Journal of Women and Minorities in Science and Engineering 0(0):0–0 (2021)

SCIENCE IDENTITY AND HISPANIC STUDENTS IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM)

Sharon Schembri[1,*] & Joanne Rampersad-Ammons[2]

[1]*Professor and Cal Turner Endowed Chair, Department of Business Administration, Fisk University, Nashville, Tennessee, USA 37208*

[2]*Professor, Chemistry and School of Earth, Environmental and Marine Sciences, University of Texas Rio Grande Valley, Edinburg, Texas 78539*

*Address all correspondence to: Sharon Schembri, Department of Business Administration, Fisk University, Nashville, TN; Tel.: +(615) 329-8681, E-mail: sschembri@fisk.edu

Our research investigates science identity in the context of Hispanic science, technology, engineering, and mathematics (STEM) students and addresses the question of how they construct meaning of their science identities. Our qualitative research design uses group interviews to arrive at a symbolic description of current self, combined with a narrative collage method to arrive at a performative definition of the future self. Results from a large sample of 75 participants support the theory of science identity with evidence of participants viewing their future self as a research scientist or an altruistic scientist. Extending the theory of science identity, the findings also show evidence of a non-scientist trajectory and a non-relational dimension. The non-scientist trajectory is a future self-conception that excludes science or scientific practice. The non-relational dimension is an absence of humans, where people are simply missing from the future self-conception. Our work contributes to science identity theory by showcasing the experiential meaning of identity for Hispanic STEM students. Our research design also provides a stepwise approach to identifying the meaning of science identity for students. Practical implications also include tailoring professional development programs to encourage and facilitate recognition for Hispanic STEM students. More specifically, the practical implications of this work include developing elements of Hispanic science identity, such as self-recognition and recognition by others, as well as the humanistic dimension. Recommended strategies are bringing STEM professionals into the classroom as well as allowing STEM students to experience professional settings.

KEY WORDS: *Hispanic, STEM, science identity, undergraduate students, future self, recognition, narrative, collage, professional, humanistic*

1. INTRODUCTION

Culturally, being a scientist is highly gendered and racialized (Carlone et al., 2015; Wong, 2015). The deep-seated gender/race beliefs and barriers in science, technology, engineering, and mathematics (STEM) have manifested a white, male hegemonic context (Carlone et al., 2014, 2015; Ong et al., 2011; Wong, 2015). Those without such embodied traits may struggle to identify with the scientific profession (Archer et al., 2015; Carlone, 2003; Johnson et al., 2011). Consequently, the status quo is reproduced (Carlone and Johnson, 2007) within a matrix of oppression (Johnson et al., 2011), complicating and problematizing the development of a science identity (Carlone and Johnson, 2007; Malone and Barabino, 2009).

Our research focuses on the question of how Hispanic STEM students construct meaning of their science identities. Science identity (or what nascent scientists believe they can achieve) is central to science success (Brickhouse et al., 2000; Drew, 2015; Kozoll and Osborne, 2004) and is especially important for underrepresented minority students in STEM fields (Koyama, 2007; Malone and Barabino, 2009; Miller-Cotto and Byrnes, 2016; Syed, 2010; Syed et al., 2011). Determination to succeed and intention to persist are fragile and often critically tested when examples of success in their sphere of influence are lacking. Consequently, there is a call to better facilitate underrepresented minority student success and persistence in STEM (Ceglie, 2011; Chang et al., 2014; Estrada et al., 2016; Graham et al., 2013; Merolla and Serpe, 2013; Simon et al., 2017).

Identity trajectories shift, reshape, and transform continuously through participation (Bricker and Bell, 2014; Jackson and Seiler, 2013; Johnson et al., 2011). This dynamic process creates a pattern of identity (Holland et al., 2001; Wenger, 1999) that enables persistence, or perhaps, works against persistence (Jackson and Seiler, 2013). Students construct identity through action. This is a dynamic and participatory process. In this way, identity is performative, and practicing science impacts what science means (Rahm and Moore, 2016; Tan et al., 2012). Accordingly, identity is negotiated through participation, and science identity relates to what students consider as *"who they think they are"* (Brickhouse et al., 2000, p. 443).

2. THEORETICAL FRAMEWORK

Seeking to capture such complexities for successful STEM women, Carlone and Johnson (2007) focus on women of color and report three interrelated dimensions of science identity: competence, performance, and recognition. Across these three dimensions, Carlone and Johnson (2007) present evidence to identify three science identity trajectories as the research scientist, the altruistic scientist, and the disrupted scientist. These dimensions and trajectories are illustrated in Fig. 1.

A strong science identity is demonstrated by someone who has competent scientific knowledge, is motivated to understand the work scientifically, has the skills to perform scientific practices, and recognizes themselves as a *"science person,"* as do others (Carlone and Johnson 2007, p. 1190; Lu, 2015, p.743). More specifically, those holding a research scientist identity think and act like a scientist, are passionate about science, recognize themselves as being scientific, and others do too (Rodriguez et al.,

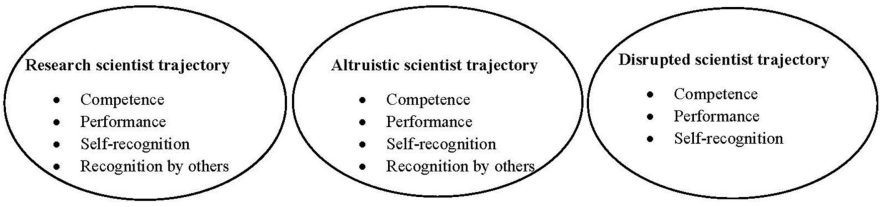

FIG. 1: Science identity trajectories and dimensions

2017), whereas those holding an altruistic scientist identity regard themselves as a vehicle for altruism, creating innovative meanings of science (Carlone and Johnson, 2007). In contrast to both the research scientist and the altruistic scientist trajectories, the disrupted scientist identity seeks, but does not necessarily receive, recognition from meaningful scientific others, such as peers, faculty, and professionals (Carlone and Johnson, 2007). For a disrupted scientist identity, self-recognition is a work in progress, where the fragility and fear of an unknown outcome highlights vulnerability (Rodriguez et al., 2017). Beyond self-recognition, peers, faculty, and family generate outside recognition (Rodriguez et al., 2017). Peer recognition enables intellectual acceptance (Bukoski and Hatch, 2016), and being part of an elite scientific community reinforces, for example, the *machismo* culture of Latino masculinity (Lu, 2015); yet, while the family is highly respected in the Latinx culture, the family are not considered *"meaningful others"* in the science and STEM context (Rodriguez et al., 2017, p. 14).

