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Dominant Discourses About What It Means to Be "Good" at Mathematics: How High-Achieving Young Women Negotiate Tensions Within Their Evolving STEM Identities

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Abstract: Cultural beliefs about what it means to be "good" at mathematics profoundly impact students' perceptions of their abilities and how they come to see themselves in STEM. These beliefs can be traced back to dominant societal discourses about mathematical aptitude and achievement. These dominant discourses are communicated to students in a myriad of ways through family, friends, media, and overall societal norms. They reify deficit perspectives (often gendered, classed, and racialized) about who is or can be mathematically competent. In this investigation, we used a framework of dichotomies within dominant discourses about what it means to be "good" at mathematics to interpret retrospective narratives from a larger phenomenological study of accelerated mathematics course-taking. Focus group and individual interview data from two high-achieving young women were analyzed to understand how evolving beliefs about mathematical competence impacted their STEM identity development. These dichotomies explain the questioning of their mathematical competence and their subsequent decisions to decelerate from the most rigorous program of study at their high school. Our participants negotiated tensions in their STEM identities as a result of a mathematics culture that too often values speed, correctness, and competition over collaboration, productive struggle, and help-seeking. They continue to navigate these tensions as college students and as STEM majors. Our framework can be used to understand how mathematics experiences contribute to students' struggles to develop robust STEM identities.

Keywords: identity; gender; mathematics; acceleration; algebra; calculus; STEM; dominant discourses; dichotomies

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1. Introduction

The STEM education community is increasingly taking a sociocultural perspective on learning and attending to the need to foster more positive and productive mathematical identities (Bishop, 2012; Darragh, 2016; Hall et al., 2018; Radovic et al., 2018). Students' sense of themselves as "good" at mathematics is particularly important for individuals in mathematically intensive STEM fields, including physics, engineering, and computer science (Cass et al., 2011). Much of the existing literature on STEM identities has focused on students' experiences within and beyond the classroom (Archer et al., 2010; Bishop, 2012; Rosenberg et al., 2024). However, less attention is given to how societal norms and cultural discourses that reflect these norms might counter efforts to foster productive mathematical identities in STEM. In the United States (USA), there is a long-standing presumption that students who accelerate their secondary mathematics courses and complete calculus in high school are better positioned for STEM majors and careers (Bressoud, 2021; Seymour & Hunter, 2019). Dominant discourses about what it means to be "good" at mathematics (Archer & Mendick, 2024; Darragh, 2015) are deeply intertwined with decisions that students, parents, and teachers make about accelerating mathematics courses. As such, acceleration becomes not only a mathematical pursuit, but a cultural expectation, as high-achieving students strive to distinguish themselves from their peers and to improve their competitiveness for admission to elite universities (Galanti, 2019).

In this investigation, we offer a framework built upon prior theorizations of gender and mathematical identity to examine dominant discourses about mathematical tasks in secondary classrooms. We use this framework to interpret the narratives of two undergraduate young women majoring in STEM as they reflect on their accelerated mathematics experiences in one socioeconomically and racially diverse secondary International Baccalaureate (IB) program in the US. Their narratives of six years of mathematics learning make explicit the ways in which girls negotiate tensions between dominant discourses about what it means to be "good" at mathematics and their beliefs about themselves.

2. Literature Review

Secondary students' perceptions of what it means to be "good" at mathematics are often framed by objective metrics of success in the form of courses taken and grades earned. These seemingly straightforward metrics are consistent with Western cultural beliefs about mathematical ability as being innate and immutable (Douglas & Attewell, 2017). Hidden behind these cultural beliefs are the complexities of the sociocultural contexts in which secondary students learn mathematics. These complexities include societal, parental, teacher, and peer expectations for engagement in mathematics practices (Nasir, 2002). Students' beliefs about their own mathematical competence and their sense that others recognize them as being "good" at math are profoundly influenced by these expectations.

Studies of STEM identity development, particularly in the context of accelerated course-taking, may reflect dominant discourses that both describe and create the ways that students see themselves and are seen by others in mathematics (Bartholomew et al., 2011). The social construction of mathematics achievement and the ability to reason as masculine traits (Hottinger, 2016; Mendick, 2005; Walkerdine, 1998) can make it more difficult for girls to build robust mathematical identities. Competitive settings in particular can exacerbate the challenges girls face in seeing themselves as productive knowers and doers of rigorous mathematics. We can interrogate traditional discourses of underperformance in women in STEM by emphasizing a sociocultural perspective on how high-achieving girls develop positive mathematical identities (Jaremus et al., 2020; Joseph et al., 2017; Radovic et al., 2017).

2.1. Hyper-Acceleration and Its Socialized Assumptions

Beliefs about what it means to be "good" at mathematics are deeply embedded in Western educational systems (Anderson et al., 2018; Foyn et al., 2018). These beliefs are pervasive and communicated to students in a myriad of ways through family, friends, media, and overall societal norms (Hottinger, 2016). Often unexamined, these socialized assumptions about the world are replicated within a community or culture and are communicated explicitly and implicitly (Maccoby, 2014). These assumptions are presumed to be correct by community members, and as such, they are rarely examined or challenged. Accelerating mathematics courses by two or more years has become an increasingly common practice in the US for high-achieving students despite the potential negative impacts on the depth of mathematics learning (McCallum & Nowak, 2020; Picciotto, 2016; Sheffield, 2017). The term hyper-acceleration has been used to describe the study of Algebra I in Grade 7 or earlier when it is typically taught in Grade 9 (Galanti, 2019). The association of smartness with selection for hyper-acceleration can create very narrow beliefs about what it means to be "good" at mathematics (Galanti et al., 2021). We use the term deceleration to describe a high-achieving student's subsequent decision to leave the most rigorous course trajectory available to them based on taking Algebra I in Grade 7 or earlier (Galanti, 2021). The presumption that faster is better in secondary mathematics course-taking creates the need to understand how individual perceptions of mathematical competence may evolve if and when high-achieving students make choices to decelerate their mathematics course-taking.

