1-1-2018

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Recommended Citation

Burton, G., & Vicente, M. (2018). A Narrative Analysis Examining Influential Factors of a Minority Research and Training Program. *Journal of College Student Retention: Research, Theory and Practice* https://doi.org/10.1177/1521025118813605

HHS Public Access

Author manuscript

J Vocat Behav. Author manuscript; available in PMC 2021 August 01.

Published in final edited form as:

J Vocat Behav. 2021 August 1; 23(2): 187–213. doi:10.1177/1521025118813605.

A Narrative Analysis Examining Influential Factors of a Minority Research and Training Program

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Abstract

The implementation of minority research and training programs at the postsecondary level has risen to close the educational achievement gap and generate a highly skilled and diverse science workforce. Numerous studies identify interventions influencing positive outcomes among minority research and training participants achieving graduate degrees. However, many of these studies utilize quantitative methods. To capture student voices and rich descriptive experiences, this study utilized a multiple case study featuring a narrative approach. Cross-case analysis identified four factors influencing matriculation into advanced degree programs: belonging and inclusion, peer mentoring, confidence as a scientist, and family influence. Findings from this study expand the current body of knowledge and provide implications for practice to better serve underrepresented students in the science, technology, engineering and mathematics disciplines.

Keywords

undergraduate research; mentoring; inclusion; narrative; science; technology; engineering and mathematics

Introduction

National data over the past 40 years indicate a significant educational disparity among racial and ethnic groups in the United States of America. Students from Hispanic or Latino, African American, American Indian, and Pacific Islander groups are proportionately underrepresented at all higher education levels, especially in science, technology, engineering and mathematics (STEM)-related fields (National Science Board, 2014). Furthermore, the number of underrepresented minority (URM) groups that continue into STEM-related careers after graduation declines. African Americans represent only 11% of the overall workforce of all STEM jobs while the White population represents more than 70% of STEM workers (Carnevale, Smith, & Melton, 2011). With racial and ethnic minority groups predicted to make up more than half the national population by 2050, minority students are assets into which educators must tap to strengthen the STEM workforce, the vibrancy of the economy, and health care (Museus, Palmer, Davis, & Maramba, 2011).

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Scientific advancement depends on scientific talent; however, a lack of diversity represents a loss of talent and impedes scientific progression.

To close the educational achievement gap and build undergraduate pathways to generate a highly skilled and diverse talent pool that meets the demands of emerging STEM fields, the implementation of workforce training programs at the postsecondary level has risen. For the past 40 years, federally funded minority research and training (MRT) programs have been used across U.S. colleges and universities as a method to patch the leaking science *pipeline* (Schultz et al., 2011). In 2004, the U.S. federal government spent $2.8 billion on educational programs aimed at increasing the number of students in the STEM disciplines (U.S. General Accounting Office, 2005). The National Science Foundation, National Institutes of Health, Howard Hughes Medical Institute, and other federal agencies provide funding for the development of science support programs serving URM students interested in pursuing a career in STEM fields.

U.S. federally funded MRT programs aimed at increasing the representation of URM in STEM disciplines utilize a broad spectrum of educational activities, training opportunities, and professional experiences designed to increase student persistence toward the completion of doctoral degrees. Program components include, but are not limited to, undergraduate research (UR), mentoring, academic and career advising, and financial support. Although the number of science-related degrees have slowly increased over the past decade, partially due to the utilization of MRT programs, this increase has not been adequate to establish an impactful representation in either academic or industry research careers.

The majority of the studies examining participation of URM students in MRT programs utilize quantitative or a mixed-methods approach, which may be influenced by the traditional scientific inquiry of researchers in STEM disciplines. The studies utilize simple descriptive statistics with surveys to measure students' self-reported gains (Hunter, Laursen, & Seymour, 2007; Laursen, Hunter, Seymour, Thiry, & Melton, 2010; Seymour, Hunter, Laursen, & DeAntoni, 2004) and commitment to pursue a graduate level degree immediately following an MRT experience (Craney et al., 2011; Eagan et al., 2013). However, quantitative methods can be ineffective when analyzing contemporary research issues or phenomena under study (Webster & Mertova, 2007). According to Webster and Mertova (2007), quantitative methods often overlook issues that might be important for the students. For instance, studies that use graduate student attendance data to promote the value of research experiences are unable to demonstrate such research experiences, or other factors, as the cause of continuance into graduate school (Mabrouk & Peters, 2000).

Narrative inquiry, on the other hand, provides a rich framework in which researchers study how people experience and perceive the world through their stories (Webster & Mertova, 2007). Narrative analysis allows researchers to hear the multiplicity and complexity of student experiences and focuses on participants' self-generated meanings (Esin, Fathi, & Squire, 2014). Narratives reveal information about the inner world of the storyteller and the identity, intentions, and feelings of the person telling the story (Murray & Sargeant, 2011), opening a space for researchers to analyze participant experiences related to social issues, such as social inequalities and gender relations (Esin et al., 2014). Unlike quantitative-based

surveys, narrative inquiry embraces a culturally responsive approach that explores the social context and culture in which the experience took place and in which the knowledge was constructed (Webster & Mertova, 2007).

Only a few qualitative studies exist that capture participant voices when examining degree persistence of URM students in the sciences (Gibau, 2015; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Johnson, Brown, Carlone, & Cuevas, 2011). Hurtado et al. (2009) examined the development of scientific career goals among URMs at various institutions and science programs and emphasized the use of student voice through the analysis of semistructured focus groups. Johnson et al. (2011) examined the experiences of three women of color who have completed advanced degrees and are currently employed in science. The study explored the pathways successful women have taken and the dynamics of inequity within and beyond science through the use of dialogue. However, neither of these two programs focuses on the influences of MRT programs.

