Abstract

Biology degrees are not equally accessible to all people. There is a disparity in STEM degree attainment for URM (underrepresented minorities) and whites even though the same rate of these student groups begin STEM degrees. Thus, there is a need to have a better understanding of the challenges faced by URM— in this case, Latinx students—and how the development of a science identity increases their likelihood of completing a biology degree. This case study examines the connections between a Latina student developing a science identity and her pursuit of a STEM degree. Parental support, science extracurricular activities, and being part of a science community are all ways that students can build their own science identity. However, these factors are more likely to be absent for students from underrepresented groups. For this case, it was found that the practice of science, as opposed to doing school science, proved critical for Esperanza's (pseudonym) development of an identity. She was also a part of a science community thickening her science identity, which has been associated with perseverance in STEM majors. Understanding the work of science identity development can help mitigate the leaking STEM pipeline.

The Process of Science Identity Development: Esperanza's Persistence in the Face of Adversity

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Biology degrees are not equally accessible to all people. Only 16% of Latinx who begin college as STEM majors in 2004 completed a STEM degree by 2009 (Cullinane, 2009). Thus, there is a need to have a better understanding of the challenges faced by Latinx students and how the development of a science identity increases the likelihood of completing a biology degree.

This paper addresses this issue through the case study of a Latina's exposure to science, her developing science identity, and her pursuit of a microbiology degree.

To facilitate this discussion of identity, it is important to articulate the various textures and nuances of the term "identity" within the context of my research. I am dealing with the definitions of identity broadly, and, more specifically, the importance of stories to one's identity, along with individuals' multiple identities within their communities. Identity is the way an individual is recognized as a certain kind of person in a given context (Gee, 2000a). I expand upon these ideas and argue that identity is shaped by one's position, prestige, power, and context and manifests through activity, which reflexively shapes identity (Van Horne & Bell, 2017). Building an identity can augment a person's agency, which is evident through activity. A change in identity changes an individual's positioning, participation, and opportunities for learning. A person's identity comprises a collection of stories (Sfard & Prusak, 2005), activity (Brickhouse, Lowery, & Schultz, 2000; Heidi Carlone & Johnson, 2007), and being recognized as a certain kind of person in context (Gee, 2000b).

Science identity work builds on an individual's science identity trajectory (movement in relation to science through space and time), which changes based on context and social interactions (Calabrese Barton et al., 2013; Fields, 2010; Jackson & Seiler, 2013). Heidi Carlone, Scott, and Lowder (2014, p. 218) explain that science identity work "involve[s] different performances and take[s] on different meanings depending on the norms, practices, values, and

demands of the setting." I focus on students' science identity work because it highlights the process of authoring oneself in science (Barton & Tan, 2010). To study this, I have captured Esperanza's actions and the relationships she forms with others in order to gain insight into how she positions herself as a particular kind of person over time and space (Calabrese Barton et al., 2013). I have also recorded the stories that she tells about herself. Sfard and Prusak (2005) explain that stories about a person told either by the person or by others about the person are reifying, endorsable, and significant, and provide insight into their identity. Put another way, the stories define identities in the repetitive actions, the positioning of the person, and membership or non-membership among communities. As people are telling their stories to others, they are also telling their stories to themselves (Holland, Lachicotte, Skinner, & Cain, 1998), so they will act to fulfill those stories. By looking at Esperanza's activities and listening to her stories, I have a comprehensive view of her identity work.

This research fills a gap in the literature on how science identity is developed and sustained through life challenges and attainment of a biology degree, thus retaining valuable students in the STEM pipeline. So, unlike other case studies researching science identity, this study is about a Latina and the process of her science identity development during challenging times. Through an in-depth investigation of this student's science identity development and her pursuit of a microbiology degree, this case study will provide insight into her journey and goals, which may contribute to a better understanding of science identity development in underrepresented students.

Conceptual Framework

I am framing my research on identity through a socio-cultural lens, or as the way people author themselves and others author them (Holland & Lave, 2001). Identities are manifested through activity or performances, which reflexively shapes identities (Van Horne & Bell, 2017) and identities can increase agency (Barton & Tan, 2010). Past experiences mediate an identity, but they are not necessarily cumulative. In other words, a person does not obtain or add to an identity when s/he fills up the "science identity basket" with science experiences. Identity is about how a person interprets experiences and how those experiences moderate their current context, or as Roth and Lee (2007) write, an identity is a manifestation of the cultural-historical possibilities for a given time and context. Of note, in identity research, one cannot just list experiences as a way to measure a "thickening identity" (Jackson & Seiler, 2013); rather, we should look deeply into how activity, agency, and culture influence the individual and their actions. Therefore, identity is a social construct that is being dynamically negotiated in a temporal context and, as Gee (2000) explains, identity is never fully formed and is always potentially changing.

While Gee explores how outside forces can influence a person or the "kind of person" they become/are, Urrieta (2007) emphasizes how a person comes to understand themselves and position themselves through relationships and actions into figured worlds. While these are different points of reference, I accept that identity includes both understandings and utilize both lenses as I examine Esperanza's science identity development.