2.2. High-Achieving Girls and Mathematical Identities

While hyper-acceleration as a marker of mathematical competence may be unique to the US, the international impact of dominant discourses on high-achieving girls in mathematics has been well documented. Over the past 30 years, multiple studies have described negative effects on high-achieving girls who were selected for the highest secondary mathematics pathways in their teenage years (Boaler, 1997b; Boaler et al., 2000; Foyn et al., 2018; Solomon, 2007a; Wolfe, 2019). In research on accelerated mathematics students (ages 13–16) in the United Kingdom (UK), young women reported anxiety and feeling like they did not belong in high-ability classes (Boaler, 1997b). Boaler suggested that this was the result of the mathematical pedagogy prevalent in Western societies (e.g., modeling a low tolerance for mistakes, framing the teacher as the all-knowing authority, emphasizing rote learning over conceptual understanding of mathematics). Solomon (2007a) reported similar findings in her analysis of UK students' narratives of learning mathematics within ability groups. The high-achieving girls (ages 13–15) associated being "good" at mathematics with speed and fixed or natural ability. The girls in Solomon's study characterized high-achieving boys as having these qualities while questioning their own competence. Research conducted by Wolfe (2019) involving Australian girls in mathematics revealed that many of the participants felt they were "not good enough" (p. 206), despite being highly successful in the subject. The young Norwegian women studied by Foyn et al. (2018) also discussed navigating persistent tensions between wanting to succeed and being seen by others as "too good" (p. 91) at mathematics.

A significant body of research (e.g., Collins et al., 2020; Esmonde et al., 2009; Gholson, 2016; Joseph et al., 2017) has also addressed how gender intersects with other oppressed and privileged identities such as race, ethnicity, and class in assigning competence in mathematics education. This intersectionality often creates additional challenges and complexities for girls of color to construct positive and productive mathematical identities. The impact can be especially deleterious for high-achieving Black girls who are more likely to feel pressured to counter racial and gender stereotypes about mathematics performance (McGee, 2013).

A student's mathematical identity encapsulates the ideas and beliefs they have about who they are within the context of mathematics, how they engage in learning, and how they are positioned by others in mathematical discourses (Bishop, 2012). We build upon our prior work in STEM learner identity (Cribbs et al., 2015; Galanti & Holincheck, 2022) to define competence as one's belief in their ability to understand mathematics content. We also follow Carlone & Johnson (2007) by conceptualizing identity as a student's sense that they can perform their competence in mathematics and be recognized by others as competent. Performance is distinct from competence in that it focuses on a student's belief about their ability to carry out and complete mathematical tasks. Recognition is defined as seeing oneself and believing oneself to be seen by others as a math person. Mathematical identities are constituted in the ways that students position themselves or are positioned by others in mathematics classrooms (Solomon, 2007a), and this positioning occurs both within and beyond the classroom walls. Horn (2008) argued that secondary mathematics course sequences are "lived, represented, enacted, and negotiated by the students, teachers, and others who inhabit them" (p. 204). These identities are constructed in course selections, classroom experiences, and community expectations amidst dominant discourses describing mathematical ability as speed, effortlessness, and correctness (Boaler, 1997b; Boaler et al., 2000; Solomon, 2007b).

2.3. Framework of Dichotomies for Interpreting Mathematical Identity

Social constructions of mathematical ability can make it more difficult for girls to see themselves as "good" at mathematics. Mathematics ability is often perceived as innate (Leslie et al., 2015), and competition becomes a way to recognize and elevate mathematical competence (Esmonde, 2011). Speed and independent thinking are positively associated with beliefs about mathematical ability (Fish et al., 2023; Horn, 2007; Robinson-Cimpian et al., 2014), while memorization can create a presumption of competence and a barrier to the pursuit of conceptual understanding (Boaler, 1997a). Stereotypes about being good, and not necessarily exceptional, at mathematics are grounded in beliefs that memorization, hard work, and help-seeking explain the success of students from minoritized populations (Archer & Mendick, 2024; Chestnut et al., 2018).

We offer a series of dichotomies (see Table 1) to describe the tensions that learners may experience as they situate themselves within dominant discourses about mathematics ability and achievement. The first descriptor within each dichotomous pair reflects what society values more when considering what it means to be "good" at mathematics, while the second descriptor captures what is often less valued. We have elected to use the terms "more valued" and "less valued" in our conceptualization of these dichotomies rather than characterizing beliefs about mathematical ability as "masculine" and "feminine" (e.g., Jaremus, 2021; Mendick, 2005). This approach allows us to more inclusively interpret dominant discourses as experienced by mathematics learners of all genders. We also seek to reduce the potential of the framework being misused to reify gendered norms about who can be "good" at mathematics. We constructed identity implications for secondary mathematics learners within these dichotomies (see Table 1, right column) based on our prior work with STEM teachers and learners (Holincheck & Galanti, 2023; Lane et al., 2021; Rosenberg et al., 2024). We further argue that these identity implications are relevant across secondary STEM learning contexts.

Table 1. Dichotomies within dominant discourses about what it means to be "good" at mathematics.

