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Mathematics Identity: Conceptualization, Core Components, Theoretical Perspectives, and Educational Implications

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Abstract

This review article examines mathematics identity as a multidimensional and context-sensitive construct that helps explain students' relationships with mathematics beyond test scores and cognitive performance. Mathematics identity is discussed at the intersection of learners' self-perceptions in mathematics and the social experiences they live through while participating in mathematical practices. Building on major strands in the literature, the paper synthesizes psychological and subjective perspectives such as competence and value-related beliefs, sociocultural perspectives such as participation, belonging, and recognition in communities of practice, and narrative and discourse approaches that emphasize identity as continually rewritten through experience and storytelling. A prominent explanatory framework highlighted in the review conceptualizes mathematics identity through three components: interest, competence and performance beliefs, and recognition by significant others such as teachers and peers. The article also summarizes evidence linking mathematics identity to achievement, engagement, motivation, persistence, and longer-term orientations toward advanced coursework. Finally, it discusses how identity is shaped by classroom norms and interactions, and offers instructional implications: learning environments that make students' ideas visible, distribute participation more equitably, treat errors as productive, and recognize students for their mathematical thinking can strengthen mathematics identity; therefore, identity-supportive pedagogical principles should be explicit targets in teacher education and curriculum development..

Keywords: Engagement; Mathematics Identity; Recognition

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INTRODUCTION

The increasing visibility of the concept of identity in mathematics education is closely related to the growing recognition that mathematical learning cannot be adequately explained solely through cognitive performance and achievement scores. An identity lens enables researchers to consider students' participation in mathematics, how they position themselves within mathematical activities, who is recognized as a "doer of mathematics" in classroom settings, and how these processes intersect with issues of equity (Cobb et al., 2009; Darragh, 2016). Identity research in mathematics education draws from different theoretical traditions, leading to the emergence of diverse approaches in the literature regarding the definition and use of identity. However, these approaches largely agree that identity is a context-sensitive and dynamic construct rather than a fixed trait (Darragh, 2016; Holland & Lave, 2001). From this perspective, mathematics identity offers a powerful explanatory framework for understanding students' relationships with mathematics.

In this review, mathematics identity is conceptualized as a multidimensional construct formed at the intersection of students' self-perceptions related to mathematics and their social experiences during participation in mathematical practices. Psychological or subjective approaches emphasize competence beliefs such as self-efficacy, as well as motivational elements including interest and value (Bandura, 1997; Wigfield & Eccles, 2000). In contrast, sociocultural approaches highlight identity as being constructed through participation, belonging, and recognition within mathematical communities (Lave & Wenger, 1991; Wenger, 1998). Narrative or discursive approaches further conceptualize identity as constituted through stories about mathematics constructed by individuals and others, foregrounding its evolving and experience-based nature (Sfard & Prusak, 2005). Integrative models combining these perspectives suggest that mathematics identity can be meaningfully understood through three core components: interest, competence/performance beliefs, and recognition (Cribbs et al., 2015; Hazari et al., 2010).

Accordingly, this article revisits the question "What is mathematics identity?" not simply by restating existing definitions, but by synthesizing key strands of the literature to clarify the conceptual boundaries of the construct and to distinguish it more systematically from closely related concepts (Darragh, 2016). In doing so, it highlights recurring conceptual ambiguities in prior work—such as inconsistencies in how identity is operationalized across studies and how its core dimensions are theoretically grounded. The article then consolidates evidence on why mathematics identity matters by critically reviewing its documented links with achievement, participation, and persistence, and by discussing how these relationships have been framed in different research traditions (Cribbs et al., 2015; Cobb et al., 2009). Finally, it integrates the core components of mathematics identity (interest, competence/performance, and recognition) with the major theoretical approaches used to explain them (psychological, sociocultural, and narrative), offering an organizing framework that makes explicit how

these perspectives converge and diverge and where further conceptual refinement is needed. The article then explores identity formation processes in relation to teacher–student interactions, classroom norms, and peer and cultural contexts (Cobb et al., 2009; Lave & Wenger, 1991; Sfard & Prusak, 2005). Finally, the development of mathematics identity is discussed as a temporally extended and non-fixed process, and implications for instruction and curriculum design are presented (Anderson, 2007; Holland & Lave, 2001).

LITERATURE REVIEW

Mathematics Identity

A review of operational definitions of mathematics identity reveals that researchers approach to the construct from different theoretical perspectives. This diversity stems partly from linking mathematics identity to affective characteristics at the individual level, such as interest, beliefs, and motivation, and partly from emphasizing the role of social environments and interactions in identity formation. As a result, mathematics identity has been defined and examined in multiple ways, underscoring the importance of explicitly grounding the concept in empirical research (Darragh, 2016).