Methodology

The purpose of this qualitative study was to learn about the challenges faced by a Latina and how her developing science identity motivated her to continue her education in a STEM-

related field, despite the challenges. To achieve this, a case study methodology was employed. Case studies focus on a "phenomenon within its natural context" (Yin, 2014). This type of investigation sheds light on the development of science identity in a Latina, Esperanza (a pseudonym). This case study focused on one purposefully selected (Stake, 1995) individual, who represents an exceptional case and is analyzed in order to understand and learn more about specific aspects of her perception and decisions.

Researcher's Positionality

The researcher is a white female who has known Esperanza since 2005 and has maintained occasional contact with her since she graduated from high school in 2008. The researcher taught Esperanza in high school and was her mentor for her science research projects.

Data Collection and Analysis

The author conducted four interviews for this case study. The first two interviews, completed in November 2013, lasted approximately ninety minutes each. The last two interviews (January 2014) were full day, case study interviews (Yin, 2014). To supplement the interviews the researcher obtained documents and recorded observations. The interviews were transcribed. Then the documents along with the interviews and observations were read thoroughly and memos were generated that represented analysis and interpretations (Corbin & Strauss, 2008). External codes were generated from the theoretical framework for this research (Graue & Walsh, 1998) and internal codes emerged during analysis. The theme of her identity development will be analyzed for this paper. This theme was supported by multiple data sources. The interview protocol was designed to allow both the participant and researcher to have some flexibility

during the administration of the interview. The questions included in the interview were thought to have both a "holistic description of the story" (Zeldin & Pajares, 2000) and to elicit relevant data to answer the research goals. Member checking of transcriptions, interpretations, and the extended research report, triangulation, and analytic memos enhance the authenticity of this work (Corbin & Strauss, 2008).

Research Findings

Descriptive Findings

Esperanza is a 23-year-old Latina single mother of two children in her fourth year of part-time undergraduate studies in microbiology. She was removed from her birth mother, an undocumented Latina, at five years old, due to a neglectful environment. She was placed in foster care with several different families and occasionally group homes until she was 13, when she was placed with a Latino family, who adopted her a year later. Once she was adopted, she moved from a midwestern city and began tenth grade at a high school in a suburb of a large city in the southwest. When she graduated from high school, she had three semesters of dual enrollment college credit from community college. After graduation, she married her boyfriend and enlisted in the US Air Force with the goal of being trained as a lab technician; however, she was discharged after basic training. She then lived with a girlfriend while her divorce was processed. She enrolled in a western state university where she completed three semesters of courses toward a microbiology degree while working full-time. She eventually married her girlfriend and gave birth to a daughter. After the relationship ended, Esperanza moved with her daughter to a different state to live with her daughter's biological father (not her previous husband). She explained, "This situation living with my daughter's biological father was not a

good situation for us and we left within six months." In the year before that, she had made some contact with her birth mother. After her birth mother invited her to move in with her, Esperanza agreed, and she and her young daughter moved in. She realized soon after arriving that it was not a safe place and they needed to leave. Esperanza found herself homeless in the city where she had spent her early life. With the help of state support agencies, she found a job, daycare for her daughter, and housing. She enrolled in college again to continue her pursuit of a microbiology degree. At this point, she met her second child's (a son) father and moved in with him. She is currently enrolled in college and working full time. In spite of her history, her interest in microbiology has been a constant. She started taking college classes in high school and continued wherever she lived for six months or longer. Despite challenges, she has completed her degree in microbiology and is working in a hospital.

Analytical Findings

Upon preliminary analysis of the data, three primary themes emerged that contributed to Esperanza's development of a science identity and continued persistence in her STEM major. These themes were member-checked and detected by a second coder. Data from interviews, documents, and observations were then coded and organized under these themes: 1) Cultural identity 2) Community identity, and 3) Development of science identity. In consideration of the length of this proposal, I will focus on just one theme, the development of science identity.

Process of developing a science identity. During the third interview, Esperanza explained that before age eleven, she had no idea what she wanted to be. She never really had any examples of careers or anyone talking to her about her future goals or careers. However, she

remembers at age twelve that she wanted to be a coroner. She said, “I just thought it would be interesting,” but she had no idea that she would have to go to medical school to be a coroner. If she had been part of a family with professional parents, she would likely have had more guidance on her career aspirations. Following her interest in being a coroner, she wanted to be a forensic scientist. She thought this was influenced by television shows. In middle school, she was much more interested in history than in science. She said, “The first time I became interested in science class was when I was in biology my tenth-grade year. I had always liked history, but science was boring since we just read and answered questions in a textbook.”