Dichotomous Pair	Identity Implications for Secondary Mathematics Learners
Fast v. *Slow*	I see myself as mathematically competent when I take math courses before most people. I see myself as mathematically competent when I solve problems quickly.
Competitive v. *Collaborative*	I am only good at math if I enroll in more advanced courses or if I am better than other people at solving problems. I don't benefit from working with others when I am solving challenging problems.
Real understanding v. *Memorization*	I don't just memorize mathematical facts and procedures. I work to understand how to apply the facts and why the procedures work.
Independent v. *Dependent*	I don't need help from others or to ask questions to solve problems. I can solve difficult mathematics problems on my own.
Naturally able v. *Hardworking*	I am good at math because it comes easily to me. I see myself as mathematically competent if I can do math without having to work hard. I see myself as mathematically competent if I can do math without making mistakes.
Exceptional v. *Good at mathematics*	I am really good at math if I take the most advanced courses. Other people say I am a math genius. I am confident that I am really good at math.

The dichotomies in Table 1 allow us to interrogate how dominant discourses influenced the identity formation of two young women who were recognized as mathematically competent by accelerating their secondary courses. We wanted to understand how beliefs about being "good" at mathematics either supported or challenged their STEM identity development. Our examination of mathematical identity development also draws upon more recent research on the narrated experiences of gifted adolescent girls and women in STEM classrooms (e.g., Boston & Cimpian, 2018; J. B. Ernest et al., 2019; Guthrie, 2020) and the pressures they feel to conform with societal norms. The two young women in our study attended the same middle and high school and followed similar trajectories in mathematics, beginning with accelerated Algebra 1 in Grade 7, before proceeding toward STEM majors in college. Although hyper-acceleration created a pathway to take dual-enrollment multivariable calculus and linear algebra in high school, both participants chose to decelerate their mathematics course-taking from this fastest pathway. By applying this framework of dichotomies to analyze retrospective narratives of secondary mathematics experiences, we seek to illuminate how these young women negotiated societal norms and persisted in advanced mathematics. Our study addresses the following research questions:

1. How are dominant discourses about what it means to be "good" at math reflected in the mathematical identity narratives of high-achieving young women in STEM?
2. How did the decision to decelerate from the fastest secondary mathematics course trajectory impact high-achieving young women's sense of mathematical competence?

3. Methods

3.1. Context of Investigation

This research extends a larger 2019 empirical examination of 15 college students' retrospective narratives of hyper-acceleration at one IB high school (Galanti, 2021). In contrast with Advanced Placement (AP) calculus programs offered in many US high schools, the IB program emphasizes interdisciplinary learning across six subject groups in preparation for post-secondary education. At the time of this study, students could choose to study advanced mathematics at one of two levels in the IB diploma program. The Higher Level (HL) two-year course focused on constructing and justifying mathematical arguments using calculus and statistics. The Standard Level (SL) two-year course approached the same topics with less rigor and more contextual problem solving. Students who were hyper-accelerated in secondary mathematics had access to the HL mathematics sequence in Grades 10 and 11 and dual-enrollment multivariable calculus and/or linear algebra during Grade 12.

3.2. Participants and Setting

West Valley High School (pseudonym) is a racially and socioeconomically diverse suburban school of over 2000 students. IB classrooms at West Valley High School typically do not present behavioral or work completion challenges to teachers, but student anxiety about grades and achievement is pervasive among IB students. The cultural constructions of gender and mathematics (Hottinger, 2016) in this study are situated within a highly resourced community where enrollment in Grade 7 Algebra I carries a presumption of mathematical competence. Approximately 50% of students in this school district complete Algebra 1 before Grade 9, which is more than double the rate for the US overall (Remillard et al., 2017). An estimated 14% of students at West Valley High School were hyper-accelerated in Algebra 1 at the time of the study. Our two participants (Elizabeth and Ashley, pseudonyms) identified as cis-gendered and White and attended West Valley High School for four years. They were two years ahead of many of their peers at the start of high school because they had taken Algebra I in Grade 7 and Geometry in Grade 8. Elizabeth and Ashley did not remain on the hyper-accelerated pathway to multivariable calculus and linear algebra in high school, but they still chose to major in STEM in college. Their narratives were selected for further interpretation in this investigation because they had described their decision to decelerate their mathematics course-taking.

3.3. Choosing an Interpretative Mode of Inquiry

In the larger study, we drew from the tenets of hermeneutic phenomenology (Heidegger, 1988; Kim, 2015) in which the participants are positioned as the knowers. The researchers make their own beliefs and assumptions explicit in the interpretation of participants' truths. Hermeneutic phenomenological research explicates unique, idiosyncratic meanings (Cho & Trent, 2006) and provides a contextual lens that is often missing in large-scale quantitative studies of student outcomes in accelerated secondary mathematics. Our inductive approach to the interpretation of narratives in the larger study was critical to understanding the lived experiences of high-achieving mathematics students in a culture that equates acceleration with being "good" at mathematics. In this study, we pivoted to a deductive approach to make inferences about how the lived experiences of two high-achieving young women reflected dominant discourses about mathematical competence within this culture.

The first author's positioning as a former electrical engineer and as a veteran high school mathematics teacher at West Valley High School at the time of this research study provided a depth of understanding of the phenomenon of hyper-acceleration. She taught the participants' Grade 9 Algebra I course, and her personal recollections were highly relevant to the interpretation and construction of their narratives as college students. Her immersive knowledge of the societal norms and dominant discourses related to classroom engagement, students' sense of mathematical competence, and the pedagogy of advanced mathematics at West Valley High School increased both the trust of our participants and the trustworthiness of our interpretation of data. The second author's experiences earning a master's degree in physics, teaching high school physics, and researching gender in STEM offered an additional perspective on the participants and their experiences. We understand the personal and professional challenges that young women face in navigating STEM majors and careers, and as women in STEM, we are deeply committed to opening doors to STEM professions for more students.

