What is a “Math Person?”: Students’ Interpretation of Identity Terminology

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We investigated seven undergraduate students’ definitions of two terms used in mathematics education research: “identity” and “math person.” Students’ interpretations of these terms were compared to an existing identity framework (Cass et al., 2011; Cribbs et al., 2015). Participants’ definitions for “identity” varied widely, emphasizing different aspects of personal, social, and mathematics identities. In contrast, students were fairly uniform in describing a “math person” as an individual who enjoys and/or is proficient in mathematics, which is consistent with known factors related to mathematics identity. This second finding bears relevance given the use of self-identification as a “math person” in measurements of students’ mathematics identity. These results guide our development of survey items meant to assess aspects of student affect in the mathematics classroom, with the ultimate goal of providing instructors actionable insights into their classroom climate.

Keywords: Math Person, Identity, Mathematics Identity

Research has shown that the development of a strong mathematics identity is critical to students’ persistence in STEM and success in their math courses (Meece et al., 1990; Boaler & Greeno, 2000; Gonzalez et al., 2020). However, *identity* and *mathematics identity* have been conceptualized and measured in different ways by different scholars (e.g., Sfard & Prusak, 2005; Cass et al., 2011). As part of a project aimed at measuring various aspects of student affect, we reviewed instruments developed to measure identity and became curious about students’ interpretation of these constructs – and of the survey questions intended to measure these constructs. With an eye toward understanding the student perspective, as well as to reducing measurement error in our own work, we ask:

(1) How do students conceptualize “(mathematics) identity” and “math person?”
(2) How do students’ perspectives relate to usage of these terms in prominent mathematics identity frameworks?

To begin answering these research questions, we interviewed seven undergraduate students enrolled in university mathematics courses and considered their responses in relation to the mathematics identity framework used extensively by Cribbs and colleagues (Cribbs et al., 2015; Cass et al., 2011; Godwin et al., 2016; Dou et al., 2019).

Mathematics Identity & Relevant Literature

The framework we use for mathematics identity (Cass et al., 2011; Cribbs et al., 2015) has its origins in studies of science identity (Carlone & Johnson, 2007), has been refined over time (Hazari et al., 2010), and has been positively linked to students’ persistence in STEM majors and career choices (Cribbs et al., 2015; Cass et al., 2011; Verdín & Godwin, 2015; Godwin et al., 2016). In this framework, *mathematics identity* refers to how one views themselves in relation to mathematics; this is distinct from, but not entirely independent of, *personal identity* (one’s individual characteristics) and *social identity* (one’s characteristics as a member of a group or community). In empirical studies, self-identification as a "math person" (or "science person" etc.) has repeatedly been used as a measure of mathematics (science, etc.) identity (e.g., Cribbs et al., 2015; Gonzalez et al., 2020; Shanahan, 2008; Hazari et al., 2010; Carlone & Johnson, 2007). Three constructs have been shown to contribute to a positive mathematics identity, as measured by seeing oneself as a "math person": competence/performance, interest, and recognition (Cribbs et al., 2015). *Competence/performance* refers to a student's beliefs about their ability to understand and perform in mathematics, *interest* as a student's desire to learn mathematics, and *recognition* as how students think that others perceive them and their mathematical abilities. In this study, we explored seven students' interpretations of "identity" and "math person," and compared these to these interpretations, respectively, to the identity factors (mathematics, personal, social) and mathematics identity factors (competence/performance, interest, recognition) described above.