3. METHODS

This study evolved from an interdisciplinary discussion between a physical scientist and a social scientist about how to best serve Hispanic students in their STEM endeavors. The specific research question is, *"How do Hispanic STEM students make meaning of their science identities?"* To address this question, we began with a group discussion to identify current self-conceptions, followed by a narrative collage approach to illustrate future self-conceptions.

3.1 Authors' Positionalities

Both authors are female scientists, with just one being a woman of color and neither being Hispanic, but both working at a Hispanic Serving Institution. Stemming from the basic concern of student success, the authors engaged in a genuine dialogue about the different perspectives of physical science and social science. Over time, this interdisciplinary dialogue brought to light the challenge of understanding Hispanic students' needs and specifically, science identity. As researchers, and scientists, we too have had to navigate career pathways, and so the question of science identity is highly relatable. Given this personal experience of developing a scientific career, we deliberately addressed potential biases while collecting and analyzing evidence. We took time to self-check and to check in with the other as a strategy used in this regard. Interactive dialogue was key to achieving this level of awareness. Effectively, we built reflexivity into the research process.

3.2 Participant Details

We conducted our research within a large, regional, Hispanic Serving Institution that hosted a STEM enrichment program funded by the Howard Hughes Medical Institute.

The entire program comprised 123 undergraduate students from across various STEM disciplines, including science, mathematics, engineering, computer science, and psychology: 73 males and 50 females, with 86% identifying as Hispanic. From that sampling frame, the study sample included 82 participants, 40 male and 42 female students, 87% Hispanic, with 85% science majors and 15% engineering and computer science majors.

In focusing on Hispanic students, we consciously strived to be culturally sensitive and incorporated deliberate efforts to ensure that we treated the study participants in a fair, equitable, and transparent manner. With an emphasis on voluntary participation, the informed consent process required a signature from each potential participant. We provided assurances of confidentiality, and reported findings in a de-identified manner with the use of pseudonyms. Moreover, throughout the research process, we reminded participants that if they were not comfortable about answering a question, they were welcome to either decline or terminate their participation or both. An example of how this consideration played out occurred when one participant shared that the inspiration for her career was a good friend who had died. In telling this story during a group discussion, the participant became upset. In response to this participant's emotional reaction, we invited her to withdraw, but she decided to continue. Her choice to share openly and then continue in the project indicates the level of safety and comfort that we had been able to establish within the space. In other words, the participant felt safe enough to retell the story and comfortable enough to continue, despite becoming emotional. Considering procedural ethics in this type of research is essential not only for regulation purposes, but also for the protection of vulnerable populations and reasons of research quality (Tracy, 2010, 2019).

Another important consideration is the appropriateness of describing our research participants as Hispanics. Terms referencing ethnicity, such as Hispanic, are sometimes used interchangeably with other terms, such as Latino/a or Latinx (Martínez and Gonzelez, 2020). Recognizing the heterogeneity among those originating from Latin America, Hayes-Bautista and Chapa (1987) argue for the use of Latino, rather than Hispanic. In contrast, given the Federal population classification system and the need for researchers to be consistent with that Federal designation, Treviño (1987) argues for the use of Hispanic rather than Latino. While the debate regarding the use of such terms has shifted over time and will continue to be revisited going forward, the term Hispanic is used throughout this paper because this research was conducted at a Hispanic Serving Institution, and 87% of the study participants consciously self-identified as Hispanic.

3.3 Research Design

In seeking to operationalize the question of how Hispanic STEM students make meaning of their science identities, our research goal was to identify and describe what and how Hispanic students consider their current and future self in the context of STEM. With that goal in mind, we implemented a qualitative, open-ended, and

unstructured approach to investigate and document Hispanic STEM students' science identities. Notably, context dependency is an underlying assumption of this approach and the following discussion details the importance and relevance of this aspect of the research.

Direct questioning by way of interviewing, for example, enables open-ended questioning about how experience is created and given meaning, but one-on-one interviewing negates the social context (Silverman, 2005). An alternative to direct questioning and individual interviewing is to access stories or narratives through which people describe their world (Holstein and Gubrium, 2004). Given that social processes shape the meaning of experience (Berger and Luckmann, 1966), good and valid research investigating the experiential meaning of identity needs to be situated in the given social context. However, while a focus group offers a group (social) context, a standard focus group follows a structured protocol to explore a topic (Krueger, 2014). In contrast, assuming context dependency and assuming the world is not distinct but rather an experienced world where individuals actively make sense of the world(s) they experience, the students' experience of science that informs their worldview perspective is an appropriate research focus (Kozoll and Osborne, 2004). In this way, we were able to document identity through the eyes of Hispanic STEM students.

To achieve this intention, the physical scientist author of this paper hosted and invited potential participants to a career development workshop which the social scientist author of this paper facilitated. We introduced the workshops as a creative exercise designed to help students with career goals as well as to help identify what Hispanic STEM students require to achieve their career goals. The workshop facilitator spent some time explaining her background and how she had come to be involved with doing this type of research, given that she was previously unknown to the participants. This deliberate disclosure enabled a degree of trust, rapport, and credibility to be developed, which demonstrated honesty, vulnerability, and transparency, adding to research rigor (Tracy, 2010, 2019).

The facilitator supported the comments of each participant joining in on the conversation by first validating their thinking and then gently probing by asking for an example or more specific details of their comments. Establishing trust, rapport, and credibility between researcher and participants in this immersive way, demonstrates the researcher as a reliable research instrument and further adds to research rigor (Tracy, 2010, 2019).

Once participants had shown a willingness to contribute and converse, the facilitator asked them to consider the personal items they had brought with them to the workshop. From these personal items, we asked participants to identify and describe an object they considered symbolically reflective of their current self. One by one, participants told the story of how their chosen object was symbolic of their current self. Discussion about and around symbolic objects and the comments that followed allowed free-flowing expression of the self, with minimal social risk. Importantly, we posed questions as *"what"* and *"how"* rather than *"why"* to facilitate granular reflective rather than simple explanatory

responses. This indirect and reflective technique enabled participants to detail aspects of themselves that may have otherwise stayed hidden. We encouraged further dialogue by asking for either specific examples or more details on points and issues raised or both. Gradually, each participant contributed to the conversation, some more confidently than others; however, all contributed somewhat, nonetheless. This initial process took up the first hour of the workshop. In the second hour of each workshop, we asked participants to illustrate their future self creatively with a collage.

In this second stage of the workshop, the facilitator introduced participants to the craft materials made available to them at each of the multiple tables. Craft materials included dated scientific trade periodicals, nature magazines, lifestyle magazines, and other full-color glossy publications, as well as scissors, glue, tape, glitter, colorful piping, foam pieces, pens, pencils, crayons, markers, and plain/colored cardboard. We invited participants to use these materials creatively to construct a collage that illustrated them in their future scientific career. We asked participants to think about what this future self might be doing in their career and what a typical day might be for this future self.