Within this framework, some studies conceptualize mathematics identity primarily through individuals' beliefs about their mathematical performance and the utility of mathematics. For instance, Martin (2000) defines mathematics identity as individuals' beliefs about their abilities to perform in mathematical contexts, their beliefs about the instrumental value of mathematical knowledge, the motivations that emerge from these beliefs, and the strategies they employ in learning or doing mathematics. Bishop (2012) similarly describes mathematical identity as a set of beliefs related to commitment to mathematics, while Leatham and Hill (2010) define it more broadly as one's relationship with mathematics. In a related vein, Cribbs et al. (2015) conceptualize mathematics identity as how students see themselves in mathematics based on their perceptions and everyday experiences, and Crossley et al. (2018) frame it as the degree to which students identify with mathematics.

From a broader theoretical standpoint, identity is commonly associated with how individuals understand and perceive themselves. Gee (2000) defines identity as a belief about "what kind of person" one is. Importantly, identity is viewed not as a static trait but as a socially constructed and interactionally shaped phenomenon that is continuously influenced by individuals' experiences, learning processes, and participation in communities (Holland & Lave, 2001). When applied to mathematics, this perspective positions mathematics identity as grounded in how individuals see themselves within mathematical culture, encompassing both self-understandings and others' perceptions of them in mathematical contexts (Martin, 2007).

Approaches that further specify the scope of mathematics identity emphasize its constituent elements, including beliefs, attitudes, emotions, dispositions, and motivation to learn and use

mathematical knowledge (Froschl & Sprung, 2016). Cobb et al. (2009) highlight that mathematics identity includes how students think about themselves in relation to mathematics, the extent to which they develop commitment to mathematics, and the value they attribute to it. Similarly, mathematics identity has been linked to persistence, interest, and motivation in learning mathematics (Ruef, 2020). In this sense, the construct can be understood simultaneously as a set of psychological components (e.g., interest and competence beliefs) and as a sociocultural process shaped by recognition, participation, and classroom norms (Cobb et al., 2009; Cribbs et al., 2015).

Taken together, these definitions suggest that mathematics identity is a complex construct encompassing students' self-definitions as individuals who are interested in mathematics and value their mathematical achievement, their positioning and recognition within social contexts, and the ways these dimensions become visible through patterns of participation and performance in educational settings (Satmaz, 2023). Let us present all these definitions in Table 1.

Table 1. Operational definitions of Mathematics identity in the literature: A comparative summary

Source	Definition / Conceptualization	Theoretical lens / framework	Key emphases / components
Martin (2000)	Individuals' beliefs about their ability to perform in mathematical contexts, beliefs about the instrumental value of mathematics, motivations emerging from these beliefs, and strategies used for learning/doing mathematics.	Primarily individual/psychological (belief–motivation oriented).	Ability/performance beliefs; value/utility; motivation; strategies.
Bishop (2012)	A set of beliefs related to commitment to mathematics.	Psychological (belief/commitment oriented).	Commitment; beliefs.
Leatham & Hill (2010)	One's relationship with mathematics (broadly construed).	Broad/umbrella (relational framing).	Relationship with mathematics.
Cribbs et al. (2015)	How students see themselves in mathematics based on their perceptions and everyday experiences.	Self-perception with links to context/experience.	Self-view in mathematics; perceptions; everyday experiences.
Crossley et al. (2018)	The degree to which students identify with mathematics.	Identification/affiliation framing.	Identification strength; affiliation.
Gee (2000)	Identity as a belief about "what kind of person" one is.	General identity theory (self-understanding).	"Kind of person" belief; self-concept.
Holland & Lave (2001)	Identity as socially constructed and interactionally shaped; dynamic rather than fixed, continuously influenced by experience, learning, and participation in communities.	Sociocultural (social construction; participation).	Social construction; interaction; participation; dynamism.
Martin (2007)	Mathematics identity grounded in how individuals see themselves within mathematical culture, including both self-understandings and others' perceptions in mathematical contexts.	Sociocultural (culture, positioning/recognition).	Self-positioning; others' perceptions; mathematical culture.
Froschl & Sprung (2016)	Mathematics identity specified through constituent elements such as beliefs, attitudes, emotions, dispositions, and motivation to learn/use mathematics.	Component-based, largely affective/psychological.	Beliefs; attitudes; emotions; dispositions; motivation.
Cobb et al. (2009)	How students think about themselves in relation to mathematics, the extent of commitment they develop, and the value they attribute to mathematics; also shaped by recognition, participation, and classroom norms.	Bridging psychological and sociocultural.	Self-understanding; commitment; value; participation; classroom norms.