3.4. Data Collection and Analysis

Elizabeth and Ashley participated in separate focus groups designed to elicit students' shared experiences as mathematics learners in the West Valley High School community over six years beginning with Algebra 1 in Grade 7. The semi-structured focus group interview protocol included retrospective questions about how students felt about math in Grade 7 and their feelings about math at the time of the interview (when they were enrolled in college). Students were also asked to describe their successes and struggles in mathematics, what it means to be "good" at mathematics, and to reflect on their choices to accelerate and/or decelerate in mathematics in Grades 7–12. The first author deconstructed and reordered the focus group transcripts to form chronological identity narratives for both Elizabeth and Ashley. These narratives were used to develop individual interview protocols tailored for each participant's focus group responses. Elizabeth and Ashley elaborated on specific transcript excerpts from the focus groups in their individual interviews. The first and second authors engaged in collaborative in vivo coding (Saldaña, 2021) of the interview transcripts. We found evidence of tensions between students' experiences in mathematics and the influence of societal, parental, teacher, and peer expectations for engagement in the practices of mathematics. This motivated our work to build upon prior research to develop a framework related to dominant discourses in secondary mathematics education (see Table 1), and further analyze Elizabeth's and Ashley's retrospective identity narratives. In our second cycle coding, we engaged in provisional coding (Saldaña, 2021) using the dichotomies described in our framework as a priori codes to understand how Elizabeth's and Ashley's lived experiences reflected dominant discourses about mathematics.

We established dependability and confirmability by building an audit trail of transcripts and memos from multiple interviews and settings. Two mathematics education experts provided peer scrutiny (Shenton, 2004) of our group interview transcript coding, and participants were invited to clarify statements and researcher interpretations from their interviews. A triangulation of the findings was achieved by comparing participants' group interviews and individual interviews and evaluating the consistency across their responses.

4. Findings

To honor our participants' experiences and perspectives, we present the individual stories of Elizabeth's and Ashley's mathematics journeys in the findings below. We interpret how their sense of themselves as "good" at secondary mathematics reflects dominant discourses. In some instances, we found evidence of the more-valued descriptors within dichotomous pairs, consistent with a strengthening mathematical identity. In other instances, we found evidence of the less-valued descriptor.

4.1. Elizabeth's Narrative

Elizabeth was classified as gifted in Grade 3. At the time of the study, she was majoring in behavioral neuroscience at a top-tier state university after making two explicit choices to decelerate her mathematics after studying Algebra I in Grade 7 and Geometry in Grade 8 (See Table 2). First, she enrolled in the IB SL sequence during Grade 10, and she then chose to complete the second year of the SL course during Grade 11 in lieu of returning to complete the more rigorous two-year HL course. She decided not to take a mathematics course during her senior year. Elizabeth's evolving mathematical identity as an accelerated mathematics student can be described by several dichotomies. These represent both beliefs about herself and the messages that she received from others.

Table 2. Elizabeth's secondary mathematics course pathway. Bolds represent student deceleration.

Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Algebra I	Geometry	Algebra II	**IB Standard Level Year 1**	IB Standard Level Year 2	**None**

4.1.1. Competitive v. Collaborative

Elizabeth's narrative reveals the tensions between hyper-acceleration in mathematics as an academic necessity in a competitive culture and its failure to build the sense of competence that she needed to enjoy and persist in the most advanced mathematics courses. During the focus group conversations, Elizabeth shared distinct memories of early competition in mathematics after she was placed in the gifted center at her elementary school.

> I didn't go to recess with the people who were in general education or lunch with the people who were in general education. It was really intense. You were only with like the smart people who came from Whispering River Elementary. It's very separated and from there it's kind of like competitive and has been ever since. I just remember that I always disliked math. I wasn't awful at it or anything, I just really didn't like it.

As early as elementary school, Elizabeth equated mathematics with being smart and with the broader expectation to be better than other students. Studying Algebra I in Grade 7 was not a purposeful decision driven by enjoyment or interest in mathematics; instead, it was a necessary step to preserve her social position. In her focus group, she shared that she did not like being bored in class and took pride in taking advantage of the "opportunity to take a more difficult class than you are supposed to". Yet, in retrospect, she voiced the tensions between maintaining status and building confidence in mathematics that hyper-acceleration may present for students on this competitive pathway. In her individual interview, Elizabeth described how acceleration as social capital (Gutiérrez, 2011) could become a diminished opportunity to engage in mathematics.

> It was a big deal which math class you were in, and I mean, if you weren't taking Algebra 1 in seventh grade, then you weren't. . . It wasn't even an option to not take Algebra 1 in seventh grade. There are definitely people that did it because that's just what they have to do. That's what their parents are telling them they have to do because they got high enough on the Iowa [algebra readiness test], but maybe they didn't ever want to. There's tons of people who are just in classes because that's the expectation, but it's not where they should be. And then, they end up hating learning. There's a lot of people who did do Algebra 1 in seventh grade who probably thought it was not the right decision for them. I think it kind of destroyed their confidence in math.

Elizabeth emphasized how students wanted to preserve their social status as "better" than others by enrolling in accelerated mathematics courses. She also sensed the tensions that could come with needing this recognition while worrying that others might discover they were not "good" at mathematics.