The first day she attended class at her new high school, it was obvious to the author, who was her regular biology teacher, that Esperanza had an interest in science. She was actively involved in the class and asked thoughtful questions. At her teacher’s suggestion, she switched into the honors biology class, increasing her opportunities to develop science skills and interest. Students in advanced science classes are more likely to develop a science identity (Lee, 2011; Tyson, Lee, Borman, & Hanson, 2007). She was reticent about changing classes because she had never been in an honors class, but she assimilated well. An honors biology class requirement was to do a science research project. Esperanza surprised her honors biology teacher by designing a very involved original project, and working in the lab on weekends and holidays, along with older students in upper-level science classes. She said during the fourth interview, “Doing science fair changed my impression of science…I think it was the way science was approached. My new high school teachers approached science differently as opposed to my first high school… I think it was also the ability to do it. My first high school does not have science fair I would have never been able to do it. The process of doing it changed my perspective. By doing science, that changed my impression of science it opened up doors that I didn’t know were

there."

As a high-school student, she competed in science fair from tenth through twelfth grades, even though after tenth grade, science fair was no longer a requirement for her classes. Every year, she placed first in the microbiology category at school and she placed first, second, and third in the regional science fair, qualifying for the state science fair. Her projects started off relatively simple: measuring the inhibition zones made by garlic and other bacteria inhibitors. The following year, she said, "I was tired of getting mold on my bassoon reed, so I developed an inhibitor that was safe for people and stopped mold from growing on my expensive bassoon reeds. In my senior year, I tested types of bacteria that inhibited other bacteria, thus developing a safe bacteria inhibitor of pathogenic bacteria. I always thought of this as the battle-bots for bacteria. Let the strongest one live!" Esperanza came into the lab on her own time and completed her projects. Her projects progressed to be very complex, and that meant that she spent nearly every weekend of the fall and winter in the lab.

Through successfully competing in science fair and her long hours in the lab, others recognized Esperanza as a scientist, consequently influencing the way she thought of herself. Each year Esperanza competed in the microbiology category. During her senior year, she was walking through the display hall as students were setting up their projects. Esperanza had already set up her large red board (the same board she used every year), and she heard students from another high school talking about her project. They said their teacher told them to find the project on the big red board and make sure they read it because the student was very good in microbiology and would probably win the microbiology category. Esperanza was known as a scientist beyond the walls of her school, at another school two hours away. After the science fair, Esperanza told her teachers "other students in my category were coming up to me for advice

about future projects during judging." Esperanza won the category that year with her project. This recognition from students outside of her school helped her realize that she was known as a competitor in the microbiology category.

Esperanza was part of the school's science research community. She became a mentor to the younger students in the lab. Emphasis on laboratory science and science social interactions has been shown to improve achievement in minority females (Von Secker & Lissitz, 1999). Prior to this time in her life she said "I really didn't think about science ideas." This inclusion in the community of practice (Lave, 1992) helped her identify as a scientist. She added, "The approach to science was so different and getting to do science research changed my perspective. I had never thought about going to college and doing science. I realized that this was a real application, not like AP classes that say this is what college is like." Here, she recognized the discrete differences between typical school science and engaging in science (Brickhouse et al., 2000). She disclosed in the fourth interview, "I felt like as I was doing my science project the teachers saw something in me that I didn't know was there. I had never done science fair before. Science fair is for nerds. Then I really liked it and decided that I am going to do science fair for my whole life." Getting to do her own experiments, in other words, getting to do what scientists do. In high school Esperanza took eleven science courses; the state required only three science courses for graduation. These ranged from advanced biology, chemistry, and physics to science research and medical microbiology classes. She took college classes at the local community college during high school years to be able to fit more science classes into her schedule. During high school, she also attended a two-week camp for students interested in medical professions in another state. Development of science identity through science experimentation is supported by research on the effectiveness of undergraduates completing a science research experience (S. H. Russell,

Hancock, & McCullough, 2007).

Discussion and Contributions to Teaching

Family support is a known contributing factor for minority student success (M. L. Russell & Atwater, 2005); while Esperanza has had an incredibly difficult family life with no support, her fellow science research students in high school provided good surrogate support—a community of practice—through classes, science fair, and her extracurricular activities. She developed an identity as a scientist: "I am going to do science fair for my whole life." Even though Esperanza made some "poor choices" (her words) after high school, she stuck with her goal to be a microbiologist. Biddle, Bank, and Slavings (1992; 1987) found that identity with personal norms is one of the major predictors to undergraduates staying in school.

Esperanza took advanced science classes, which Russell and Atwater (2005) found to be important for future success in science majors. Flexibility in access to advanced classes is an important component in increasing underrepresented minorities in STEM. Students whose parents are absent, unsupportive, or who lack knowledge about curricular options may need the support of teachers and counselors. Professional development for teachers to become supportive of non-mainstream students may also be part of the equation; research has shown that many teachers hold unconscious stereotypes about the ability of students by demographic characteristics (Riegle-Crumb & Humphries, 2012).

The practice of science, as opposed to doing school science, proved critical in Esperanza's development of an identity. She was able to practice science due to science fair and independent research opportunities, and the presence of a science research community. Such communities are not always present in schools, as Esperanza herself noted. It is important to foster such

communities in order to support the development of scientific identities among underrepresented minorities. Typically, these opportunities are available in advanced science classes but we need to redesign all of our science classes to give all students an opportunity to experience “doing science.”

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