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Feeling Different: An examination of underrepresented minority community college students' major persistence intentions through the lens of STEM identity.

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ABSTRACT

Feeling Different:

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Community colleges play a key role in serving the higher education needs of students in this country. This includes more than 40% of all Bachelor Degree graduates in science and engineering and approximately 50% of all students from traditionally underrepresented minority groups. While it is well known who attends community colleges and who majors in STEM, the role community colleges play in the decisions of underrepresented minorities to pursue Bachelor's degree in STEM fields is not known. The goal of this research was to better understand the role the community college environment plays in URM students' academic and social integration on campus and their college and STEM major persistence intentions. In this study, a STEM identity model was used to make sense of the STEM experiences of eight underrepresented students in community college. The findings of this study include: (1) guidance and support was a significant input to academic and social integration for all participants and influenced identity integration for some participants; (2) altruism emerged as an important part of STEM identity and persistence intentions of participants; (3) inclusion and exclusion were important to STEM identity development and overall identity integration, academic and social integration, and ultimately informed participants' persistence decisions.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	v
DEDICATION.....	vi
LIST OF FIGURES.....	vii
CHAPTER 1: INTRODUCTION.....	1
Statement of the Problem.....	4
Purpose of the Study.....	4
Significance of the Study.....	6
Overview of the Conceptual Framework.....	7
Overview of Methods.....	8
Researcher Perspectives.....	9
Assumptions.....	10
Definitions of Terms.....	11
Summary.....	12
CHAPTER 2: REVIEW OF LITERATURE.....	13
URM Student Experiences.....	13
The Culture of STEM.....	13
Underrepresented Minorities in STEM.....	15
Identity Development.....	16
Persistence.....	24
Persistence in Higher Education.....	24
Persistence in STEM.....	30

A model for examining persistence of students in STEM.....	32
Summary.....	38
CHAPTER 3: METHOD	39
A case for Qualitative Methods.....	39
Methodology.....	43
Setting and Participants – Nature of the Sample.....	44
Data Collection.....	47
Observations.....	47
Interviews.....	47
Data Analysis Procedures.....	49
Validity and Reliability.....	53
Summary.....	54
CHAPTER 4: ANALYSIS AND FINDINGS.....	55
Participants’ Profiles.....	55
Participant Responses Organized by Conceptual Framework.....	61
Identity.....	63
Identity Integration.....	69
Environment.....	73
Integration.....	76
Persistence Intentions.....	84
Overview of Findings.....	90
Findings 1: Guidance & Support.....	91
Findings 2: Altruism.....	93

Findings 3: Inclusion.....	95
Summary of Findings.....	99
CHAPTER 5: Discussion and Conclusions.....	101
Discussion of Findings.....	102
Question One Discussion.....	102
Student Services & Support Programs.....	103
Singular status of URM students in STEM courses.....	106
Academic group work.....	107
Summary.....	107
Questions Two Discussion.....	108
STEM identity.....	109
Racial/Ethnic Identity.....	110
Gender Identity.....	111
Summary.....	112
Question Three Discussion.....	113
Academic Integration.....	113
Social integration.....	114
STEM persistence.....	116
Evaluation of model.....	117
Conclusions.....	118
Identification of Researcher Bias.....	121
Limitations.....	122
Implications for practice.....	123

Implications for future studies.....	124
Concluding Remarks.....	124
REFERENCES.....	126
APPENDICES.....	139
Appendix A: Recruitment Script.....	139
Appendix B: Observation Protocol.....	140
Appendix C: Interview Protocol.....	145
Appendix D: Consent Forms.....	153

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DEDICATION

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LIST OF FIGURES & TABLES

Figure 2.1: Integration Continuum.....	29
Figure 2.2: Integrated Identity.....	33
Figure 2.3: Disintegrated Identity.....	34
Figure 2.4: Science Identity.....	35
Figure 2.5: Identity Development model for academic and social integration.....	36
Table 3.1: Student Participant Characteristics.....	46
Figure 3.1: Initial Coding Structure.....	51
Figure 3.2: Final Coding Structure.....	52
Figure 5.1: More complete identity development model for academic and social integration...119	

CHAPTER 1

INTRODUCTION

Increasing the number of students participating in science, technology, engineering, and mathematics (STEM) is critical to national interests. In 2005, the National Academies of Science called for an effort focused on increasing the number of workers for scientific fields, thus bolstering U.S. global competitiveness and stopping the exportation of high-skilled STEM jobs (Augustine, 2005).