4.1.2. Real Understanding v. Memorization

Elizabeth also described the lack of meaningful challenge in her middle school courses as a lost opportunity to build her sense of competence and *real understanding* of mathematics. In her individual interview, she recalled that her Algebra I experience as *memorization* of facts and formulas did not make her passionate about mathematics or confident in her abilities. She lamented that Grade 7 Algebra had been too easy. Her expectation of advanced middle school courses was that they should have challenged her to understand how math works and lay a foundation for concepts in future courses. Her Grade 8 Geometry teacher had inconsistent expectations for students to either reproduce exactly what they had been taught or to conduct things they had never seen before. Elizabeth elaborated, "I think if she had taught it in a way that expected the higher expectations of understanding, we would have been able to apply the concepts [on the exams]". Elizabeth also offered a contrast between her middle school mathematics experiences and her Grade 9 Algebra II experience. In the individual interview, she described how her own confidence to persist in mathematics related to her teacher's emphasis on building connected understandings.

> Algebra II was not, "Here's a formula. Here's the questions you're going to get, and then this is how you solve it using that formula". It was, "Here's how this formula works. Here's a question that might include tons of different topics, and you could solve it in different ways, but you have to figure out how to get to the right answer". So, that's a higher expectation of understanding.

Elizabeth also shared that it was near the end of her high school mathematics journey when she began to develop a *real understanding* of mathematics concepts.

> Something I didn't even realize until you get to calculus really, is that math is all connected. If somebody takes the time to tell you why it exists and how it makes

> sense, then it's so much better than having to just remember, I don't know, using the Pythagorean Theorem in Geometry, with no concept of why it is that way.

Elizabeth's beliefs about what it means to be "good" at math evolved, shifting from mathematics as the less-valued *memorization* in middle school to the more-valued *real understanding* at the end of high school.

4.1.3. Fast v. Slow

Although she did not take a mathematics course during Grade 12, Elizabeth scored in the top 10% internationally on her IB SL examination a few months before graduation. She proudly described this accomplishment to her focus group peers as her greatest achievement in mathematics. She recalled her surprise when receiving her score:

> I literally screamed and fell on the floor because I literally thought I had failed. I was like "Colleges are going to think I'm crazy because I failed my IB exam and I am not taking math my senior year".

In her individual interview, Elizabeth elaborated on the intensity of this reaction. The admissions counselor at her first-choice college had told her that she would not be admitted if she did not take a mathematics course during her senior year despite having completed a two-year IB course sequence with calculus in Grade 11. Elizabeth resented this narrow view of her mathematical proficiency, especially since she had chosen a *fast* route to completing high school calculus and expected to resume her study of calculus in college. She was frustrated by the college counselor's suggestion that she was less mathematically competent because she had taken a *slower* accelerated pathway than many of her peers. In this case, it was the counselor's beliefs about mathematics that caused Elizabeth to question her own competence.

4.1.4. Naturally Able v. Hardworking

In her further reflection on her decisions to decelerate her mathematics course-taking, Elizabeth wondered how her trajectory might have changed had she experienced appropriately challenging mathematics prior to high school. Having to work hard in Algebra II led her to believe that she was not *naturally able*. She positioned students who "just get it" without *working hard* as the ones who belonged on the most accelerated pathway to multivariable calculus in Grade 12.

> HL mathematics was for the people who were geniuses, like they were so good, and they just got it. Everything I heard about HL was like, "It's the worst IB class in the world. Don't take it. It's so scary". Then, I knew if I just started out with HL, by senior year, I'd probably be taking multi-var, and that's really scary. I think at that point in freshman year, I had gotten a lot more confident in how I understood math, but I think it just started too late. It was ninth grade. Maybe if I had been learning that way for the past three years, then I would have been like, "Oh, I can handle it". But I didn't feel that way.

Elizabeth believed that *hard work* was the key to her mathematics success and that only *naturally able* students should take the most accelerated courses. Her beliefs reflected dominant discourses about what it means to be "good" at mathematics. In Elizabeth's view, hyper-acceleration in Grade 7 was an educational necessity because she was smart, but her narration of middle school experiences with Algebra I and Geometry explains how she was challenged to construct her sense of mathematical competence in those critical years. Her middle school mathematics teachers' emphasis on *competition* and *memorization* did not foster her love of mathematics or her sense of mathematical competence. She questioned her *natural ability* to excel on the most accelerated mathematics path and selected a slower, less rigorous high school mathematics sequence. Yet her deceleration choices and recognition in the form of a high IB exam score built her confidence to continue her study of mathematics and STEM at the university level.

4.2. Ashley's Narrative

Ashley was a collegiate athlete and environmental engineering major who had earned a scholarship to become a military officer. As a secondary student, Ashley made two explicit choices to decelerate her mathematics beyond Grade 7 Algebra I (see Table 3). She chose IB SL mathematics during Grade 10 in anticipation of returning to the two-year HL trajectory during Grades 11 and 12, believing that additional time to experience precalculus content would allow her to be more successful. However, Ashley again decided to decelerate after completing one year of the HL sequence by returning to complete the SL course in Grade 12 because it was a less stressful path. Ashley's evolving mathematical identity as a struggling mathematics student within an accelerated mathematics culture can be described by several dichotomies. These oppositions represent both beliefs about herself and the messages that she received from others.

Table 3. Ashley's secondary mathematics course pathway.

Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Algebra I	Geometry	Algebra II	**IB Standard Level Year 1**	IB Higher Level Year 1	**IB Standard Level Year 2**

4.2.1. Naturally Able v. Hardworking

Ashley believed her struggles in mathematics began when she was identified for gifted services in mathematics after Grade 4, while many of her peers were identified in Grade 3. In her group interview, she vividly recalled her elementary teachers' recommendation that she join the accelerated path to be selected for Algebra 1 in Grade 7.

> "Oh, she's special, so we're going to recommend her for advanced placement in fifth grade". From fourth to fifth grade, I went from general education to gifted and talented. I guess I missed a grade of math somewhere in there because gifted and talented was ahead in math.