Studies have demonstrated, with varied methods and populations, that mathematics identity can be linked to several student outcomes. Here, we highlight a few of these findings related to students' persistence and success in STEM classes. In a large study of undergraduate calculus students, Cass et al. (2011) found that three of the factors related to mathematics identity (interest, performance, recognition) were significant predictors of students choosing careers in engineering. In another study, Boaler and Greeno (2000) conducted interviews with high school students and found that those planning to leave the discipline often lacked interest in the procedural nature of the mathematics being taught. This link between mathematics identity and retention in STEM courses has been examined in studies alongside other outcomes, such as success in math courses. For instance, Meece et al. (1990) employed surveys with middle schoolers in suburban communities and found that students' ratings of the importance of math predicted their future enrollment in mathematics courses. They also determined that students' performance expectations in their math courses strongly predicted their subsequent grades. More recent studies have further explored this relationship between students' mathematics identity and performance. For example, Gonzalez et al. (2020) demonstrated a positive correlation between mathematics identity and mathematics GPA for Black secondary students in a large-scale survey across the U.S. From these findings and others, we consider fostering a positive mathematics identity in students to be an important component of their persistence and success in STEM. This study presents a first look at understanding terms associated with mathematics identity, so that we may more accurately and sufficiently assess it in students.

Methods

In Spring 2022, we conducted IRB-approved interviews with undergraduate students at a large public research university in the southwestern United States. These interviews are part of a larger project intending to add questions to the mathematics department's end-of-course evaluations for assessing the current atmosphere in mathematics classrooms at the university. A preliminary version of such a survey included items aimed at measuring students' (1) sense of community, (2) sense of belonging, (3) sense of inclusion in mathematics classrooms, and (4) self-perceptions of ability and identity. As part of the design process, we developed an interview protocol to better understand how students interpret terms and respond to questions.

One purpose of the interviews was to gain insight into the design of the selected questions to inform the revision and refinement of the survey items. Accordingly, the interview was structured to investigate how participants interpreted the terms and questions and to understand how these interpretations informed their responses. This study employs clinical interview methodology using open-ended, think-aloud interview questions (Clement, 2000). The interview protocol consisted of two major parts. First, students were asked to define each of six terms: “sense of community,” “sense of belonging,” “sense of inclusion,” “math person,” “identity,” “classroom climate.” Second, participants responded aloud to free-response and Likert-style items from the survey, while explaining the reasoning behind their responses and their interpretations of the questions as written.

Invitations to participate were distributed via email from the instructor of record to students in all levels of undergraduate mathematics classes. Seven students participated in the interviews and were each compensated with a $15 e-gift card. These students had a wide range of experience with mathematics at the university, with enrollments from college algebra to upper-division proof-based courses. Interviews lasted between 30-60 minutes and were conducted remotely, using web-based video conferencing software.

Data analysis was conducted on de-identified transcripts of the seven clinical interviews. The transcripts were automatically generated by the video conferencing software and then verified and edited for accuracy by members of the research team. Participant responses for the first set of interview items (defining terms) were analyzed using conventional content analysis (Hsieh & Shannon, 2005). This process involved identifying themes and patterns in the students’ responses *without* using preconceived codes. Though our analysis involves comparing students’ responses to an existing mathematics identity framework (Cass et al., 2011; Cribbs et al., 2015), we decided not to use the existing framework for creating initial codes from the interview transcripts. We wanted to ground our developed codes in the key thoughts and concepts from the students’ responses, without preconceived notions of what “identity” or “math person” could mean. Our codes were then refined through several iterations with constant comparison. Final primary codes capture the essence of student responses, with secondary codes and modifiers used as needed for additional specification.

Although this coding process was implemented for all parts of the transcripts, we restrict our attention to students’ definitions of “identity” and “math person” in this study. We leverage our codes to understand how participants define these terms and compare their definitions to the factors that influence mathematics identity formation (Cass et al., 2011; Cribbs et al., 2015). In particular, we examine how these students’ definitions for “identity” relate to the personal, social, and mathematics components of identity and how their definitions for “math person” relate to the performance/competence, interest, and recognition factors of mathematics identity.

Results

Identity

We first present themes which emerged from students’ responses to the item, “What does ‘identity’ mean to you in the context of the mathematics classroom?” Note that, due to time constraints while interviewing, only five of the seven students responded to this question. Representative excerpts from each student are shown in Table 1, with key sections bolded; the right-hand column displays the codes assigned to each excerpt.