Gibau (2015) emphasized the importance of incorporating student voices to understand the experiences of URM students and examine types of interventions that may or may not work at an institution. In the study, Gibau examined interview data from past evaluations that were conducted and transcribed by an external reviewer intended for program assessment. In contrast, this study not only examined experiences of undergraduate students during their participation in an MRT program using preexisting data from program reports but also narrative style data from interviews between the researcher and participants.

The results of the present study add to the current body of knowledge examining a MRT program and gauge its influence on advanced science degree attainment and career choice of URM students. This information provides institutions and training programs with improved supports and resources necessary to better serve URM students in STEM majors and to enrich minority representation in academic or industry research careers. The following are the questions addressed by this study: What are the experiences of students who participated in an undergraduate minority research program? Which experiences were most critical to their persistence into graduate school?

Research Design

Constructivism promotes an inquiry design focusing on meaning-making through coconstructed narrative between the researcher and participants. According to Stake (1995), case studies are effective for describing and expanding the understanding of a phenomenon and are often utilized in studying people and programs in education. The study herein utilized a multiple case study featuring extensive use of narrative to generate a thick descriptive environment (Creswell, 2014). Thus, this study provides a constructivist understanding of the multiple perspectives of students who participated in a minority research program and matriculated into graduate programs.

In postmodern constructivism, knowledge does not exist in a state pending discovery but rather is constructed by people through interactions with the world (Gordon, 2009). Therefore, learners construct their personal knowledge as a result of reflecting on their experiences. The epistemology of constructivism, the method of acquiring knowledge, is

both subjective and relative. Although reality may exist separate from experience, it can only be known through experience, thus resulting in a personally unique reality. Thus, no single truth exists but rather multiple truths are constructed through personal, active experiences.

To examine the experiences of students who participated in an MRT program and matriculated into graduate programs, a multiple case study featuring extensive use of narrative was utilized. Qualitative research provides the flexibility needed for participants to retell their stories in a meaningful form through narratives rather than numbers and still to employ a systematic approach to gather empirical evidence (Denzin & Lincoln, 2008). The constructivist paradigm recognizes the complex nature of multiple realities in which *reality* is constructed through personal, unique experiences. In qualitative research, instead of trying to capture *truth* and generalize and predict *truth* for a larger population, the researcher tries to understand how the participants' social reality is constructed. Since qualitative interviews are natural extensions of conversations, interviewees become partners in the research rather than subjects to be tested (Rubin & Rubin, 2005).

Constructivism emphasizes the interaction between researcher and participant for the construction of meaning (Mills, Bonner, & Francis, 2006). With narrative research, the sharing of stories with researchers provides a way of understanding people's interpretations of their own worlds and important life events (Murray & Sargeant, 2011). The stories shared represent participants' meaning-making and how they select what to tell an audience, which may include societies, cultures, families, and other influential events in their life. Therefore, this study promoted an inquiry of context-focused meaning-making through coconstructed narrative between the researcher and participants.

Institutional Setting—Since this study examined participants of an MRT program, understanding the institutional context in which students attended is important, as it may have influenced their responses. Located in the southern region of the United States, the research site was a doctoral degree-granting institution with extensive research activity and a student population of about 30,000. The university is recognized as the state's flagship institution. The state in which the institution is located has one of the largest minority general populations in the United States (U.S. Census Bureau, 2015). Despite a state population of 32% African American and a city population of 50% African American, the institution's 2016 student enrollment was 70% White, 12% African American, and 6% Hispanic or Latino/a. Thus, the research site constitutes a predominant white institution.

Program Description—The MRT program selected for this study is funded by a national agency through a competitive grant in which an academic institution may seek funds for program implementation and development, with the goal of increasing doctoral level minority researchers. Established in 2004, the program's mission is to provide a diverse group of undergraduate students in the biomedical or behavioral sciences research training, academic and personal development, and career opportunities that promote student retention and success while enhancing diversity in the sciences. The MRT program supports 20 URM students per year. During the academic year, participants conduct research under a faculty member for 15 hours per week, receive hourly wages and travel funds to attend and present research findings at scientific meetings, attend bimonthly educational activities and

seminars, and receive regular academic, career, and personal counseling. Undergraduate student eligibility for admittance includes U.S. citizens or lawfully admitted for permanent residence, majoring in the natural, physical, or behavioral sciences relevant to biomedical research and planning to enter a doctoral program in the biomedical sciences directly upon graduation, competitive grade point average, sophomore or junior, and individuals from underrepresented racial and ethnic groups (defined as African Americans, Hispanics or Latinos, American Indians, Alaska Natives, Native Hawaiians, and other Pacific Islanders), individuals with disabilities (defined as those with a physical or mental impairment that substantially limits one or more major life activities), and individuals from disadvantaged backgrounds.

Researcher's Role—The researcher of this study served as the program coordinator for the MRT program since the start in 2004. Thus, the researcher had accessibility to program documents, an understanding of the institutional setting and local values, and familiarity with program participants. According to Bonner and Tohurt (2002), insider-researchers have a greater understanding of the culture being studied, maintain the natural flow of social interaction, and promote the telling and judging of truth through established intimacy. There are proposed drawbacks associated with an insider-researcher, including ethical considerations and the impact of biases (Floyd & Arthur, 2012; Sykes & Potts, 2008). However, in order to establish awareness of ethical considerations and perceived bias on data collection and analysis, the researcher implemented several strategies throughout the research process. For instance, anonymity of the program and individual participants was maintained, the researcher kept a reflexive journal as an audit trail, and interpretations were shared and validated with informants.