While this external recognition as a gifted student could have contributed to her sense of mathematical competence, Ashley doubted that she was *naturally able*. In her individual interview, she shared that she needed to work hard to perform and felt pressured to earn high grades in mathematics classes. She saw the same concerns in her friends.

> I was set up from the second I started in seventh grade to just be like, "Well, I'm not good at this, I need to get a good grade. . . I'm not getting good grades in math, I have to get a good grade". I saw it with a lot of my friends, too. Everybody was always freaking out, and then half the time you're not really absorbing and thinking about it, you're just like oh, this is what I have to do.

Ashley's statement reflects the dominant discourse that people who are "good" at math have *natural ability* and should not have to *work hard* to earn good grades in mathematics.

4.2.2. Independent v. Dependent

In her individual interview, Ashley recounted failing multiple tests in Grade 7 Algebra I and her fear that she would "get pulled from the program" if she did not start to earn passing grades. She recalled crying, "I hate math, I hate math!" when the Algebra I teacher called her parents to express concern about her progress. Ashley believed that she was not able to learn mathematics *independently*. Her father helped her to learn ratios and proportions and she persisted in the course, but she summarized the experience as "scarring". In the focus group, she described being *dependent* on her friends in later classes who helped her with mathematical problem solving. She recalled, "So all my friends in my class would teach me everything. . . they would be just like, 'Here's how you do it'. Then I would figure it out". During the individual interview, Ashley elaborated on the geometry help she received from a friend at swim practice, sharing, "I was able to absorb a lot more because I was putting in more time with it, I guess because my peers were the ones teaching me, so I had to".

Ashley doubted her mathematical competence because she felt *dependent* on others to learn mathematics. Her willingness to be vulnerable with her parents and her peers did not transfer to the mathematics classroom, where she was reluctant to ask questions in class.

> Other kids would be going up and spending that time asking her these questions, but I was already so lost from the class, and I think because of my bad experience in Algebra 1, I just wasn't as comfortable with a teacher. It's like, "oh, I don't want her to think I'm stupid, I'm just going to ask my friends".

Ashley believed that asking questions would demonstrate that she lacked competence, and she did not want her teacher to see her as *dependent* and less able. Her reluctance reflects dominant discourses about *independence*, or not needing to help, as indicative of being "good" at mathematics.

4.2.3. Real Understanding v. Memorization

Ashley's anxiety about earning good grades drove her reliance on *memorization* in Algebra I and Geometry. In her individual interview, she related her doubts about her mathematical abilities to her need to follow procedures exactly as her middle school teachers demonstrated. She did not want to make mistakes, and she shared in her individual interview that she did not feel that she could explore other strategies that might lead to *real understanding*.

> I think that self-doubt is also what leads you not to consider multiple approaches to a problem. When you're like, "oh, I have to get this right", you see what the teacher does and you're like, "that's what I have to do to get an A". You're just going to try and do that even if it doesn't really work for you.

Ashley shared that her fear of being wrong created a "mental block" when she was not able to correctly solve problems. In the focus group, she reflected on her experiences in high school; she placed a higher value on *real understanding* as she described her growing comfort with risk-taking and explorations in her mathematics learning.

> I came from feeling like there had to be one right way all the time, until like maybe halfway through high school. It made such a big difference for me to finally be like, "oh, I can try different things", 'cause I was so set. I was like, "there's one right way to do everything". I was crazy about it, and it drives you insane to think, oh, "I'm not getting it, I'm not getting it". When I started doing it and doing different ways and being able to get the right answer while my peer was getting the right answer a different way, that's when I started to learn.

Ashley reflected on her experiences with her Grade 12 IB mathematics teacher and told her focus group peers, "He really wasn't teaching me that much. He didn't understand why you didn't understand what he just explained to you". She felt that she was developing her *real understanding* of mathematics by working on homework problems outside of class. Despite her growing sense of her own mathematical competence, Ashley strongly expressed her regret that she had studied Algebra I in Grade 7. Her desire to share her story in this study was driven by her perceived need to rely on *memorization* as necessary to earn high grades in middle school. She lamented that she had missed out on building important knowledge. Her emergent valuation of *real understanding* contributed to her sense of self as a mathematical problem solver as she progressed through her high school mathematics courses.

4.2.4. Exceptional at Math v. Good at Math

Ashley's decisions to decelerate in mathematics while in high school were related to her beliefs about herself and about what it means to be competent in mathematics. She shared that she "wasn't good at math until college". When asked what it means to be "good" at mathematics during the focus group, Ashley initially quipped, "I get As, so I am good at math". She later offered a second response, "The ability to solve problems and to know where to go back to more than anything". This shift in Ashley's responses represent the tension she feels between grades as recognition of mathematical competence and her emerging sense of herself as mathematically competent. Ashley recounted her placement in a "regular" math class in college and being "so high above all my peers that I felt like a superstar". She also spoke with pride about tutoring her peers outside of class. Although she maintained her belief that being successful in math was measured by grades, she attributed her success in mathematics and engineering courses to knowing how to make use of her resources and the problem-solving acumen she had acquired in her IB courses.

> Here [in college], it's the only place I've ever gotten straight A's in math, and I think it's because in high school, I didn't fully grasp the idea of like, "oh, I'm knowing where to go back to", and "knowing how to do problems is what matters, and not just getting the right answer".

In her individual interview, Ashley elaborated on her initial response about what it means to be "good" at mathematics.

> When I say get an A to be good at math, that's just, I think, the pressure cooker mindset that we have. That's why I didn't consider myself good until now. I was also so results-oriented until recently. I think that's why I couldn't get an A. I don't know what's going on, but it's working. I'm trying to keep riding the wave.