There was little to no overlap in themes between the students’ definitions of “identity.” Two students, Student1 and Student2, described “identity” in a general sense, which was decontextualized from the mathematics classroom. Student1 described “identity” as how someone views themselves (and thinks others view them), with particular focus on one's personality and interests. On the other hand, Student2 specifically called for going beyond “just who you are,” and instead defined “identity” as including one’s morals and values. Both students interpreted identity as an "inner" part of oneself but differed in whether they focused on a person's actions or values.

The remaining three students thought of "identity" specifically in the context of their mathematics classroom but were influenced by different components of the classroom. Student3 conceptualized "identity" as what one contributes to the mathematical and social environment of the classroom. They focused on the interactions that one has with their peers and TAs, as well as the effects these interactions have on establishing a hierarchy within the class (teacher > TAs > students). Student4's definition of "identity" was less about interpersonal interactions and more about one's math ability. The impact of the teacher is still significant in this definition, but only insofar as the teacher is able to foster the student's mathematics identity. Student5 also highlighted the similarities between "math person" and "identity," focusing on a person's priorities and interests related to math as central to their identity in the math classroom. However, unlike the previous two students, this definition omitted interactions with people in the classroom and instead emphasized a student's personal motivations.

Table 1. Excerpts of student responses to "What does 'identity' mean to you in the context of the mathematics classroom?" with coding. Emphasis added.

Excerpt	Coding
Student1: It's, it's who you are and what makes you different…If I can play guitar, which I'm trying to do, but I suck at it. **If I suck at playing the guitar, that adds to my identity**, because there are not as many people in the world who suck at playing the guitar. And so you keep adding that. Well, I also like video games. Well, people who suck at guitar and who play video games is even smaller in between. Well, I also like creative writing, and **it keeps getting smaller and smaller until you're your own unique person**.	How you view yourself; How others view you; Skills; Likes and Interests
Student2: Because I think of identity more of like an inner, like a personal level rather than just who are you, what are your credentials. What are, like, **what are your values, what are your morals, what do you support**? How do you, like, do you respect people?	Personality (vs. achievements); Values/morals; Respecting others;
Student3: So, I guess I would identify identity in, like, the math class as, like, like, your own personal identity. Like, **what you do, how you contribute to the classroom at all, if you do**. So, like, if you are someone that's like, "Hey, I'm really good at math. I can help you. Like, here's my phone number, like, I can help tutor you." I feel like that's, like, your sense of identity. Um, I feel like in the math class, because there is very little peer interaction, there isn't really a lot of identity."	Making Contributions (to class); Interactions (student-student)
Student4: I think identity in a math class has quite a bit to do with the teacher. Because in my, in my earlier days, like in middle school and high school, when I was doing math, **I didn't have a very good**	Teacher-dependent; Academic identity;

teacher. So, I was, my main instinct was just to think, "well, my teacher isn't good. I'm not understanding, even though they tried to explain. So, **I'm not very good at math…**So, yeah, it all boils down to, firstly, **if you're a math person**, which we addressed already. But also, your teacher and how you're, how you develop in the math class over the years.**"**	"Math person"; Developing skills
<u>Student5</u>: Um, I don't think [personality traits and interests are as] significant as…like it kind of, **it kind of goes hand in hand with like my definition of a math person**. Like, are you more single minded like, into like, you know, your major and your career, or are you, you know, like balancing kind of a lot of like interests and priorities? Because I know some people who will spend like hours studying for a class that I might spend a couple…you know, like, it just, it just, you know, **some people are just like really into getting everything and getting the theory and I do, I do think that like contributes to identity**.	Personality (not as important); Priorities (single-minded vs. broad interests, studying); Inconsistent definition (self); Likes and interests (concepts, theory)