Participant Selection—After receiving institutional review board approval from the university, the researcher sent private e-mail invitations to all former students who participated in the MRT program at the research site and continued onto graduate school. Out of the 38 invitation e-mails sent out, 15 former program participants responded. Purposeful sampling was utilized for this study to include participants of homogeneous traits, such as gender and years of participation, but also various science-related disciplines, including biology, chemistry, engineering, and animal science, and career paths in order to select information-rich cases. From the 15 respondents, the researcher purposely selected 10 participants, 5 females and 5 males. All 10 participants partook in the MRT program for at least two consecutive semesters, completed their bachelor degrees from the institution within 6 years, identified as a member of an underrepresented group in the sciences, and enrolled into graduate programs, including masters and doctoral level degrees. The majority of the participants who responded for the study were African American and one Hispanic or Latino. Of the 10 selected participants, 5 were African American females, 4 were African American males, and 1 Hispanic or Latino male. Two participants earned their bachelor's degree between 2007 and 2009, four earned their degrees between 2010 and 2012, and four between 2014 and 2016. Five of the participants matriculated immediately into graduate school postgraduation, four matriculated within 3 years, and one after 7 years.

Data Collection—Data collection began in May 2017 and continued through August 2017. Data from multiple sources, including participant interviews, documents from the MRT program, and a reflexive journal were utilized. The use of multiple sources of data adds to the richness of the study and offers a means of triangulating the data gathered in the interviews (Creswell, 2014). Triangulation entails the use of more than one method to gather data, such as interviews, observations, questionnaires, and documents, to ensure study trustworthiness.

Interviews.: In Gibau's (2015) qualitative study, graduate student experiences were explored through narrative data extracted from archived program evaluations. In keeping with a constructivist approach of meaning-making, the researcher of this study captured student narratives from in-depth, individual interviews directly with the participants, not extracted from archived program evaluations. Unstructured, conversational style interviews were used to promote storied responses. Unlike structured interviews that tend to control conversations and skew toward the interest of the interviewer, nondirective interviews are informal and conversation style aimed at gathering in-depth information (Gray, 2009). For this study, each dialogue began with one broad, open-ended prompt, "Tell me about your college experience," to initiate storied responses. As each interview unfolded, nonpredetermined follow-up questions were asked, encouraging continuous narratives and further investigating emerging themes. Examples of follow-up questions or prompts used during the interviews include:

1. Tell me about when your interest in science started.
2. Describe your decision-making process to attend college.
3. Walk me through an event where you believed you were treated differently.
4. Tell me more about the individuals who influenced your decision to attend graduate school.

Due to geographical locations of the participants, individual interviews were performed online using WebEx videoconference software. Interview times varied in length and by participant. Interviews lasted approximately 45 minutes on average.

Archival documents.: The second source of information consisted of documents from the MRT programs' annual progress reports. The MRT program administrator submits progress reports to the sponsoring agency annually during each 4- to 5-year funding cycle (2004–2008, 2009–2013, and 2013–2018). In qualitative research, documents allow the researcher to distinguish patterns with another data source for comparison and triangulation with what participants share about their experiences (Freeman, deMarrais, Preissle, Roulston, & St. Pierre, 2007) contributing to graduation and graduate school enrollment. Progress reports include materials from program evaluations, student participation and research activity, academic achievements, and general program outlook. The researcher compared student narratives with program documents for narrative accuracy and trustworthiness.

Data Analysis—The use of traditional coding and developing themes was utilized to analyze the qualitative database (Stake, 2006). The narrative framework included cross-case

analysis of the codes, themes, and categories. Interviews were recorded and transcribed verbatim. Subsequently, pseudonyms or fictional names were assigned for each participant, and all identifiable information, such as schools, family names, and cities were removed (Kaiser, 2009).

To identify common themes and variations that also represent individual narratives, analysis included cross-case coding (Ayres, Kavanaugh, & Knafl, 2003; Stake, 2006). The individual profiles aided in the discovery of what Seidman (1998) referred to as “connective threads” among the participants (p. 110). During the coding cycle, pattern coding was utilized to connect material across participants into more meaningful units of analysis (Miles & Huberman, 1994). The descriptive codes from each interview were divided into categories according to word and phrase repetitions and organized by hand on a large wall chart. Then, the codes were reduced into the most salient categories relevant to this study. After close examination, several similar themes and events were identified. All categories were combined into the following four meta-categories: confidence as scientist, family influence, belonging and inclusion, and mentoring. Supportive information from the four meta-categories include selected fully illustrative quotes from the participants formatted into conventional paragraphs.

Trustworthiness

Credibility.: According to a constructivist approach, research does not aim at uncovering a scientific *truth* but at exploring the question of meaning in context (Shkedi, 2005). Truth explores the perceptions and understandings of a phenomenon under examination. To ensure credibility of interpretation, the chain of evidence collected during each analytical step was preserved. Preserving all transcribed documents and notes protects the researcher from misleading voices and inaccurate interpretation. In addition, member checking was utilized in which the data and interpretations were presented back to the participants, so that they can confirm the credibility of the information and narrative account (Creswell, 2014). Thus, to ensure findings represent the experience of the participants, the researcher conducted follow-up discussions with participants involving the verification of emerging theories and inferences formed during the dialogues.