Ashley's statements indicate that she believes As in mathematics are related to being *good at math*, yet she considers this descriptor distinct from the more valued *exceptional at math*. It was evident that she did not consider herself *exceptional at math* when she stated, "I am not ready for difficult math; I am afraid of not being good enough. I can't think when I don't know how to do a problem. I never want to be traumatized by math again".

Ashley's articulation of competence in her college mathematics courses represents her questioning of dominant discourses about what it means to be successful in mathematics. She had been convinced that her *hard work* and her *dependence* on the help of others to earn As in mathematics reflected a lack of *natural ability*. As she engaged in more *collaborative* learning and problem solving in college, she built more confidence as she could connect her mathematical thinking to her *real understanding* of mathematics. Despite this confidence, Ashley still struggles to see herself as *exceptional at mathematics*, reflecting the profound impact of dominant discourses on learners.

5. Discussion

In this study, we interpreted the narratives of two high-achieving young women to understand how their mathematical identity construction was impacted by dominant discourses about what it means to be "good" at math. Elizabeth's and Ashley's narratives reveal the ebb and flow of mathematical identity development within the context of accelerated course-taking. They had garnered social recognition of their mathematical competence with selection for Algebra I in Grade 7. By the end of Grade 9, each made ostensibly less-valued choices related to their sense of their own competence when they chose to decelerate by taking the less rigorous SL course in Grade 10.

Elizabeth's and Ashley's narratives offer subjective evidence of several dominant discourses about what it is to be "good" at math, framed as six dichotomous pairs (*competitive v. collaborative*, *real understanding v. memorization*, *fast v. slow*, *naturally able v. hardworking*, *independent v. dependent*, and *exceptional v. good at math*). These dominant discourses created tensions in these young women's evolving identities within a high-achieving mathematics culture.

In our a priori coding of the narratives, we were careful to distinguish between two dichotomous pairs that appear similar (*competitive v. collaborative* and *independent v. dependent*). Although *collaborative* and *dependent* as the lesser valued descriptors in their respective dichotomous pairs may seem similar, it is important to distinguish between them in the contexts of their respective dichotomous pairs. *Competitive v. collaborative* focuses on how teachers and students are socialized in educational systems of individual merit (Darnon et al., 2023). Students often believe that being better than others in mathematics is more important than working productively with others to solve problems. Collaboration may actually detract from their goal of being better than others. In contrast, *independent v. dependent* focuses on what students believe about needing help from others when solving mathematics problems. In Ashley's case, the *independent v. dependent* dichotomous pair was connected to feeling like she could not solve math problems on her own because she needed her father and friends to help her. In Elizabeth's case, the dominant discourses inherent in the *competitive v. collaborative* dichotomous pair created social pressures to compare herself to others when evaluating her own mathematical competence.

Both young women explicitly questioned their mathematics abilities at multiple points in their mathematics journeys. They attributed their successes to *hard work* consistent with the less-valued descriptor of the *naturally able v. hardworking* dichotomous pair. Elizabeth believed that she could not succeed at the highest level of mathematics despite a strong record of prior achievement because she felt she didn't "just get it" like many of her peers. Yet her lack of confidence in her abilities reflected her belief that her competence in middle school mathematics was defined by *memorization*. Her emerging belief that *real understanding* could come with the *hard work* of making connections across mathematics topics contradicts the dominant discourse that STEM requires raw intellectual talent (Meyer et al., 2015). Like the high-achieving adolescents in the (Solomon, 2007a) study of ability grouping in mathematics classrooms, our participants initially questioned their mathematical competence because they believed that other students were more *naturally able* in mathematics. Despite the mathematical successes that positioned them to major in STEM fields in college, they continued to resist identifying themselves as naturally able.

Ashley's and Elizabeth's inability to see themselves at the highest level of mathematics also reflected a view of who was *exceptional in mathematics v. good in mathematics* at West Valley High School. This view is consistent with prior research about high-ability girls and maladaptive motivational patterns (Dweck, 1986), wherein girls may avoid rigorous mathematics courses because of fear of experiencing failure (Wolfe, 2019). Dominant discourses about what it means to be "good" at mathematics can also be inferred from our participants' voicing of their deceleration decisions. Ashley argued that her fear that she was "not good enough" at mathematics as measured by test grades motivated her need to rely on *memorization* as the less-valued descriptor in the *real understanding v. memorization* dichotomous pair. Her decision to decelerate her course-taking created space for her to pursue *real understanding* and is consistent with prior research on girls' "quest for understanding" to make sense of taught mathematics (Boaler, 1997a, p. 292).

Our findings for both participants help explain the identity tensions felt by young women who are competing in mathematics environments that value speed even at the cost of understanding. The dichotomous pair *fast v. slow* explicitly reflects a common mathematics culture where students are compared based on how quickly they answer mathematics questions and how they perform on timed tests. These dichotomies are also implicit within accelerated course-taking pathways as students associate the speed of course completion with mathematical competence. Our participants believed speed in answering math questions and in progressing through coursework was more important than being better than others at mathematics; it was a metric of their individual smartness.