Ruef (2020)	Mathematics identity linked to persistence, interest, and motivation in learning mathematics.	Motivation/persistence oriented.	Persistence; interest; motivation.
Satmaz (2023)	A complex construct encompassing students' self-definitions as people interested in mathematics and valuing achievement, their positioning/recognition in social contexts, and how these become visible via patterns of participation and performance in educational settings.	Integrative (psychological + sociocultural synthesis).	Self-definition; value/achievement; recognition/positioning; participation; performance.

As Table 1 makes explicit, the literature converges on a shared core: mathematics identity concerns how learners define and position themselves in relation to mathematics through intertwined beliefs about competence/performance, the value and meaning attributed to mathematics, and sustained affective–motivational orientations (e.g., interest, commitment, persistence). At the same time, the definitions consistently signal that these dimensions do not operate in isolation; they are enacted and transformed in context through social interaction, recognition by others, and participation in mathematical practices. Thus, mathematics identity is best understood not as a stable individual trait but as a dynamic, multidimensional construct that integrates psychological components with sociocultural processes—providing a coherent basis for the syntheses and discussions that follow.

The Importance of Mathematics Identity

Mathematics identity is regarded as a critical variable in mathematics education because it makes visible students' self-perceptions and sense of belonging within the discipline (Darragh, 2016). Research consistently demonstrates significant associations between mathematics identity and students' academic achievement, classroom participation, and motivation to learn mathematics (Cribbs et al., 2015; Cobb et al., 2009). As such, mathematics identity provides a conceptual lens that goes beyond what students know to explain how they relate to mathematics and engage in mathematical activity (Cobb et al., 2009; Darragh, 2016).

The importance of mathematics identity is also evident in students' advanced course choices and longer-term engagement with mathematics. The literature indicates that identifying with mathematics and seeing oneself as a "math person" supports persistence, sustained engagement with challenging tasks, and intentions to continue in mathematics-related domains at later stages of education (Cass et al., 2011; Cribbs et al., 2015). In this respect, mathematics identity is instrumental not only for understanding students' current performance but also for explaining their long-term educational trajectories and persistence in mathematics-related fields (Cribbs et al., 2015; Darragh, 2016).

From an instructional perspective, mathematics identity is closely tied to classroom norms, teacher feedback, and the recognition of students' mathematical contributions (Cobb et al., 2009; Cribbs et al., 2015). Studies have shown that positioning certain groups of students as "good at mathematics" and relying on narrow definitions of success can lead others to disengage from mathematics and experience a diminished sense of belonging (Boaler, 2002; Grootenboer & Jorgensen, 2009). Moreover,

teacher expectations and societal stereotypes, such as gender-based beliefs, may negatively influence students' identification with mathematics and their identity development (Gunderson et al., 2012). These findings highlight the potential of inclusive classroom climates and identity-supportive teaching practices as powerful levers for enhancing mathematics learning (Cobb et al., 2009; Cribbs et al., 2015).

Components of Mathematics Identity

Mathematics identity consists of multiple interrelated dimensions that shape students' self-perceptions in relation to mathematics. One widely used explanatory framework conceptualizes mathematics identity through three components: interest, competence/performance beliefs, and recognition (Cribbs et al., 2015; Hazari et al., 2010). Within this framework, interest refers to students' inclination toward mathematical activities; competence/performance beliefs capture their self-evaluations of their ability to do mathematics; and recognition reflects their perceptions of being seen as mathematically competent by significant others such as teachers and peers (Cribbs et al., 2015).

From a psychological (individual-level) perspective, the components of mathematics identity are primarily conceptualized as internal and self-referential constructs, such as students' competence beliefs, affective orientations (e.g., interest), and perceived value of mathematics. These components capture how learners interpret their own experiences in mathematics and how they evaluate themselves as potential "math persons." In contrast, from a sociocultural perspective, mathematics identity is not treated merely as an internal attribute but as something co-constructed through classroom interactions and normative expectations. Identity, in this view, is shaped by how students participate in mathematical practices, the roles they take up within classroom communities, and how they are positioned and recognized as "doers of mathematics" (Cobb et al., 2009). Narrative approaches similarly frame identity as being constituted through mathematics-related stories told by individuals and others, allowing analytic distinctions between "actual" narratives about oneself and "designated" (future-oriented) narratives that express aspirations and idealized identities (Sfard & Prusak, 2005).