At a time when STEM fields are increasingly important to our national security, health and competitiveness, we are neither supporting the research nor producing the diverse pool of scientists and engineers we need to fuel our future... Beyond the obvious logic of numbers—the more people in a field, the more likely it is that talented practitioners will appear—research suggests that a diversity of perspectives enriches science and makes engineering more responsive to a global pool of clients. (Chubin & Malcom, 2008, para. 1 – 2).

To achieve this increase in the STEM workforce, it is necessary to diversify the STEM fields, taking advantage of the rich resource that members of traditionally underrepresented groups have to offer. If we want to attract and retain students from underrepresented groups, we need to better understand how they experience the process of becoming scientists (Hurtado et al., 2009). Only through this understanding can higher education institutions and STEM disciplines be able to design and implement programs that will bring talented URM students into STEM major programs of study.

In a 1998 survey of students graduating from high school and enrolling in college, approximately one third of all students had intentions of majoring in Science and Engineering

(Mendoza & Johnson, 2000). Interestingly enough, this percentage varied little across gender and racial groups (Asian Americans being the only exception with more than 40% intending to major in STEM). Degree completion rates, however, are not so uniform. Only 24% of African American, Latina/o, and native American first-year students are retained through graduation, while more than 40% of their non-minority counterparts graduate (Center for Institutional Data Exchange Analysis, 2000). To fully understand the disparity in these numbers and the complexities of diversifying STEM fields, it is necessary to understand more about how underrepresented students experience undergraduate STEM programs and the processes by which these students either become or reject becoming scientists and engineers.

In a 2001 report on diversifying STEM, the American Association for the Advancement of Science (AAAS) emphasized the need for research examining the teaching/mentoring and learning interactions between college and university faculty and underrepresented students in STEM, and the institutional and STEM departmental culture impacts on students' experience (George, Neale, Van Horne, & Malcom, 2001). Such research is needed to enable the creation of a scientific research culture that will recognize and value the knowledge and perspectives that URM bring to the enterprise. One of the most important questions needing to be answered is: how will we interest students from traditionally underrepresented groups in pursuing STEM careers, especially those with high ability?

In their review of research on URM in STEM, the AAAS report found that studies do not examine the full spectrum of colleges and universities, mostly focusing on "Research Extensive" and "Research Intensive" universities, with few looking at community colleges (George, Neale, Van Horne, & Malcom, 2001, p. 6). Community colleges enroll close to half of all students from groups traditionally underrepresented in STEM (Mendoza, & Johnson, 2000). Moreover, 44% of

all science and engineering graduates attend community college at some point in their educational trajectories (Tsapogas, 2004). Consequently, community colleges are poised to play a critical role in setting more students from underrepresented groups on the path toward careers in STEM, and there is a need to better understand the experiences of STEM community college students, in particular students from traditionally underrepresented groups.

In the last ten to fifteen years, studies have identified factors that affect undergraduate retention, including instruction, culture, academic support services, and social climate. For example, studies of African American, Latina/o American, and American Indian undergraduates indicate that social support and university comfort are the strongest predictors of student attrition/persistence (Gloria, Robinson Kurpius, Hamilton, & Wilson, 1999; Gloria & Robinson Kurpius, 2001; Gloria, Castellanos, Lopez, and Rosales, 2005). Espinosa (2011) found that “college experience and college environment were paramount relative to high school performance and family background characteristics” (p.231) in their impact on the persistence of women of color in STEM fields. With this in mind, the fact that URM STEM majors often describe their experiences as isolating, and the community of science as cold and unwelcoming, now known as a “Chilly Climate,” (Malone & Barabino, 2008; Wasburn & Miller, 2006; Seymour & Hewitt, 1997; National Council for Research on Women, 2001), it is no surprise that URM students often switch majors (Astin, 1993).

This study will provide a first look at issues faced by URM STEM students pursuing degrees at community college, leading to a better understanding of what role, if any, community colleges play in the decisions of URM students to enter, continue in, or leave their STEM majors as well as discovering what factors have bearing for college persistence. The use of science identity provides a means for making meaning of the distinctive experiences of students in

different majors and from different backgrounds as well as the influences of gender, race, and ethnicity (Carlone & Johnson, 2008). It is anticipated that understanding the ways and contexts in which students take up, reject, and/or transform their STEM identity will shed light on the impact of the community college environment has on the persistence intentions of URM students pursuing STEM.

