy student may still have organized thoughts, and a student who is hesitant to share may still have elaborate reasoning (Ball, 2011). In this sense, teachers' differential use of evidence could be pigeonholing students or reinforcing perceptions of students as being certain types of math learners. Further, previous research has revealed the impact of sociohistorical forces (Martin, 2000) on teachers' positioning of students along lines of race, class, gender, language, and disability. Though this study did not collect students' demographic information, future work should examine the role that sociohistorical forces may have on teachers' differential use of evidence.

Expanding what teachers look at when evaluating students may give teachers new lenses into students' thinking. This study suggests that teachers already access a wide range of evidence when describing students, but they may not apply that evidence equitably across students. Doing so could at the very least shift teachers' perceptions of students and at the very best open up the potential for more students to be seen by their teachers as developing mathematicians. Future studies should explore the malleability of teachers' perceptions of students as math learners when asked to use a range of evidence, in particular with groups of students who have been historically marginalized from success in mathematics. Future studies might also explore the evidence that teachers to use to support their perceptions of student characteristics beyond performance and aptitude.

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