Dependability.: Reliability in a positivistic approach examines if a research procedure yields similar results when repeated with the same methods and participants. However, in constructivist research, every narrative claim is unique and may not be replicated at a different time or context (Shkedi, 2005). To address the dependability of this study, however, a comprehensive research design and a chain of evidence in the final report were demonstrated, including data gathering details, and sufficient and accurate citations, allowing the reader to assess the research practices followed (Shenton, 2004; Shkedi, 2005).

Results

Multiple case narratives provide a rich framework in which researchers study how people experience and perceive the world through their stories (Webster & Mertova, 2007). Narratives reveal information about the inner world of the storyteller (Murray & Sargeant, 2011), open a space for researchers to analyze participant experiences related to social issues

(Esin et al., 2014), and explore the social context and culture in which the experience took place and the knowledge constructed (Webster & Mertova, 2007). The cross-case analysis in this study suggested four themes that were consistent for all participants. These themes are as follows: confidence as scientists, family influence, mentoring, and belonging and inclusion.

Confidence as Scientists

Many of the participants described their UR experience in the MRT program as a supplemental form of instruction that enhanced their scientific knowledge, science identity, and success in the classroom. They gained confidence in their ability to conduct science, which influenced their persistence in a science major, degree attainment, and matriculation into graduate programs. In the initial years of college, Anna often felt hesitant of her personal capabilities. She stated, “You know there were times along the way I felt like I could not do it.” However, Anna described how research training strengthened her sense of confidence in the classroom. Anna explained, “I would go into a class and understand what the teacher was talking about because I could see it in real life … I never really knew anything until I started working in the lab.” Lenny acknowledged his UR expe rience as highly impactful during his undergraduate studies and a determinant factor on his decision to pursue graduate school. According to Lenny:

> I got to include pretty much multiple things I’ve learned in undergrad whereas if you don’t do research, you kind of just forget it along the way. You kind of get to learn how to be a scientist and feel like a scientist in undergrad, as far as figuring things out and what not . . . I’ve written abstracts on my own. I’ve done pretty much all my research on my own except use instruments that I couldn’t use alone.

Although Ryan described his UR projects as not as successful as some other students, he “gained a lot of valuable experience seeing the real struggle research can have.” Ryan stated:

> The lab helped me understand that things don’t always work. When starting a new project you will come across walls you have to get through or find other avenues which helped me grow as a scientist. I learned it’s okay to struggle and will struggle and you have to keep moving forward … it taught me the small struggles and an opportunity to do it again correctly.

Patricia described how learning the experiments and doing them correctly changed her perception of science. Patricia shared:

> Before I started research, I thought, ‘This is so intimidating’. But then when I did that I was like, ‘Hey, I can do this. This isn’t bad at all’ … Being able to do the experiments and do them well and correctly and also write the paper was a good experience for me … It was a pivotal moment when I was like I can do this.

Patricia also described her scientific knowledge as *extensively greater* than those who did not participate in research experiences. Patricia stated:

> I can’t explain the divide in the people I see whether be comments on Facebook or just discussions I have with friends on their views on climate change, evolution,

> GMOs … I see a huge, huge difference between me and people who haven't had an extensive research background.

Through exposure to research, Jeremiah attributed his UR experience as an influential factor in pursuing a career centered on research. Jeremiah explained his first research opportunity with protein science and his second opportunity with virology, his new *true passion.* With excitement in his voice, he discussed in depth his research topics. Jeremiah discovered that his true passion leaned more toward a research-focused career with a doctor of philosophy rather than a medical degree. Jeremiah explained:

> I had always focused on becoming a physician, an infectious disease physician, but the thing is that I realized that I actually cared more about life science research, specifically the development of novel therapeutic things of that nature and that obviously skewed more towards getting a PhD rather than getting a MD.

Abigail also described her research experience as an opportunity to "learn new things" and "work with cool instrumentation." According to Abigail:

> I never really knew anything until I started working in the lab. Working in the laboratory provided me with hands on opportunity to learn processes and take my scientific knowledge to a whole another level … Now when I read I actually know what's happening because I've seen it happen. It just adds to a whole new level to knowledge. It increases your scientific knowledge.

Brandon explained how UR gave him a *leg up,* an academic advantage, over other students. When asked to describe his UR experience, Brandon responded:

> If you have any research experience under your belt, you really have a leg up on other students … research provided me with an academic advantage in comparison with other students. I felt more experienced and had more knowledge in application than other students through exposure to different methods and techniques from undergraduate research. It exposed me to things I may not have had the chance to attend or learn and strengthened my resolve to continue into graduate school.

Family Influence

Participants discussed the influence of their family, particularly their parents, on their educational development and motivation to attend college and graduate school. Most participants shared a personal interest in science and a desire to attend college from a young age. Participants shared memories of receiving their first science-related gift from their parents as a child, described a stimulating learning environment at home, and expressed a sense of parental pressure for them to attend college and achieve academic success.

Bethany reflected on her childhood as growing up "in the heart of the city, the poor area of town." According to Bethany,

> Where we grew up one of two things could happen; some people can get into that life and think that's all they can do or they could say their life is not what they want it to be and choose to fight against it.

Despite financial hardships, Bethany reflected on the positive influence her family had on her educational success. According to Bethany:

> I would say for me and my siblings we chose to not stay, and I would attribute that to being … that my parents said, 'Get out of this … you don't have to stay like that' … My parents instilled in us education is important. They pushed that we would go to college and do well in school. My parents were like, 'You need to get an education, you need to get some type of training'. My family pushing education as being very important is the reason why I'm here.