Students who perceive that a slowing down in course-taking may help them to learn content are also at risk of being socially positioned as less capable of pursuing STEM majors and careers. Our participants' decisions to take less rigorous high school courses were accompanied by a questioning of their own mathematical competence consistent with dominant discourses. Elizabeth's and Ashley's narrated identities were consistent with prior research about girls positioning themselves and being positioned by others as having less right to be in advanced mathematics (Boaler et al., 2000; Mendick, 2005; Solomon, 2007b). However, their retrospective narratives as young women represent deceleration as supporting the strengthening of their mathematical identities with deeper learning and persistence in mathematics and STEM. Elizabeth and Ashley did not succumb to the dominant discourses of not being "good" at math or the stereotypical feminine "not good enough assemblage" (Wolfe, 2019, p. 27). Despite their doubts about the quality of their learning in their early courses and their own abilities to succeed in their later courses, Elizabeth and Ashley completed high school calculus and clearly articulated their continuing interest in STEM. In our own work with advanced secondary mathematics and physics students, we have seen all too often that students' decisions to decelerate are associated with the less-valued descriptor in the *fast v. slow* dichotomous pair. However, for students like Elizabeth and Ashley, deceleration became an opportunity to build *real understanding* of mathematics and to develop their mathematical resilience (Lee & Johnston-Wilder, 2017). They challenged societal beliefs that the most accelerated course pathway represented mathematical success at West Valley High School. Deceleration can thus be viewed as productive and consistent with the idea that mathematics should be personally and culturally valuable (P. Ernest, 2018). Deceleration, when framed as a reflective, positive choice, has the potential to help more students to persist in advanced mathematics and to see themselves in STEM career fields. At the same time, there is a very real danger that the framing of deceleration as a positive or purposeful choice can affirm social messaging that girls are not knowers and practitioners of mathematics (Hottinger, 2016). Framing a less accelerated mathematics course trajectory as a better decision for girls may only serve to reinforce dominant discourses and reduce the participation of girls in advanced secondary mathematics. Research indicates that gender imbalances in the most advanced courses can make it increasingly difficult for girls to see themselves in these classrooms despite their identification as gifted in mathematics (Kerr & Huffman, 2018). Furthermore, a greater gender imbalance in classrooms can have negative effects on gifted girls' academic self-concept (Preckel et al., 2008).

Limitations

We engaged in this research to interpret the stories of two young women in STEM and to examine how dominant discourses influenced their decisions as they progressed through secondary mathematics courses. We selected these young women from a larger group of students who participated in the larger phenomenological study based on their decision to decelerate their mathematics course-taking. Both participants were former students of the first author of our study. We believe that her teaching insights enriched the study, but we made efforts to reduce potential power imbalances. We used focus groups and carefully constructed interview protocols to frame questions in ways that encouraged thoughtful and honest responses. Another limitation of our approach is that the data were collected retrospectively. We relied on participants' descriptions of their educational experiences from as early as eight years old; their recollections as adults may be influenced by their changing perspectives over time. Future research in this area could use a longitudinal research design to study learners' mathematical identity development over time.

We make no claims that our findings are generalizable, as this was not our goal. The narratives interpreted by the research team and presented in this manuscript are unique to the two individuals who participated in the study. At the same time, our framework of dichotomous pairs and identity statements can be applied in other mathematics and STEM education research contexts.

6. Conclusions and Implications

Deceleration offered space for Elizabeth and Ashley to develop stronger mathematical identities as they navigated beliefs that they and others held about mathematics. They were able to build their sense of competence and see themselves as "good" at mathematics, whether it was by enrolling in a less rigorous course, repeating challenging content, or seeking help from others outside of class. A questioning of mathematical competence, when framed as a productive or even necessary choice, has the potential to help students who question their STEM identities.

Elizabeth's and Ashley's narratives challenge societal beliefs about choosing advanced secondary mathematics courses. As high school students, they navigated the tensions in their mathematical identities. They chose to forgo recognition from others (and themselves) as being good at mathematics in order to increase their sense of competence in mathematics. They continue to navigate these tensions as college students and as STEM majors. Many students, parents, teachers, and administrators hold static beliefs grounded in Western history and culture about what it means to be "good" at mathematics. The first step in effecting change is raising awareness of how these beliefs can be harmful. Dominant discourses about innate mathematical ability too often position students from minoritized groups in STEM to doubt their own competence and to see themselves as "less than" as compared to peers (Gargroetzi, 2024; Louie, 2017).

All stakeholders in mathematics education can work to counter the impact of dominant discourses. Teachers can influence students' beliefs about the value of reasoning, sense-making and mistakes in learning mathematics (Lane et al., 2021). Emphasizing creative problem solving and multiple representations of mathematical thinking while balancing competition with collaboration (Boiangiu et al., 2016) can contribute to more equitable beliefs about what it means to be "good" at mathematics. Teachers who challenge the common categorization of "fast" or "slow" learners of mathematics can reframe mathematical competence as taking the time to make productive connections between ideas (Horn, 2007). Developing a more inclusive and less competitive culture of risk-taking (Boaler, 1997b; Radovic et al., 2017; Solomon, 2007a; Sun, 2019) can better support each and every learner in mathematics and STEM. Being *naturally able*, *fast*, *competitive*, and *independent* is too often the more socially valued way to engage in mathematics. By challenging learners to think deeply, justify their reasoning to others, and make connections, we can make progress in changing dominant discourses about the less-valued ways of participating in mathematics learning.

Our framework of dichotomies has the potential to expand our understanding of why many high-achieving students seek to accelerate mathematics courses and why many struggle to persist in advanced mathematics course-taking. Students who accelerate their mathematics study face unique identity pressures because they have already been recognized as “good” at mathematics. While this study elicits the individual stories of two young women in STEM, the literature makes clear that their experiences are not unique to women (Fernandez et al., 2024). Beliefs about a student’s level of mathematics course-taking frame not only their mathematical identities but also their social identities. Students with intersectional social identities associated with race, gender, and socioeconomic status are differentially impacted by dominant discourses about who can succeed in mathematics (Jones & Magill, 2023; Leyva, 2017). Understanding the role of identity, as constructed by a student’s sense of mathematical competence and perceived recognition by others within these dominant discourses, is crucial if more students are to pursue and persist in math-intensive STEM majors and careers.

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