These components are observable in instructional contexts. Students' interest in mathematics and their perceptions of competence support participation and persistence, while recognition—such as having one's mathematical thinking valued and made visible—functions as a critical mechanism for strengthening identification with mathematics (Cribbs et al., 2015; Cobb et al., 2009). Considering these components together allows for a more holistic understanding of students' relationships with mathematics, extending beyond achievement to include interest, recognition, and classroom positioning (Darragh, 2016).

Taken together, the literature suggests that the components of mathematics identity are best understood as mutually constitutive rather than as separate factors. Interest and competence/performance beliefs capture students' subjective meanings and self-evaluations, yet these

meanings are continually negotiated in social interaction through recognition, positioning, and participation in classroom practices. From this integrative view, recognition operates as a key link between individual and sociocultural accounts: being acknowledged as competent can reinforce interest and competence beliefs, while lack of recognition may undermine them despite prior achievement. Narrative approaches further illuminate how these experiences are organized into "actual" and "designated" stories that sustain or constrain students' future-oriented engagement with mathematics. Therefore, a comprehensive account of mathematics identity requires attending simultaneously to internal interpretations, interactional processes, and the evolving narratives through which students come to see themselves—and are seen by others—as "doers of mathematics." dimension adopted a case study design.

Theoretical Approaches to Explain Mathematics Identity

From a sociocultural perspective, mathematics identity is conceptualized as a relational construct that emerges through individuals' participation in mathematical practices and communities. In this view, identity is built through processes of belonging and participation: individuals are positioned within the norms and activities of mathematical communities, and these positions gradually become integral to their identities (Lave & Wenger, 1991; Wenger, 1998). Accordingly, the roles students assume in classrooms, the types of mathematical activities they can access, and the ways they are recognized within these activities are considered central dynamics shaping identity formation (Boaler & Greeno, 2000).

Psychological or subjective approaches, by contrast, explain mathematics identity primarily through individuals' internal beliefs and evaluations. From this perspective, self-efficacy beliefs about succeeding in mathematics, perceptions of interest and value, and expectations for success are treated as key components of identity (Bandura, 1997; Wigfield & Eccles, 2000). Students' beliefs that they are capable of doing mathematics and that mathematics is valuable have been shown to support stronger identification with mathematics and more persistent engagement in learning processes (Pajares & Miller, 1994).

Discourse and narrative approaches conceptualize identity as a phenomenon constructed through language and storytelling. In this view, the narratives individuals construct about themselves (e.g., "I am good at mathematics" or "I am bad at mathematics") and the narratives circulated by others about them form the foundation of mathematics identity (Gee, 2000). Sfard and Prusak (2005) further conceptualize identity as a set of stories told about a person that can transform over time, emphasizing the constitutive role of narratives in identity formation. This approach highlights that identity is continuously reproduced both socially, through others' narratives, and individually, through self-narratives.

Taken together, these approaches suggest that mathematics identity is most productively understood as a multi-layered construct in which individual meanings and social processes are inseparable. Psychological accounts clarify the internal resources that support identification with mathematics—such as self-efficacy, task value, and expectations for success—yet these beliefs are developed and sustained within sociocultural contexts where participation, access to meaningful activity, and recognition shape what it is possible to become. Discourse and narrative perspectives bridge these levels by showing how experiences of participation and recognition are translated into enduring stories about who one is (and can be) in mathematics, thereby stabilizing or transforming identity over time. From this integrative standpoint, mathematics identity emerges through a continuous interplay among internal evaluations, interactional positioning within communities, and the narratives through which these experiences are interpreted and communicated.

Development of Mathematics Identity

The development of mathematics identity is understood not as a stable attribute but as a dynamic process shaped by experiences over time. Identity research explains this process through the continual reorganization of students' self-narratives about mathematics in response to new experiences, conceptualizing identity as a "bundle of stories" (Sfard & Prusak, 2005). Reviews of the mathematics identity literature similarly emphasize that, despite differences across theoretical traditions, there is broad agreement that identity is context-sensitive and changeable (Darragh, 2016).

This developmental process is closely tied to students' participation in mathematical practices and their positioning as "mathematics learners" within classrooms. Students are understood to develop not only mathematical concepts and skills but also a learner identity that encompasses how they see themselves and how they are seen by others within mathematical communities (Anderson, 2007). From this perspective, identity development becomes visible through dimensions such as engagement in classroom interactions, the ability to imagine oneself as a person who does mathematics, and alignment with classroom norms and practices (Anderson, 2007).