Patricia discussed how education and learning were strong foci in her upbringing at home. Patricia shared how her mother would only buy her and her sisters educational toys and encouraged learning things outside of what they would normally consider. Patricia shared:

> Science was not a shock to me. Science itself was never like 'this is really cool' because we were always exposed to it in childhood. My mom would buy us chemistry sets, microscopes, and telescopes … that's probably what sparked my interest in science at a young age.

When it came time to attend college, some participants expressed a sense of parental pressure on them to pursue college and achieve academic success. These participants described college as "not an option" in their homes but rather as a preaccepted continuation of their education. Jeremiah shared, "My parents they, you know, kind of laid down the law. They said that there was no option for me other than to go to college." Similarly, Elizabeth stated, "It wasn't an option in my house. My mother was always like you need an education and it's good for you." Anna also expressed, "The decision to go to college for me, uhm,… was not an option. My parents wanted me to go to college." The family influence continued throughout their undergraduate studies.

Participants also described supportive attitudes and motivation from their parents when they were thinking about graduate school. During the interview, Abigail discussed her support and influence family had during her undergraduate studies and decision to continue into graduate school. Abigail stated:

> My family, especially my parents, were supportive of me. Whenever I talk about anything or scientific to them I can see the excitement in their eyes. I know they want this for me so bad. They wanted it just as bad if not more than I did so they had a really big influence on me.

Although Abigail felt she "would have done it anyway," seeing the excitement of her parents became a source of further motivation. Abigail stated, "Their involvement and excitement encourages me to do it even more."

Brandon also explained the strong influence his mother had on his decision to pursue a graduate degree. Brandon stated,

> My mother recently received her PhD … Watching her return to school was a strong influential factor that pushed me to succeed and continue into graduate school … [she] was a big influence and motivator and kept pressing me on.

Brandon described his mother as an inspiration and motivator for persistence into graduate school.

Mentoring

Participants also discussed the influence of mentoring relationships on their academic training. Anna described her support network as a "community of mentors" ranging from MRT program staff to faculty, and to fellow student peers. Anna shared:

> The college path was not an easy journey. My parents did not attend college and so it was hard to navigate exactly what I wanted to do. I didn't know what to major in or what majors were available outside of doctors, lawyers, and teachers … I got involved with basically the whole community of mentors and the guidance got me where I am here today … Through the fostering of mentors and the support group of people knowing I can do it really helped me get through the process. Of course, I had my parents in the background saying you can do it, you can do it, but I couldn't go to them for technical stuff. So, it took the people in these programs to deal with issues, deal when people who told me I couldn't do it because I couldn't pass physics.

Jeremiah described his participation in the MRT program as a pivotal point in his career and academic training. Jeremiah explained how the program offered opportunities to seek advice and support. Jeremiah stated:

> I felt I needed more of an individualized experience in order to fully realize my talents. That is why I viewed the programs as incubators … They like push you forward and give you personalized advice and incentives and they're kind of pushing you along to realize that dream of becoming a scientist.

Abigail credits her mentors and MRT opportunities for being where she is today in her academic and career development. She described how mentors impacted her decision to pursue graduate school. Abigail explained:

> I finally came up with that conclusion because a lot of people helped me and kind of introduced me to research, mentored me all along the way from freshman year you know and all way until I left. And you know that really impacted me in a positive way because I was like I want to be like y'all.

Not only did the mentoring she received throughout the years influence her decision to attend graduate school but also to "be a role model or be that person for somebody else while at the same time doing the research."

Participants, including Anna, Patricia, Bethany, Abigail, Ryan, Elizabeth, and Lenny, described the interactions with fellow graduate students from the laboratory as a major source of encouragement, guidance, and socialization. For instance, Abigail stated, "Everybody [graduate students] from when I started to the time I finished I was so nurtured and gave all the help I needed" and "As I became a more advanced student, I started discussing life with the grad students, you know, with navigating grad school and what I should look into." Ryan described limited interactions with the principal investigator of the laboratory and stated, "It was the graduate students I spent most of my time with. They

taught me the instrumentation." Lenny described the limited level of interactions between him and his research advisor. Lenny shared:

> When I went to him for questions he was like, 'Did you follow the policy? Did you ask three other people [graduate students] before you come in?' … I started collaborating with the graduate students, you know, and got my project off the ground. We worked together as a team supporting each other.

Belonging and Inclusion

During the interviews, participants discussed feelings and events pertaining to their sense of belonging when they first arrived on campus and throughout their college experience. Some of the students expressed feelings of *shock* and isolation when transitioning from a smaller or more diverse high school to the large predominant white institution campus. Ryan explained how going from a high school graduating class of 45 students to a biology course with 900 students was "pure culture shock" and a "very difficult transition." Ryan shared,

> The environment wasn't bad but coming from a small school, it was a hard transition … Especially the use of computer-based testing and limited teacher interactions because of the large classroom size. This was a big shift I had to overcome.

Anna, who described her high school as rich in diversity with individuals from different ethnicities and religions, did not witness the diversity she was familiar with in high school and at times felt isolated. Anna stated:

> One thing that did got me at the end of the day was when I walked into a classroom and only seeing myself as one of the few minority students. Or in my chemistry classes I may be the only minority student. Sometimes I thought of it as a great way to defy the odds but then I really had no one that can relate to me. There were in their cliques and friends and I was often on my own trying to figure out things, you know.