Inviting participants to be actively involved in this creative process saw some initial hesitation and resistance but with a little encouragement, they were soon observed to be happily collaborating, moving freely about the room, and readily discussing what images they were finding, or not. Construction of the collages became a group effort where participants were individually creating collages but also actively collaborating to find specific imagery. The narrative collage method is particularly suited to investigations where imagination plays a role in contexts related to the domain of the imagined (Kostera, 2006). This creative approach enabled participants to illustrate what/how they considered constitutive of their future self, with minimal personal risk. As an experiential method, the narrative collage method provides a performative definition and enables a depth of insight into the social phenomena under investigation (Kostera, 2006).

Upon completion of the collage, we invited participants to tell the story of their future self, as illustrated in the collage. Listening to each collage description, the facilitator sought to probe on certain points for either clarification or expansion or both. Again, we posed probing questions as *"what"* and *"how"* rather than *"why"* questions to encourage reflection rather than explanation. Probing and clarification of the intended meaning of each collage and the elements within ensured the research team had captured an accurate depiction of the experiential meaning of the future self. This step also enabled a credibility check to ensure that the interpretation of the meaning of the collages was from the participant's perspective, rather than the researchers' perspective.

3.4 Analytical Approach

In keeping with the non-linear research process of qualitative research, the analysis began concurrently with conducting the group discussion workshops. During the workshops, we consciously considered participant dialogue in the context of the original

premise of supporting Hispanic students in their STEM endeavors. This effort to self-check within the analytical process is a form of reflexivity that adds to the research rigor by way of adding a depth of sincerity (Tracy, 2010, 2019).

Analysis of the verbal and illustrative narratives offered by participants was achieved by applying the theoretical structure presented by Carlone and Johnson's (2007) science identity framework. To begin this analytical process, we considered each collage in terms of evidence for each of Carlone and Johnson's (2007) science identify dimensions of competence, performance, and recognition. For example, engaging with scientific knowledge in the field or the laboratory is considered evidence of competence; use of scientific tools such as test tubes, microscopes, and other measuring tools is considered evidence of performance; describing oneself in a scientific role and/or interacting with others in scientific roles is considered evidence of recognition. During this process, the analytical emphasis was on considering parts of the verbal explanations and elements of the visual imagery relative to the whole of the evidence, including theory. This process involved switching back and forth between the parts and the whole and back to the parts again. In this way, small details, as well as broader horizons, could be recognized. Effectively, the experiential meaning expressed by the participants was revealed, while simultaneously reflecting on and integrating theoretical knowledge. Reflexivity was further built into the analytical process with the research team re-reading the verbatim workshop transcripts, repeatedly reviewing the collages, revisiting the emergent themes, and reorganizing iteratively until we achieved stability. Such evidence of reflexivity adds to the rigor of research (Alvesson and Sköldberg, 2017).

We considered parts of the verbal explanations and visual evidence in the context of the evidence as a whole. By swinging back and forth between these perspectives, we sought to identify *what* participants considered constitutive of their current self and *how* participants considered that current self. In turn, we sought to identify *what* participants saw as their future self and similarly *how* participants considered what was constitutive of their future self. From there, analysis shifted to consider possible meanings and varying frames of reference, including divergent evidence and theories. This process of synthesis and verification sought to identify commonalities across what participants experience as science identity and how. The outcome of this *what* and *how* analytical process enabled identification of the essence of each participant's science identity. This analytical process of synthesizing meanings and essences is a representation of the phenomenon at a particular time and space following an imaginative and reflective study of the phenomenon (Silverman, 2005).

4. RESULTS

We begin to present results by reporting the symbolic expressions of the current self and continue with narrative collages of the future self. Applying Carlone and Johnson's (2007) science identity framework as illustrated in Fig. 1, research scientist and altruistic scientist trajectories are confirmed along with competence, performance, and rec-

ognition dimensions therein. Extending Carlone and Johnson's (2007) science identity framework, we report a non-scientific trajectory as well as a non-relational dimension.

4.1 Results: Symbolic Expressions of Current Self

Participants identified an object that they considered to be symbolic of their current self and described this symbolic reflection. Table 1 provides a summary of the selected objects presented along with a summary of the symbolic descriptions.

As Table 1 shows, some participants suggested their electronic calendar and planner to be symbolic of their organizational skills. Other participants presented unique objects, offering distinct meanings. Miguel, for example, produced a pen and very proudly explained the hi-tech engineering contained in the pen, which was not conspicuous at first glance. He described this pen in intricate detail and he went on to express how this *"highly tactical"* pen made him feel *"safer."* For Miguel, this piece of technology, which looked like an everyday pen, was his weapon in the STEM world. In other words, Miguel felt as if he needed to know that he had a hidden potential to use as needed.

Similarly, Louise wore an analog watch to demonstrate authority, and Elisa carried her violin pin on her backpack as a reminder of her interest, ability, and passion for art and music. Although these objects quite subtly display an expressed meaning that may only be known to the individual, they are indeed meaningful to the participants that

TABLE 1: Select tabular summary of symbolic objects

Participant pseudonym	Object: what	Symbolic meaning (as expressed by participant): How
Miguel	Fountain pen	Hi-tech, tactical pen that makes him feel safer
Louise	Analog watch	Being responsible and demonstrating authority
David	Premedical student organization t-shirt that reads, "Medicine: to cure sometimes, to comfort always"	Community service orientation and altruistic motivation
Elisa	Violin pin	Double major in engineering and music
Sally	Fortune cookie insert that reads, "New financial resources will soon become available"	This fortune message was received just prior to sitting pre-SAT exams to get scholarship awards; received highest grade in school district
Jonas	Large set of keys	Keys to the building where he works as a janitor, where he and his family go to church; described as keys to his life
Andy	Fold-up bike	Reflects on diverse background and ability to adapt

carry them as a standard daily practice. For analytical purposes, and as shown in Table 1, the objects themselves were considered *"what"* participants considered as their current self, with their expressed meaning considered *"how"* participants considered their current self. We take the same approach in analyzing collages on the future self.

4.2 Results: Narrative Collages of Future Self

As with the analysis of objects symbolizing the current self, analysis of each collage revealed what and how participants considered their future self. Table 2 presents an example of how we analyzed this visual text. As Table 2 shows, the visual elements of Delia's collage considered *what* she sees as her future self, while the meaning she expressed in these elements considered *how* she sees these attributes of her future self. The prominent imagery in this collage relates to family, fun, and fitness but the image of the biology textbook relates to science and scientific knowledge.