Factors that may accelerate or hinder the development of mathematics identity include teacher–student interactions, experiences of recognition, and family-related messages. Models of mathematics identity highlight that components such as recognition, interest, and competence/performance beliefs operate together, with recognition by teachers and peers as mathematically capable individuals playing a particularly critical role in identity development (Cribbs et al., 2015). Research focusing on educators emphasizes that teachers' classroom practices are decisive in shaping mathematics identity (Barba, 2022). Studies also indicate that identity development begins early and unfolds through socio-educational interactions with teachers and peers, positioning early childhood settings as fertile contexts for identity work (Hachey, 2021). Within the family context, parental mathematics anxiety has been

shown to relate to children's mathematics achievement and anxiety, particularly in situations where parents frequently assist with mathematics homework (Maloney et al., 2015).

Processes of Mathematics Identity Formation

An individual's mathematics identity is shaped mostly by prior mathematical experiences and the narratives constructed based on those experiences. Patterns of success and failure in mathematics may, over time, foster self-narratives such as "I am good at mathematics" or "mathematics is not for me." From a narrative perspective, such stories constitute the core material of identity (Sfard & Prusak, 2005). In this sense, mathematics identity is not merely a reflection of performance but a construct that explains how students see themselves in mathematical contexts and how these self-perceptions are continually reproduced through experience (Cribbs et al., 2015).

Beyond individual experiences, classroom interactions and the ways teachers position students play a decisive role in mathematics identity formation. From a sociocultural standpoint, identity is closely linked to classroom norms and to answers to the implicit question of "who is recognized as a doer of mathematics," as well as to whether students' mathematical contributions are made visible (Cobb et al., 2009). Teacher feedback, expectations, and support can either strengthen or weaken students' experiences of recognition as mathematically competent individuals (Gee, 2000). Consequently, identity formation is shaped not only by students' internal perceptions but also by the social feedback and positioning practices produced within instructional contexts (Cobb et al., 2009).

Finally, mathematics identity formation unfolds over time through interactions with peers and the broader cultural and social context. Peers' acceptance or exclusion of a student as mathematically competent can influence perceptions of belonging and competence, while family expectations and societal stereotypes related to mathematics may shape students' identification with the subject (Martin, 2007). Identity is therefore not a fixed trait but a dynamic structure that is continually reconstructed through participation in different communities, new experiences, and evolving interactions (Holland & Lave, 2001).

CONCLUSION

This review demonstrates that mathematics identity provides a powerful conceptual framework for understanding processes of mathematics learning and teaching. Mathematics identity is a multidimensional construct encompassing students' self-perceptions related to mathematics, their interest in and valuing of mathematics, their beliefs about mathematical competence, and their experiences of being recognized as "doers of mathematics" within classroom settings. As such, identity helps explain not only students' current achievement but also their participation, persistence, relationships with mathematics, and long-term orientations toward the subject. As discussed throughout

this review, mathematics identity emerges and develops through the interaction of individual factors (beliefs, emotions, motivation) and social factors (recognition, positioning, classroom norms, and cultural expectations).

From an instructional perspective, supporting mathematics identity should not be viewed as an additional or peripheral goal but as a core issue of instructional design that directly shapes the quality of learning. Identity-supportive classrooms create learning ecologies that make students' mathematical ideas visible, distribute participation equitably, frame error as part of learning, and recognize students not solely through right or wrong answers but through their ways of thinking. In this context, teachers' feedback practices, task design (e.g., openness, multiple solution paths, meaningful contexts), classroom discourse, and assessment approaches function as key levers shaping how students perceive their place in mathematics. Accordingly, teacher education and curriculum development efforts should explicitly target pedagogical principles that support identity, including recognition practices, belonging-oriented classroom climates, and structured participation.

From a research perspective, studies on mathematics identity face a dual need: first, conceptual clarity and theoretical coherence, including explicit articulation of which components of identity are foregrounded and within which theoretical framework; and second, methodological diversity capable of capturing processes and development, such as longitudinal designs, mixed methods, classroom discourse and interaction analyses, and intervention studies. Research that examines how mathematics identity changes during critical educational transitions (e.g., from primary to secondary school) is particularly valuable for understanding the conditions under which teacher practices strengthen identity. Ultimately, an identity-centered approach invites us to rethink mathematics teaching not merely as the transmission of content but as a sustainable process of constructing students' relationships with mathematics.

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İ.S.: Conceptualization, literature review, drafting the manuscript (original draft), writing and revision. R.Y.K.: Supervision, critical review, editing, final approval of the manuscript.

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As this manuscript is a literature review, ethics committee approval was not required because it does not involve human/animal participants or personal data. The study was prepared in accordance with research and publication ethics; all sources were properly cited, and copyright regulations were observed.

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