Charles explained how the small classroom environment in his animal science program was beneficial at times but also produced feelings of exclusion. Charles stated:

> You know there weren't many black people in my program so I knew every black person in my program. It was different because sometimes I had to wear boots and overalls [laugh] and mess with horses and pigs and stuff. So that was cool and different. It was a double edge sword. On one hand, you knew every person you can relate to because they look like you so you can study together. But at the same time there wasn't a whole bunch of people willing to study with you.

When asked how this experience impacted him, Charles responded, "I don't know. It's [pause] hard. I don't think it impeded me but I never thought about it. I never truly felt ostracized or discriminated against but I think it was a different layer of school." Although Charles never felt direct discrimination, he sometimes felt unwelcomed or excluded by classroom peers.

In addition to feelings of isolation from fellow students, alumni experienced incidents of racial microaggressions from various faculty and staff, particularly students from the two earlier cohorts that earned their bachelor degrees between 2007 and 2009 and 2010 and 2012. Although Anna shared how she never experienced any negative interactions with fellow students, she discussed how interactions with university personnel were not as supportive. Anna stated, “I did experience issues with faculty and staff with them paying more attention to my white counterparts. It was frustrating and discouraging at times.”

Elizabeth shared details of being treated differently in comparison to White students by two different faculty members. Elizabeth shared:

> In one of my chemistry classes I asked a question and rather than my professor answering my question he said he doesn’t like repeating himself. So, after class I went up to him and asked for further explanation. He apologized and explained what I didn’t understand. Another chemistry professor, he said we can go to him if we had any questions about graded exams. I went to him because he marked a question incorrectly based on what his notes said. Instead of him acknowledging he is at fault he started questioning my priorities. It wasn’t like I was a terrible student because I had an A in his class.

Although participants expressed feelings of exclusion and incidents of micro-aggressions, they also discussed a positive sense of belonging and inclusion after participation in UR. In contrast to the classroom and general campus climate, many participants spoke of the research laboratory as a welcoming and friendly environment. Lenny stated:

> I loved the lab environment. I felt welcomed as soon as I joined … My advisor told me to make myself at home. When I arrived to the lab my advisor, he just sent me over so I had to introduce myself to all the graduate students and they all welcomed me.

Lenny described the laboratory as his *social network.* He explained how the laboratory provided a space for friendships with fellow students. Lenny stated, “I didn’t have many friends in college. I saw other students in my classes but it was my lab mates I enjoyed being around.”

Bethany described that socializing during her undergraduate years mostly involved her research experience in the laboratory. With a large smile, Bethany expressed her experience in the research laboratory as *wonderful.* She worked directly with her research mentor, doctoral students, and research technician. Bethany claimed, “They took me under their wings. They really took care of me. If I had any questions, I could ask anybody. I really loved my experience.” Elizabeth described the laboratory as a safe, inclusive environment of diverse students. Elizabeth stated:

> I stayed in a bubble. I had a very routine schedule. I would go to classes and then the lab I did research. The lab was very diverse with people from different countries. I never felt out of place. Everyone was supportive and encouraging. On campus, I felt like a minority and became accustomed to.

Discussion

Participants expressed their perceptions and experiences starting with their decision to attend college, continuing throughout their undergraduate studies and their path to graduate school. The conversation style interviews explored past experiences, the core of their scientific interest, their confidence in their ability to pursue a career in science, their sense of belonging, influential individuals, and future aspirations. The interviews examined student stories and factors that influenced the students' career and academic paths they chose. The cross-case analysis identified four common themes that addressed the following research questions: What are the experiences of students who participated in a MRT program? Which experiences were most critical to their persistence into college and matriculation into graduate school?

The emerged themes from the cross-case analysis support Lent, Brown, and Hackett's (1994) social cognitive career theory (SCCT) and Hurtado, Milem, Clayton-Pedersen, and Allen's (1998) campus racial climate model (CRCM). SCCT, based on Bandura's (1986) social cognitive theory and Hackett and Betz's (1981) career self-efficacy model, suggests that the three personal tenets of self-efficacy, outcome expectations, and interests interact with external factors to shape a person's career goals and actions. SCCT explores how career and academic interests mature, how career choices are developed, and how these choices are turned into action. In SCCT, career interests are shaped by self-efficacy, a measure of how successful a person believes he or she will be at completing a particular task or meeting a goal, and outcome expectations, defined as beliefs related to the consequences of performing a specific behavior (Lent et al., 1994). Self-efficacy and outcome expectations influence an individuals' personal agency for self-directed learning, motivation, and goal setting in guiding personal behavior.

To persist in the STEM disciplines, students must believe that they are capable of successfully completing the required education and training and implementing the learned skills once in the field. The participants expressed increased confidence in their knowledge and skills in science after participating in UR experiences, as well as enhanced ability to overcome other nonscientific obstacles. Participants discussed not only enhanced knowledge in instrumentation, data acquisition, correlation of classroom concepts to real-world applications, independent thinking but also the ability to handle life challenges and barriers. Participants also shared how research provided the opportunity for them to apply classroom knowledge to laboratory experiments. Furthermore, they believed research enhanced their research skills, personal development, and relationships and facilitated a smoother transition into graduate school.

Literature suggests the positive effects of UR on the development of student attitudes and their level of competence in the scientific disciplines. Studies found UR strengthens cognitive factors, including confidence and self-efficacy (Craney et al., 2011). Parham and Austin (1994) suggested individuals are more likely to pursue careers based on how well they can adapt and be successful in a field of study. Subsequently, increased students' confidence for science careers increases the probability that students will persist in a science major, reach degree completion, and continue into graduate programs.