The selective analytical extract presented in Table 2 shows to which identity dimension the evidence is attributed: competence, performance, or recognition. We consider Delia's textbook display of biological knowledge, evidence of competence extant in her future self. Similarly, we consider Max's depiction of an American medical training center, evidence of competence. As a tool of the scientific trade, Javier chose to include someone wearing a lightly stained lab coat. Javier described this lab coat as hiding many invisible stains that he will proudly wear in his future career. This performance aspect of Javier's future-self parallels Guadalupe's inclusion of a clinical science lab and microscope. Evidence of self-recognition is illustrated with Leila's collage that depicts

TABLE 2: Example of what and how hispanic STEM participants consider their future self

Participant pseudonym and collage	What	How
Delia's collage 	*Divertida* headline	*Divertida* means "fun" in Spanish
	Brides and bridal wars	the wedding scene is competitive
	Text words "Dare" and "Lead"	She has career and leadership aspirations
	Heart: Purple chenille piping	She wants love in her life above and beyond her career
	Pink and blue baby booties	she wants two children: boy and girl
	Well-dressed woman	Stylish and successful woman
	Female torso, weightlifting	Strength and fitness
	Anatomy and physiology of the human body	Biological, scientific knowledge

multiple elements related to women's health. In telling her story, Leila revealed that surgery as a teen resulted in lifelong negative consequences, and she sees her life mission as making a difference in women's reproductive health. Extending this analytical process across the collages of future self, Table 3 presents an iteration of the overall visual text analysis and application of Carlone and Johnson's (2007) science identity trajectories.

The overall findings, as summarized in Table 4, show 41 of the total 75 collages depicting a research scientist identity. Of the 41 collages depicting a research scientist trajectory, 16 visual elements indicate some form of scientific competence, 57 elements show evidence of performance, 25 elements show evidence of self-recognition, and 6 elements show evidence of recognition by others. Additionally, 7 of the 41 research scientist collages do not comprise any human aspect identifying an additional, previously unreported, non-relational dimension. The absence of humans in the collage signified this non-relational dimension.

Of the 21 collages depicting an altruistic scientific trajectory, 7 visual elements show evidence of scientific competence, 34 elements show scientific performance, 19 elements show self-recognition, and 7 elements show recognition by others. Two altruistic collages do not include any form of human element, reinforcing the identification of a non-relational dimension.

TABLE 3: Example of what and how hispanic STEM students consider their future self

Identity dimension	Participant pseudonym	What	How
Competence	Delia	Open textbook: Anatomy and physiology of the human body	Biological, scientific knowledge
	Max	Book by J. D. Salinger, *The Catcher in the Rye*; Medical Training Center; Mexican landscape	Wants to go to attend an American medical training center but wants a medical degree from Mexico so he can practice in Mexico, the USA, and the Caribbean
Performance	Javier	Lab coat (lightly stained)	Proud of (in)visible stains; Nobody sees all the work behind the scenes
	Guadalupe	Clinical lab science; microscope	Running tests in a laboratory as the backbone of the hospital
Self-recognition	Leila	Text that reads, *"Childbirth isn't so easy for everyone"*; text that reads, *"the doctor will see you now"*	Empathetic toward women's emotional and physical health; Working in the local community; enabling healthcare access

TABLE 4: Summary of visual analysis from collages

Science identity trajectories	Number of trajectories
Research scientist trajectory	41
Altruistic scientist trajectory	21
Disrupted scientist trajectory	0
Non-scientist trajectory	13
Total	75

While we did not identify disrupted scientist trajectories in this study, we report an important finding that 13 collages (17% of the sample) show a non-scientist future self. Also, within the identified non-scientist trajectories, 2 of the 13 collages do not comprise any human element, showing further evidence of a non-relational dimension.

As summarized in Table 4, the findings confirm Carlone and Johnson's (2007) research scientist and altruistic scientist trajectories and extend their science identity framework, with an identified non-scientist trajectory and an additional non-relational dimension. Figure 2 illustrates this theoretical contribution, and the following discussion details these trajectories and dimensions therein.

4.2.1 Research Scientist Trajectory

Those participants holding a research scientist identity have a genuine curiosity and passion for science and recognize themselves as scientific, as do others (Rodriguez et al., 2017). The collage completed by José and shown in Fig. 3 is exemplar of a research scientist identity trajectory. José is focused on mosquito-borne viruses, and he sees his future self as someone who can impact the world in this scientific domain. This collage shows multiple aspects of scientific knowledge, scientific tools, and scientific actors. José's collage shows people actively working in the field or the laboratory, taking measurements, collecting data, and recording observations. Other actors are also shown, possibly in the role of a colleague, patient, study participant, or community member. Insects and other creatures are also featured prominently. The collage in Fig. 3, there-

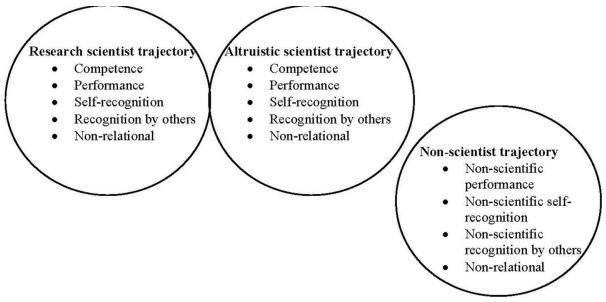

FIG. 2: Extended science identity framework: Hispanic science identity trajectories

FIG. 3: A research scientist trajectory

fore, provides evidence of competence, performance, and self-recognition, as well as recognition by others. We considered it to exemplify a research scientist trajectory. The following discussion details this dimensional composition.

4.2.1.1 Research Scientist Trajectory: Competence Dimension

We considered evidence of competence to include any scientific knowledge, knowledge work, or use of intellect (Carlone and Johnson, 2007). As shown in José's collage (Fig. 3), his future self is actively engaged as a research scientist, in the field as well as the laboratory, and he is not working alone. Scientific researchers in the field are shown to be working individually as well as collaborating with others, recording scientific data in an open field on a grassy plain, collecting earth samples from a rocky hollow, climbing through mossy treetops, and using a stethoscope to check respiratory issues in a patient in a rural setting. The orange plastic bag of blood hanging from a bulldog clip with a mass of mosquitoes feeding off the blood is a characteristic of studying mosquito-borne viruses, such as Zika. Given the negative impact of insect- and mosquito-borne viruses

in developing countries, scientists working in this area can make a significant contribution. As expressed by José, he intends to put his scientific mind to work and contribute to this area of research. Illustrating his imagined future self and demonstrating the competence dimension, José foresees his scientific intellect as useful in this research context.