These responses can be considered in light of an overall framing of identity in mathematics education literature (Cass et al., 2011; Cribbs et al., 2015). Student1 and Student2 did not contextualize their responses in terms of a mathematics classroom; instead, their responses most closely align with descriptions of personal identity (Cass et al., 2011). That is, they centered on interests and values related to the individual person. On the other hand, Student3, Student4, and Student5 contextualized their definitions within the mathematics classroom. While they also referred to aspects of personal identity, these students emphasized the social and mathematics identities that they formed in the classroom. They focused on their ability to do mathematics in the classroom, as well as the various interactions in the classroom that influence their development as a "math person." Within these responses, different components of mathematics identity were mentioned by different students: For example, Student4's response incorporates elements of competence/performance and interest, while Student5's response mostly focused on interest alone.

Math Person

In this section, we present and analyze participant responses to the item, "What does 'math person' mean to you?" Recall that "math person" is a term used to evoke a person with a positive mathematics identity (Cribbs et al., 2015). We identified more commonalities in these responses than in the identity question, with multiple students' entries receiving the same codes. Table 2 presents operationalized definitions of codes assigned to more than one student, as well as how many students (out of seven) were assigned each code. Since these codes were produced through conventional content analysis of the interview data (Hsieh & Shannon, 2005), each code may not be directly associated with the mathematics identity factors from Cribbs et al.'s (2015) framework.

Table 2. Codes for student responses to "What does 'math person' mean to you?"

Code: Description	*N*
Skills: Abilities related to successfully performing a task or action	6
Likes/Interests: Topics or activities that elicit feelings of interest or like, with or without enjoyment	5
Disinterested: Topics or activities that do not explicitly elicit feelings of interest	4
Enjoyment: Pleasure or satisfaction derived from an action or interest	4
Field of study: Reference to field(s) of study other than math	4
"Non-math person": Participant mentions "non-math" people	3
Counter-example: Participant uses a counter-example to explain a concept	3
Math is …: Subjective description of mathematics or its qualities	3
Priorities: Activities or topics that are preferentially attended to	3
Developing skills: Action of improving or expanding skills, intentionally or otherwise	2
Intelligence: Quality of being intelligent/smart, potentially in relation to others	2
Interviewee academic details: Participant gives general academic information about themselves (e.g. major or classes), with or without prompting	2
Logical: Characterized as being able to use formal/informal logical reasoning	2

A majority of the definitions of "math person" included a discussion of one's capacity to perform mathematical tasks, which we coded as *Skills*. These were sometimes explicit statements, e.g., "being good at math" as a prerequisite for being considered a "math person." Other times, students referenced skills that "math people" possessed, such as "calculating on the spot" or being able to "rearrange numbers in their head." One student who did not explicitly state the significance of skills still thought of "math people" as people who "think logically." In some capacity, all participants conceived of a "math person" as someone who thinks with and about mathematics.

Enjoyment of mathematics or mathematical thinking was also an important characteristic of "math people" for five of the seven students. This was observed in explicit statements suggesting that *Enjoyment* is essential, such as "one of the big denominators of if you're a math person is if you enjoy it." It was also implied by statements of *Likes and interests* in reference to logical or quantitative thinking, such as finding the "puzzle aspects of mathematics fun." However, one student did directly note that enjoyment was not essential, stating that "you don't have to like math to be a 'math person.'" This student's reasoning was that, after a certain point, performing mathematics becomes intuitive and does not necessarily require enjoyment (much like breathing). This is not so much a statement of lack of enjoyment as it is a statement suggesting that, after a certain level of mathematical skill attainment, enjoyment may not be a prominent factor in being considered a "math person."

Our findings with respect to "math person" were mostly consistent with a mathematics identity framework (Cass et al., 2011; Cribbs et al., 2015). The competence/performance factor can be seen in the participants' consistent focus on the *Skills* necessary to be a "math person." To them, a "math person" is someone who can perform calculations quickly or has some natural competence when it comes to mathematics. The interest factor is also clearly apparent in participants' mentions of *Enjoyment* and *Likes and interests*. However, recognition was only seen in one of the seven students' descriptions of a "math person." Student3 described a "math person" as "your person to go to" if you have a question, although they also noted that recognition by peers was not a definitive requirement for being a "math person." Overall, the seven students we interviewed did not incorporate external perceptions in their definitions.