However, an initial contradiction emerged with this theme. Unlike disconfirming evidence, a systematic process often utilized in data validation, inconsistencies in narratives can transform ambiguity into meaning (Watson, 2006). In this study, all participants shared feelings of confidence in their knowledge in science; half of the participants, however, shared behaviors of comparing themselves to gain self-evaluation of their abilities. Patricia stated, “I see a huge, huge difference between me and people who haven’t had an extensive research background.” Brandon claimed, “If you have any research experience under your belt, you really have a leg up on other students. It puts you ahead of people who didn’t have research experience.” He further explained, “I felt I had more experience and knowledge in application than others.” Anna shared, “My scientific knowledge on the undergraduate level was very high compared to my counterparts because I would go into a class and understand what the teacher was talking about because I could see it in real life.” The participants’ behavior of comparison may not be a contradiction of self-confidence but rather a practice of competition often adopted in educational settings. According to Noddings (2013), capitalism in a social system occurs when there are limited resources and individuals compete for those resources by surpassing others to improve one’s self as a means of social mobility. As with a capitalist economic system, America’s college and public school systems are embedded with competition (Noddings, 2013). The participants likely felt confident in their scientific knowledge and skills and express learned behaviors in a highly competitive environment.

STEM-based educational programs serve as environmental factors supporting a student’s career development, but other external factors have shown to provide a supportive effect on student career decisions. For this study, participants expressed a strong support system from peer mentors and family members, mainly their parents. According to SCCT, career development is also influenced by objective and perceived environmental factors. According to Lent, Brown, and Hackett (2000), other contextual factors impacting a student’s career decision may include perceptions of social supports, mentors, science educational programs, and family expectations. For example, supportive research mentors, classroom environments, family support, and socialization with peers all influence a student’s level of self-efficacy.

Numerous studies indicate that students who develop an informal mentorship relationship with faculty through UR experiences have significantly higher degree aspirations (Carter, 2002; Craney et al., 2011; McGee & Keller, 2007). Close mentoring relationships with faculty also positively impact academic performance, attendance, and satisfaction among student participants (Kim & Sax, 2009; Linnehan, 2001; Tenenbaum, Crosby, & Gliner, 2001). However, in this study, participants spoke of the mentoring and caring relationships they experienced in the laboratory with fellow students, not with the faculty. In fact, some students discussed that they had limited to no interactions with their research advisors. The student narratives indicated that the practice of peer mentoring was an influential factor for student success and graduate school matriculation. Peer mentoring involves the collaboration between individuals of similar age, educational background, laboratory experience, or with slightly different parameters (Edgcomb et al., 2010). The use of peer mentoring between graduate and undergraduate students to complement faculty mentoring optimizes the research experience and establishes a more accessible collaboration and support system for MRT program participants.

Previous studies also support the value of family involvement and support in a student's college persistence (Cleaves, 2005; Russell & Atwater, 2005). Stake and Mares (2005) found that the encouragement from family, teachers, and peers of participants of a summer science program was linked to a student's attitude toward science and their scientific abilities. Thus, Stake and Mares (2005) argued that the absence of support and involvement from significant people, such as family and friends, can reduce a student's feeling of self-efficacy and the student will be less likely to pursue a science career. Mattanah, Brand, and Hancock (2004) found students, particularly among first-generation students, who enjoy a secure relationship with parents who are supportive of their pursuit of higher education, demonstrate higher levels of satisfaction during their college experience. Slovacek, Jacob, and Flenoury (2015) found academic interventions, such as research experiences and academic support, paired with parental support and outreach, facilitate successful college transition and degree attainment for underrepresented populations.

While involvement of support systems by mentors, family, and peers may boost a student's feeling of self-efficacy, perceived barriers, such as socioeconomic status and poor campus climate, may create negative outcome expectations (Lent et al., 2000). Thus, according to SCCT, researchers must consider multiple aspects of the objective environment as well as how students perceive and respond to surrounding environmental factors. Since SCCT provides a broad conceptualization of persistence, exploring a theory that captures the unique experiences of URM students is imperative. Hurtado et al.'s (1998) CRCM discusses how structural and psychological dimensions of a campus influence students' persistence into college, specifically among underrepresented racial and ethnic groups.

According to Hurtado et al. (1998), a campus' racial climate is defined with four interrelated dimensions: (a) structural diversity, (b) perceptions and attitudes between racial groups, (c) institution's history of inclusion or exclusion, and (d) the behavioral climate. The structural diversity, the numerical representation of racial and ethnic groups on a campus, impacts the social adjustment and academic success of URM students. Greater diversity on a college campus creates more opportunities for interracial interactions and enhances college learning for all students.

However, structural diversity alone is not the only factor colleges and universities should consider in establishing a welcoming environment for URM students. Hurtado et al. (2009) also examined the psychological climate, defined as the perceptions and attitudes between racial groups and hostile behaviors students encounter, as influential factors impacting URM student persistence in college. Hurtado and Ponjuan (2005) found that Hispanic or Latino/a students who perceived a college campus climate as hostile reported a lower sense of belonging and college persistence. However, those who experienced stronger and larger numbers of interracial interactions reported a greater sense of belonging. Although none of the participants of this study shared hostile behavior, they did share incidents of racial micro aggressions and exclusion from peers and faculty on the general campus. However, participants of the MRT program also shared a sense of belonging once they joined a research laboratory. They defined their research laboratory as a welcoming environment involving graduate students from diverse backgrounds.