4.2.1.2 Research Scientist Trajectory: Performance Dimension

According to Carlone and Johnson (2007), performance is more visible than competence with the use of scientific language and tools as examples of the performance of scientific practice (Carlone and Johnson, 2007). Evidence of performance also includes the performance of a scientifically related task. For example, Isabel illustrates her future self as a scientist working with various chemicals and graduated cylinders in a laboratory setting. She foresees herself traveling to talk about her research. She also recognizes her future self as being someone successful who collaborates with other scientists. Isabel's collage also shows evidence of work/life balance with an explicit statement related to having a social life, dancing, being married, having a ranch, and doing her nails. Ultimately, Isabel sees her future self as being active in scientific and research areas, but balanced, well-groomed, and successful. Isabel describes her collage in the following quote:

> *I have the girl dancing [because] I want to have somewhat of a social life. And then, the airplane, because I want to be able to travel and talk about my research. I want to actually do some bench work in the lab and have collaborations with people ... and I hope I can still have time to do my nails haha! And then the boots, I would like to own a little ranch and hopefully, be married by then. And that girl in pink, that's me. She looks pretty successful. Those are my goals.*

As well as her collage, this comment from Isabel reinforces the identification of her science identity as a research scientist trajectory that evidences performance.

4.2.1.3 Research Scientist Trajectory: Recognition Dimension

The above description from Isabel of her collage highlights recognition of her future self as someone successful and established in a scientific career. This future self is also described and illustrated as collaborating with other scientists, which is indicative of recognition by scientific peers. According to Carlone and Johnson (2007, p. 1991), the recognition dimension is about recognizing oneself but also being recognized by others as a *"science person."*

Just as Isabel recognizes her future self as someone who is engaged with fellow scientists, Guadalupe recognizes herself as one of the scientific lab workers who are the *"backbone of the hospital."* As well as acknowledging self-recognition, Guadalupe associates herself with a collection of scientists who work in a clinical lab, running tests.

She explicitly establishes this recognition by others with the statement, *"[W]e are the ones that run the tests in the [hospital] laboratory."* Another participant, David, also recognizes and articulates his future scientific self with the announcement that he has recognized himself as a doctor since childhood. Then, he associates this recognition with his happiness. He states:

> *My career [intention] has never changed since kindergarten. It has consistently stayed as a medical doctor throughout my entire life. It is my happiness!*

Considering David's illustration of his future self in the context of his entire collage, his self-recognition contributes to the evidence of his research scientist trajectory identification.

4.2.1.4 Research Scientist Trajectory: Non-Relational Dimension

Beyond the established science identity dimensions of competence, performance, and recognition, another dimension is reported in these findings. We label this additional dimension as a non-relational dimension and is evidenced in the absence of people. As an example, the collage featured in Fig. 4 has the headline of *"Environmentology,"* and includes various performance tools, such as two white lab coats and safety goggles, as well as numerous colorful chemicals, test tubes, vessels, and stands, yet no people. The various scientific tools are displayed among cosmetic imagery, along with text highlighting different aspects related to skincare, make-up, and cosmetics. Accordingly, people are conspicuous by their absence in this research scientist collage. While the two pairs of high heel shoes placed directly below the two white lab coats might indicate human presence, no people are featured. Quite creatively, this collage presents

FIG. 4: Research scientist trajectory featuring only inanimate objects with no people and demonstrating a non-relational dimension

a strong example of a research scientist trajectory, yet this scientific world is devoid of any human element. The absence of people or a human element is an important finding that might reflect the objective nature of physical science but does not reflect the highly collaborative nature and relational orientation of the Hispanic culture. Therefore, we consider this collage to demonstrate a non-relational dimension within a research scientific trajectory. Beyond the Carlone and Johnson (2007) science identity dimensions of competence, performance, and recognition, this research contributes to science identity theory in identifying this non-relational dimension.

4.2.2 Altruistic Scientist Trajectory

In contrast to the *"Environmentology"* collage featured in Fig. 4 that shows a research scientist trajectory with a non-relational dimension, Fig. 5 shows an altruistic trajectory. This collage from Natalia depicts a focus on women's wellness, confidence, empathy, and American patriotism. Natalia's collage also features the word *"magic"* overlaid on a woman dressed in a long, flowing green dress displaying a relaxed, confident, and feminine manner. Natalia's collage also includes a soldier, with head bowed, facing a stone block wall in a state of reverence. The headline statement on the collage reads *"disorder takes understanding."* This demonstration of empathy is strategically positioned directly above the words *"women's wellness"* and the text that states, *"we can live without our hair, we can live without our breasts, we cannot live without our hope for a cure."* This text is positioned beside a picture with two white women in the foreground, one carrying a baby, and another older woman without hair, set against the background of a crowd of other women wearing pink, indicating breast cancer awareness. An emotional response is captured with the statement *"How to radiate killer confidence."* These strong words

FIG. 5: Altruistic scientist trajectory

are symbolically cutting in the context of radiation treatment and the potential terminal reality of breast cancer. More than that, these words are displayed on top of an image of twin skyscrapers and an overlaid image of the Statue of Liberty. Another prominent element of this collage is a man of color, positioned centrally, wearing a white lab coat. This evidence of scientific performance, combined with elements indicative of empathy, wellness, magic, and confidence, suggests this future self-collage illustrates an altruistic scientist trajectory. Natalia tells her story in the comment below as she talks about her collaborative intentions, her long-term goals, and her willingness to adapt along the way. Then, she announces that she is already on her way with a recent acceptance to an international institution. The story from Natalia is evidence of the dynamic transitional process from the current self to future self.

> *I would actually like to collaborate and I'd eventually like to continue my career over there after my PhD. So, you know, you have to have a goal and to get there, you never know when you're going to be presented with that opportunity. I'm actually leaving in two weeks and I'm going into reproductive biology so that's why I have a lot of breast cancer stuff on my collage.*

Like Natalia, Rebecca also demonstrates an altruistic scientist trajectory, describing her motivation as driven by a passion to serve. She aspires to be a dietitian and emphasizes the Hispanic cultural priority of family. The following quote details Rebecca's altruistic orientation and her preference to consider others before herself.

> *I'm not… I'm not, I wanna say my brain is hurting from thinking about myself too much. Like I just tend not to think about myself at all. I tend to think about others and that's actually what my motivation is. My passion is to serve people, so I wanna become a dietitian.*

Intending to become a dietitian, emotionally cloaked in the altruistic intention of serving others, Rebecca goes on to explain that she wants to be in business for herself, possibly owning a restaurant, where people are at ease about menu choices as healthy choices and where there is a children's playground to encourage physical fitness and quality parent–child interaction. She also explains that her overall intention is to give back to her family, especially her parents. Rebecca also connects her story to her grandmother's story, and she comments as follows regarding her inclusion of an image of a woman making tortillas.