Discussion and Next Steps

Participants' definitions of "identity" in the mathematics classroom were highly varied. Some students described only aspects of personal identity, while others referred to all three identity components (personal, social, and mathematical) in their responses. Additional research would be needed to understand this variation in response. In contrast, students were mostly consistent in describing a "math person" as someone that enjoys mathematical processes and has the skills necessary to be proficient at math. These components are closely related to the interest and competence/performance components of a mathematics identity framework (Cass et al., 2011; Cribbs et al., 2015). While students did not explicitly incorporate the recognition component into their definitions, this could be because they were doing the recognizing themselves by defining characteristics of a "math person." That is, the phrasing of the interview question could have made the recognition component of mathematics identity less salient in student responses.

We take these results as evidence that we might want to explicitly define "identity" or avoid the term in surveys altogether, and that using the term "math person" on our survey could be productive. Immediate next steps in the larger project will explore how students interpret terms for other affective constructs linked to student success and persistence in STEM, such as "sense of belonging" (Strayhorn, 2018). We will interview additional students from varied backgrounds from within the university to further enrich our understanding of these constructs. These results will be used to develop a questionnaire that captures meaningful information about the impact of a mathematics course on students' affect, while being brief enough to be appended to end-of-term course evaluations. The current study contributes towards this goal by providing insight into students' understanding of mathematics identity terminology, so that we may create more accurate and actionable items for instructors to assess and foster this form of identity in their students.

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References

Bishop, J. P. (2012). "She's always been the smart one. I've always been the dumb one": Identities in the mathematics classroom. *Journal for Research in Mathematics Education*, *43*(1), 34-74.

Boaler, J., & Greeno, J. G. (2000). Identity, agency and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple Perspectives on Mathematics Teaching and Learning* (pp. 171-200). Elsevier Science.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187-1218.

Cass, C. A., Hazari, Z., Cribbs, J., Sadler, P. M., & Sonnert, G. (2011). Examining the impact of mathematics identity on the choice of engineering careers for male and female students. *2011 Frontiers in Education Conference (FIE),* (pp. F2H-1). IEEE.

Clement, J. (2000) Analysis of clinical interviews: Foundations and model viability. In R. Lesh & A. Kelly (Eds.), *Handbook of research methodologies for science and mathematics education* (pp. 341-385). Hillsdale, NJ: Lawrence Erlbaum.

Cribbs, J. D., Hazari, Z., Sonnert, G., & Sadler, P. M. (2015). Establishing an explanatory model for mathematics identity. *Child development*, *86*(4), 1048-1062.

Dou, R., Hazari, Z., Dabney, K., Sonnert, G., & Sadler, P. (2019). Early informal STEM experiences and STEM identity: The importance of talking science. *Science Education*, *103*(3), 623-637.

Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice. *Journal of Engineering Education*, *105*(2), 312-340.

Gonzalez, L., Chapman, S., & Battle, J. (2020). Mathematics identity and achievement among Black students. *School Science and Mathematics*, *120*(8), 456-466.

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of research in science teaching*, *47*(8), 978-1003.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277-1288.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of educational psychology*, *82*(1), 60.

Sfard, A., & Prusak, A. (2005). Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. *Educational researcher*, *34*(4), 14-22.

Shanahan, M. C. (2008). What does it mean to be a science person? Exploring the meaning and impact of identity development in science. *Canadian Society for the Study of Education Annual Conference*.

Strayhorn, T. L. (2018). *College students' sense of belonging: A key to educational success for all students*. New York: Routledge.

Verdín, D., & Godwin, A. (2015). First in the family: A comparison of first-generation and non-first-generation engineering college students. *2015 IEEE Frontiers in Education Conference (FIE)* (pp. 1-8). IEEE.