Participants emphasized the laboratory as a welcoming environment and a source of guidance and support. This common theme affirms that the experience of a supportive and welcoming environment in the laboratory indicates an influential factor in student persistence in their major and into advance levels of education. Researchers argue URM students lack mentoring, peer support, and encounter unwelcoming classroom climates, particularly African American students (Carnevale et al., 2011; Sasso, 2008). However, participation in research projects diminishes ethnic isolation (Gasiewski, Garcia, Herrera, Tran, & Newman, 2010; Villarejo, Barlow, Kogan, Veazey, & Sweeney, 2008). (Bauer and Bennett, 2003) found UR provides students with a rewarding learning environment promoting self-discovery, self-expression, and appreciation of artistic, cultural, and creative differences. The participants in this study expressed similar feelings of ethnic isolation but developed a sense of belonging and support within the research laboratory.

Implications for Practice

This study suggests changes necessary to the academic success of URM students in STEM disciplines, including improvements to MRT program components and campus climate, enhancing student persistence in degree attainment and matriculation into graduate programs. First, there is a continuing need for a holistic institutional change. Participants shared incidents of exclusion and microaggressions by fellow peers and faculty outside of the laboratory, especially earlier cohort participants. The fewer number of incidents of exclusion and isolation reported by later cohorts indicates an evolving change in the campus climate due to multiple university diversity initiatives that need to continue. Furthermore, universities and MRT programs should implement additional diversity efforts, particularly at the level of sensitivity training, cultural competence workshops for both students and faculty, and recruitment of diverse students, faculty, and staff. Promoting systematic changes on how institutions respond and value diversity will facilitate a welcoming and nurturing environment for the entire college community.

Student narratives revealed valued social and professional relationships with other students, particularly graduate students, during their research experiences. Participants expressed that mentoring relationships provided guidance and encouragement as they progressed through their undergraduate studies and applied to graduate programs. As principal investigators of laboratories are often absent from the laboratory, the use of peer mentoring increases mentoring accessibility from diverse students. URM students should be exposed to enriched research experiences, so research should be supported at the college level, where diverse group of students work together and collaborate on research projects.

Participants in this study expressed challenging transitions from high school to a university setting. To facilitate a smoother transition to college academic life, there is a need for programs providing incoming freshmen with academic skills and social resources needed to succeed in a college environment. Scholars need to be introduced to the structure and rigor of a research university and provided with opportunities to foster meaningful academic and social connections. This could be addressed with enhanced college or university outreach activities, fostering of programs and visits to the campus, summer bridge experiences and activities, and continuing education classes for the community.

Furthermore, participant narratives revealed early exposure to science and family influence as major motivations in college persistence and graduate school enrollment. Encouraging family involvement in a student's academic journey offers invaluable benefits for students at all levels. Implementing community outreach activities to local K-12 children may spark interest in science and encourage college enrollment. Furthermore, encouraging parental involvement during undergraduate studies through invitations to research presentations, meetings, and laboratory tours creates an impactful supportive and motivational network for URM students.

Limitations of the Study

As with all methods of inquiry, this study has limitations. Although qualitative interviews are attractive for collecting detailed information, the primary source of data for this study relied on participant openness and accuracy. Social desirability bias, the tendency of an interviewee for presenting himself or herself in a favorable way rather than providing truthful answers, may alter validity of participant narratives (Fisher, 1993). The interviewer served as the program coordinator for the MRT program and worked with the participants while they were enrolled in the program. Thus, interviewer-participant rapport was easily reestablished. Building trust and rapport, the degree of comfort in the interactions between the researcher and research participants, enables the researcher further access in the study and determines the success in qualitative inquiry (Glesne, 2011). However, participants may have felt obligated in providing favorable narratives of the MRT program. Involvement of an external researcher may help diminish social desirability bias through increased anonymity.

Another limitation involves personal bias and subjectivities of interviewers themselves. Preexisting subjectivities of the interviewer may cognitively filter the representation of data. However, unlike the positivism paradigm, recognizing one's subjectivity is important in qualitative research and can lead to a more passionate and personal research (Glesne, 2011).

To document personal subjectivities, create transparency in the research process, and practice critical self-reflection in this study, a reflexive journal was maintained. The journal served as a map to the evolving understanding role of the interviewer, interpreter of data via interviews, and theoretical justifications (Glesne, 2011). In addition, open-ended questions were utilized, allowing participants to freely express their experiences while minimizing any personal thoughts and previous findings by the researcher (Creswell, 2014).

Conclusion

The results from this study provide personal narratives of participants of a MRT program on their science degree attainment and persistence into graduate degree programs. Each case provided personal and unique experiences and shared commonalities with other cases. The participants expressed a sense of belonging and inclusion in their research laboratories, supportive relationships with other student researchers and MRT program staff, enhanced scientific knowledge and self-confidence from research experiences, and family support. All of these factors influenced their persistence into college, degree attainment, matriculation into a graduate program, and career path. The results of this study support SCCT and CRCM in which the involvement of support systems structural diversity and psychological climate

of a campus impacts students' sense of belonging and college persistence, specifically among underrepresented racial and ethnic groups.

Based on findings, the study suggests a number of factors that are important to the academic success of URM students in the STEM disciplines, and potential improvements to institutional and MRT program activities aimed at enhancing student persistence into graduate programs. These include improvement of campus climates and diversity, utilization of peer mentoring, expanding research opportunities, and sustaining family and community involvement on campus activities. This study adds student voices to the current literature supporting MRT programs as effective intervention influencing positive outcomes for URM students pursing and achieving doctoral degrees. With this information, institutions and education programs may provide or improve support and resources needed to better serve URM students with science majors and enrich minority representation in academic or industry research careers.

Acknowledgments

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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