> *This picture reminds me of my grandmother who always made tortillas. She is a very hard worker and this is my background. This is like many of our home backgrounds where our grandmothers, always a housewife kind of thing, and having to provide with food, having to take care of the children kind of thing. I don't come from a rich background, I come from a poor background, and when I see this woman with a roller, I just see my grandmother and it's just me.*

Given Rebecca's background and the hard-working, domestic role model of her grandmother, Rebecca's conception of self is a traditional female role, taking care of children, and making tortillas. She then projects this traditional female self to her future goal of becoming a competent dietitian and restaurant owner. In this way, her collage and description indicate she intends to use her scientific knowledge and practice for altruistic purposes.

4.2.3 Non-Scientist Trajectory

Unlike Figs. 3–5, Fig. 6 illustrates a non-scientist trajectory. Instead, the future self-collage shown in Fig. 6 is *"knowledgeable"* like Dr. Phil, *"successful"* like Oprah, and *"flawless and famous"* like Marilyn Monroe. Rather than a future comprising scientific competence, performance, or recognition, fame and fortune are the expressed goals. While there are aspects of performance such as the shoe alongside the text that reads *"go for it,"* there are no aspects related to scientific competence, performance, or recognition. The collage featured in Fig. 6 is, therefore, put forward as evidence of a non-scientist trajectory. This non-scientist trajectory was evident in 17% of the collages, which did not include any element of scientific competence, performance, or recognition. This non-scientist trajectory is outside both the research scientist and altruistic scientist trajectories and has implications in terms of better encouraging and facilitating Hispanics in STEM.

5. DISCUSSION

Investigating science identity in the context of Hispanic STEM students, this study shows that 55% of study participants demonstrate a research scientist trajectory with

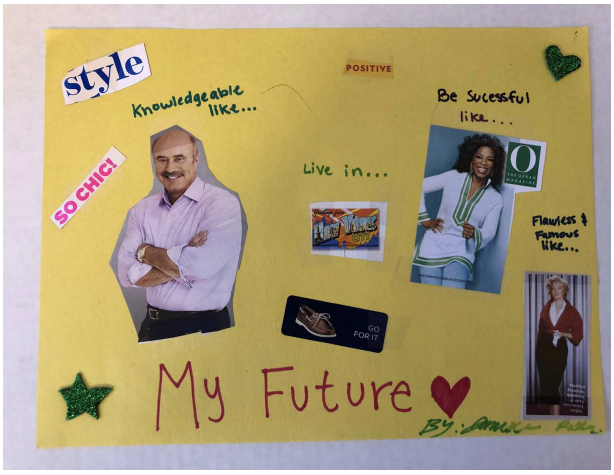

FIG. 6: A non-scientist trajectory

their passion for science, competent knowledge of scientific concepts, performance of scientific practices, and recognition of themselves as a science person, as do others. A further 28% of participants are shown to hold an altruistic scientist identity, where science is considered a vehicle for altruism and innovation, to give back and serve others. Unlike both the research scientist and altruistic scientist trajectories, the disrupted scientist trajectory seeks but does not necessarily receive recognition from scientific others (Carlone and Johnson, 2007). The findings presented here provide no evidence of a disrupted science trajectory, but there is evidence of a lack of recognition, including a lack of self-recognition and recognition by others.

Recognition of self and development of self-recognition regarding science identity is a fragile process, given the uncertainty of the outcome and the vulnerabilities involved (Rodriguez et al., 2017). For those outside the dominant race and gender, those who are not white and male, the development of a science identity is complicated (Carlone and Johnson, 2007). Consequently, minority students, including Hispanics, may struggle to identify with scientific professionals (Archer et al., 2015; Johnson et al., 2011). The harsh reality of this situation is reinforced by the findings reported here with 17% of participants illustrating a non-scientist trajectory. A non-scientist trajectory depicts a future self that lacks any evidence of scientific competence, performance, recognition, or even a human element. As a result, as this research reveals, science is missing from some future self-conceptions and science identities of Hispanic STEM students. This identified non-scientific trajectory is demonstrative of the challenges that Hispanics face in the formative years of their career. If Hispanic STEM students do not see their future self as scientifically competent, performing scientific tasks and using scientific tools, logic follows that they do not recognize their future selves as scientists, nor do they see science as part of their career trajectory.

The Hispanic culture holds distinct cultural values and, especially so, regarding relationships (Lu, 2015; Turcios-Cotto and Milan, 2013). Yet this research reports evidence of a non-relational dimension with 7 of the 41 research scientist trajectories, 2 of the altruistic scientist trajectories, and 2 of the non-scientist trajectories. That is, 17% of the collages do not feature any people. While physical science and STEM tuition are necessarily focused on the transference of scientific knowledge objectively, the neglect of how people are part of science and scientific practice is highlighted here as needing attention. We recommend attending to perceptions of how people are part of science and STEM and how scientists interact and collaborate to address and curb this identified non-relational dimension.

5.1 Theoretical Implications

The findings reported here contribute to the theory of science identity. The findings confirm Carlone and Johnson's (2007) research scientist and altruistic scientist trajectories, as well as the interrelated dimensions of competence, performance, and recognition. We extend the Carlone and Johnson (2007) science identity framework, with a non-scientist trajectory, as well as an additional non-relational dimension of science

identity. The non-scientist trajectory is identified above and beyond the research scientist and altruistic scientist trajectories. This non-scientist trajectory is an identity trajectory that does not include either science or scientific practice. Also, beyond the confirmed science identity dimensions of competence, performance, and recognition, we identify a non-relational dimension as an absence of humans. The findings reported here show that the research scientist and altruistic scientist trajectories, as well as the non-scientist trajectory, may comprise a non-relational dimension. This implies, therefore, that both research and altruistic scientist trajectories can be developed through the avenue of people and human relations—putting people in the picture, in other words.

5.2 Practical Implications

Participation in STEM enrichment programs, coursework, and lab work are practices and performances that may contribute favorably to the development of science identity (Merolla and Serpe, 2013). In this current research, most study participants (83%) were identified as holding a research scientist identity trajectory (55%) or an altruistic scientist identity trajectory (28%). Identification of a non-scientist trajectory and a non-relational dimension implies that the development of Hispanic science identity requires attention to recognition, interaction, and the basic idea that Hispanics are essential to the future of the STEM workforce.

The implication of the results reported here indicate there is value in offering Hispanic STEM students the opportunity to complete a project in a scientific role outside the university. This opportunity will allow them to see themselves as part of the scientific community, for example. This experience will assist them in recognizing themselves as scientists. Similarly, by allowing Hispanic STEM students to shadow STEM professionals, the student can collaborate and interact with scientific others. Essentially, we recommend encouraging Hispanic science identity development by offering opportunities to engage with scientific professionals, especially those of the similar race, gender, and background.

Other strategies that generate interaction and interpersonal experiences between scientific professionals and Hispanic STEM students will also contribute to the development of science identity. Industry placements, shadowing routines, and classroom guest speakers are specific examples that may encourage and facilitate Hispanic STEM science identity development. As a basic first step, relevant professionals can be invited into the classroom or lab as guest speakers or expert scientists. This presence in the classroom/lab will allow Hispanic STEM students to relate to and envision themselves in a similar role. This point applies especially when students make a meaningful professional connection with a scientist of either the same race or gender or both. Such a connection enables the students to see what is possible for their career.

Given that identity is something students develop through practice, Hispanic STEM students need to practice and perform science to be comfortable with the potential of

a scientist trajectory, and this can be achieved by offering shadowing opportunities for students to shadow a scientist for a day. Increased opportunities for students to interact with each other will also enable an improved relational dimension. Interaction with science professionals and fellow Hispanic STEM students underlines how people and human interaction are an important part of science and scientific practice. Also, increasing opportunities for human interaction in a scientific context, this mechanism reinforces the relevance of Hispanic relational values in the realm of science.

Further encouraging and facilitating the development of science identity, the research design detailed here offers a guide that can be used to better understand students. While there is no claim made regarding the generalizability of the findings, the transferability of the method is underlined as a useful tool.

Step One: Gather the students, develop trust and rapport, request a symbolic object considered reflective of the current self to be identified and described.

Step Two: Offer an array of craft items and print imagery and invite students to illustrate their future self in their scientific career.

Step Three: Conduct a what/how analysis and apply the extended science identity framework presented in Fig. 2. Be open to evidence that does not fit this framework that might further contextualize science identity within either a specific institutional context or cohort or both.

5.3 Limitations

Unlike most physical science research, the research design implemented here involves symbolism and illustration. We were aware that asking physical scientists to be creative in this way might act as a potential limitation to this research. To counter this potential limitation, we gave careful attention and preparation to bringing the participants to this creative stage of the research process. In the first instance, we established a degree of credibility and trustworthiness with study participants during the two-hour workshops. Furthermore, any evidence of a creative mind, creative activity, or creative orientation, such as Elisa's violin pin, for example, was highlighted and celebrated. When Elisa was explaining her passion for art and music and specifically, the violin, as symbolized by her violin pin that she carries with her every day, we encouraged the discussion to continue for a short time. This dialogue also allowed other participants to express their passion for art and music. Such actions demonstrated to other participants that venturing into a creative space did not incur (social) risk, and was, indeed, celebrated.

Within the analytical process, we used an iterative approach where results were repeatedly refined. This analytical approach also enabled identification of the essence of each science identity trajectory. Recognizing the limitations of this approach, however, we are aware that such essences are not totally exhaustive nor fully inclusive of what this phenomenon of science identity might be. Rather, we forward the findings reported here as an incomplete representation of science identity, and further research is needed to arrive at a more comprehensive understanding of science identity.

6. CONCLUSION

We addressed the question of how Hispanic STEM students make sense of their science identities. Our findings confirm established science identity dimensions of competence, performance, and recognition dimensions, and add a non-relational dimension. Identification of this non-relational dimension highlights the need to ensure that human relations and interaction are experienced by Hispanic STEM students in the context of science. Furthermore, we extend the theory of science identity with evidence of a non-scientist trajectory. Reporting that some Hispanic STEM students conceive of a future self that is non-scientific implies the need to nurture the vision of science and a scientific trajectory as part of their future career. More specifically, this finding translates to the required development of science identity dimensions, such as recognition. In other words, Hispanic STEM students need to recognize themselves as scientists, but they need to be given the context in which to encourage and facilitate that experience. Similarly, Hispanic STEM students need to be given more opportunities so that other scientists and science professionals will recognize Hispanic STEM students as scientists.

ACKNOWLEDGMENTS

This program was supported in part by a grant from the Howard Hughes Medical Institute.

The authors would also like to express gratitude to Heidi Carlone for her help and guidance in the development of this manuscript.

REFERENCES

Alvesson, M., & Sköldberg, K. (2017). *Reflexive methodology: New vistas for qualitative research*. Washington, DC: SAGE.

Archer, L., Dewitt, J., & Osborne, J. (2015). Is science for us? Black students' and parents' views of science and science careers. *Science Education*, 99(2), 199–237. doi: 10.1002/sce.21146.

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Garden City, NY: Anchor Books.

Bricker, L. A., & Bell, P. (2014). 'What comes to mind when you think of science? The perfumery!': Documenting science-related cultural learning pathways across contexts and timescales. *Journal of Research in Science Teaching*, 51(3), 260–85. doi: 10.1002/tea.21134.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching*, 37(5), 441–58. doi: 10.1002/(SICI)1098-2736(200005)37:5<441::AID-TEA4>3.0.CO;2-3.

Bukoski, B. E., & Hatch, D. K. (2016). 'We're still here . . . we're not giving up' Black and Latino men's narratives of transition to community college. *Community College Review*, 44(2), 99–118.

Carlone, H. B., Webb, A. W., Archer, L., & Taylor, M. (2015). What kind of boy does science? A critical perspective on the science trajectories of four scientifically talented boys. *Science Education*, 99(3), 438–64. doi: 10.1002/sce.21155.

Carlone, H. B., Scott, C. M., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, 51(7), 836–69. doi: 10.1002/tea.21150.

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge- and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, 48(5), 459–85. doi: 10.1002/tea.20413.

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), 1187–218. doi: 10.1002/tea.20237.

Carlone, H. B. (2003). (RE)Producing good science students: Girls' participation in high school physics. *Journal of Women and Minorities in Science and Engineering*, 9(1), 17–34. doi: 10.1615/JWomenMinorScienEng.v9.i1.20.

Ceglie, R. (2011). Underrepresentation of women of color in the science pipeline: The construction of science identities. *Journal of Women and Minorities in Science and Engineering*, 17(3), 271–93. doi: 10.1615/JWomenMinorScienEng.2011003010.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching*, 51(5), 555–80. doi: 10.1002/tea.21146.

Drew, D. E. (2015). *STEM the tide: Reforming science, technology, engineering, and math education in America*. Baltimore, Baltimore, MD: Johns Hopkins University Press.

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John, G. H., Matsui, J., McGee, R., & Okpodu, C. M. (2016). Improving underrepresented minority student persistence in STEM. *CBE Life Sciences Education*, 15(3), es5. doi: 10.1187/cbe.16-01-0038.

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Science education. Increasing persistence of college students in STEM. *Science*, 341(6153), 1455–6. doi: 10.1126/science.1240487.

Hayes-Bautista, D. E., & Chapa, J. (1987). Latino terminology: Conceptual bases for standardized terminology. *American Journal of Public Health*, 77(1), 61–8. doi: 10.2105/ajph.77.1.61.

Holland, D. C., Lachicotte, Jr., W., Skinner, D., & Cain, C. (2001). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

Holstein, J. A., & Gubrium, J. F. (2004). Context: Working it up, down, and across. In C. Seale, G. Gobo, J. F. Gubrium & D. Silverman (Eds.), *Qualitative research practice* (pp. 297–311). London, UK: SAGE.

Husserl, E. (1931). *Ideas: General introduction to pure phenomenology* [D. Carr (Trans.)]. Evanston, IL: Northwestern University Press.

Jackson, P. A., & Seiler, G. (2013). Science identity trajectories of latecomers to science in college. *Journal of Research in Science Teaching*, 50(7), 826–57. doi: 10.1002/tea.21088.

Johnson, A., Brown, J., Carlone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, 48(4), 339–66. doi: 10.1002/tea.20411.

Kostera, M. (2006). The narrative collage as research method. *Storytelling, Self, Society*, 2(2), 5–27.

Koyama, J. P. (2007). Approaching and attending college: Anthropological and ethnographic accounts. *Teachers College Record*, 109(10), 2301–23.

Kozoll, R. H., & Osborne, M. D. (2004). Finding meaning in science: Lifeworld, identity, and self. *Science Education*, 88(2), 157–81. doi: 10.1002/sce.10108.

Krueger, R. A. (2014). *Focus groups: A practical guide for applied research*. Thousand Oaks, CA: Sage Publications.

Lu, C. (2015). Finding los científicos within: Latino male science identity development in the first college semester. *Journal of College Student Development*, 56(7), 740–5. doi: 10.1353/csd.2015.0069.

Malone, K. R., & Barabino, G. (2009). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education*, 93(3), 485–510. doi: 10.1002/sce.20307.

Martínez, D. E., & Gonzalez, K. E. (2020). 'Latino' or "Hispanic"? the sociodemographic correlates of panethnic Label preferences among U.S. Latinos/Hispanics. *Sociological Perspectives*. doi: 10.1177/0731121420950371.

McNutt, M. K. (2019). Maintaining US leadership in science and technology. *The National* Academies of Sciences, Engineering, and Medicine. Retrieved from http://www.nationalacademies.org/OCGA/116Session1/testimonies/OCGA_191603.

Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: The role of science identity salience. *Social Psychology of Education*, 16(4), 575–97. doi:10.1007/s11218-013-9233-7.

Miller-Cotto, D., & Byrnes, J. P. (2016). Ethnic/racial identity and academic achievement: A meta-analytic review. *Developmental Review*, 41, 51–70. doi: 10.1016/j.dr.2016.06.003.

Museus, S. D., Palmer, R. T., Davis, R. J., & Maramba, D. C. (2011). Table of contents. *ASHE Higher Education Report*, 36(6), 1–140. doi: 10.1002/aehe.3606.

National Academies of sciences, engineering, and medicine. (2019). *Minority serving institutions: America's underutilized resource for strengthening the STEM workforce*. Washington, DC: National Academies Press. Retrieved from https://cte.careertech.org/sites/default/files/files/resources/MSIs_STEM.pdf.

National Foundation for American Policy. (2017). The importance of international students to American science and engineering. Retrieved from http://nfap.com/wp-content/uploads/2017/10/The-Importance-of-International-Students.NFAP-Policy-Brief.October-20171.pdf.

National Science Foundation. (2018). Science and engineering indicators 2018. National Science Board. Retrieved from https://www.nsf.gov/statistics/2018/nsb20181/report/sections/science-and-engineering-labor-force/highlights.

National Science and Technology Council. (2018). Charting a course for success: America's strategy for STEM education. Executive Office of the President of The United States. Retrieved from https://www.whitehouse.g.,ov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review*, 81(2), 172–209. doi: 10.17763/haer.81.2.t022245n7x4752v2.

Rahm, J., & Moore, J. C. (2016). A case study of long-term engagement and identity-in-practice: Insights into the STEM pathways of four underrepresented youths. *Journal of Research in Science Teaching*, 53(5), 768–801. doi: 10.1002/tea.21268.

Rodriguez, S., Cunningham, K., & Jordan, A. (2019). STEM identity development for latinas: The role of self- and outside recognition. *Journal of Hispanic Higher Education*, 18(3), 254–72. doi: 10.1177/1538192717739958.

Silverman, D. (2005). *Doing qualitative research*. Thousand Oaks, CA: SAGE.

Simon, R. M., Wagner, A., & Killion, B. (2017). Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *Journal of Research in Science Teaching*, 54(3), 299–323. doi: 10.1002/tea.21345.

Syed, M., Azmitia, M., & Cooper, C. R. (2011). Identity and academic success among underrepresented ethnic minorities: An interdisciplinary review and integration. *Journal of Social Issues*, 67(3), 442–68. doi: 10.1111/j.1540-4560.2011.01709.x.

Syed, M. (2010). Developing an integrated self: Academic and ethnic identities among ethnically diverse college students. *Developmental Psychology*, 46(6), 1590–604. doi: 10.1037/a0020738.

Tan, E., Calabrese-Barton, A., Turner, E., & Gutiérrez, M. V. (2012). *Empowering science and mathematics education in urban schools*. Chicago, IL: University of Chicago Press.

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, 16(10), 837–51. doi: 10.1177/1077800410383121.

Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Hoboken, NJ: John Wiley & Sons.

Treviño, F. M. (1987). Standardized terminology for Hispanic populations. *American Journal of Public Health*, 77(1), 69–72. doi: 10.2105/ajph.77.1.69.

Turcios-Cotto, V. Y., & Milan, S. (2013). Racial/ethnic differences in the educational expectations of adolescents: Does pursuing higher education mean something different to Latino students compared to White and Black students? *Journal of Youth and Adolescence*, 42(9), 1399–412. doi: 10.1007/s10964-012-9845-9.

Wenger, E. (1999). *Communities of practice: Learning, meaning, and identity*. Cambridge, UK: Cambridge University Press.

Wong, B. (2015). Careers "From" but not "in" science: Why are aspirations to be a scientist challenging for minority ethnic students? *Journal of Research in Science Teaching*, 52(7), 979–1002. doi: 10.1002/tea.21231.