Statement of the Problem

Most of the research on college students in STEM has focused on four-year institutions, even though more than 40% of all US undergraduates are enrolled in community college (Planty, Hussar, & Snyder, 2009). Over 35% of students enrolled in the nation's community colleges are students of color (NSF 2009) compared to 28 percent in 4-year institutions. The role that community colleges play in the production of STEM majors, and in particular in the production of URM STEM majors, is still not well understood. Though we know that factors such as minority support, culture, instruction, and social climate, among others, influence undergraduate URM STEM experiences, we do not know *how* these factors impact student experiences at community college, either promoting or inhibiting degree completion and effective transition to STEM majors at Bachelor of Science degree-granting colleges and universities (George, Neale, Van Horne, & Malcom, 2001). Community Colleges play an important role in the education pathways for many URM in STEM, yet the experiences of students in these environments are largely unstudied (Ong et al, 2011).

Purpose of the Study

The intent of my research is to examine the STEM culture on community college campuses in order to understand the role this environment plays in URM students' academic and social integration on campus and their college and major persistence intentions. Using the lens

of social identity development in STEM students, this study will examine the benefits and challenges students experience in community college STEM degree programs and how these experiences either foster or stifle the STEM identity development and impact the educational goals of these students, with a particular interest in the experiences that promote or discourage URM student engagement in STEM. This study was conducted with the goals of understanding: (1) how the community college environment influences STEM student experiences and persistence intentions. (2) What academic and social integration looks like for STEM students at community college? (3) Through what processes does academic & social integration impact STEM student major/career commitment? (4) How are the impacts of academic and social support upon students' persistence decisions complicated by major culture, stereotype threat, and/or cultural incongruence? (5) How participation in science education either promotes or impedes a sense of STEM identity and scientific self-efficacy in URM students? And, (6) how do these students make meaning of their experiences?

To achieve these goals, this study will examine a particular situation: being an URM STEM student in community college. The method of inquiry is a phenomenological approach designed to elicit a clear and complete understanding of *how* URM students experience STEM in community colleges. The study will focus on examining how these students interpret and experience the process of becoming scientists, engineers, mathematicians, and technicians at their community college. This study will be guided by the following research questions:

1. What are the developmental experiences of community college STEM students?
2. How do URM community college STEM students perceive their own identity?
3. How do URM community college STEM students describe their academic and social integration and persistence intentions?

Significance of the Study

Studies examining college STEM identity development have focused exclusively on baccalaureate and graduate degree granting institutions (Hurtado et al., 2009; Carlone & Johnson, 2007; O'Connor et al., 2007; Tonso, 2006). Similarly, studies of persistence in STEM tend to focus on students who begin their undergraduate education at four-year institutions. While it is important to understand issues of attrition from science in four-year institutions, attrition of high ability minority students from mathematics, science, and engineering who begin their undergraduate education at two-year colleges is even worse (Pascarella & Terenzini, 2005). The past decade of research shows that those students who transfer, when compared to those who do not transfer, are more likely to have been academically and socially integrated in their two-year college (Pascarella & Terenzini, 2005). But academic and social integration looks different at community college than at four-year institutions. As commuter campuses with older student bodies and a greater number of part-time students, students in the classrooms have difficulty creating the kinds of peer-groups that facilitate involvement (Astin, 1993). Likewise, because students are pulled off campus by family obligations, work at outside jobs, and often attend night or evening classes, it is unclear what role the faculty, student support services, and campus programs play in the persistence decisions of these students (Astin, 1993). This presents a need for further research into the experiences of URM students in community colleges.

The lack of research on URM in STEM represents a significant gap in the literature. Few studies in STEM education have examined why URM students choose to engage in or choose to avoid learning science. Furthermore, when examining the experiences of women of color in STEM research settings, Malone and Barabino (2008) found that the issues of race and ethnicity were more important to their participants than issues of gender, making the need for additional

research in the area of ethnic and racial minorities in STEM quite urgent. Not only is there a general lack of research in the area of racial and ethnic minorities in STEM, very little of the research has dealt with student identity development, and its influence on science learning (Brown, 2005) and STEM major persistence.

Overview of Conceptual Framework

The concept of institutional integration has become a foundational theory of college persistence (e.g. Astin, 1993; Tinto, 1993; Nora & Cabrera, 1996; Pascarella & Terenzini, 2005). Furthermore, the concept of STEM identity has received growing attention in science education literature (e.g., Brickhouse, Lowery, & Shultz, 2000; Tonso, 2006; Carlone & Johnson, 2008; Hurtado et al., 2009). This study links the two—STEM identity and institutional integration—to explore and understand STEM student persistence intentions. Situated within the context of the educational institution and degree programs, student experiences within the STEM classroom, interactions with meaningful STEM others, and participation in STEM activities and practices inform student identity development as well as her/his academic and social integration.

The construct of identity (whether academic, ethnic, gender, or science) is dynamic (Nasir & Saxe, 2003). The ongoing process of positioning that occurs within the educational context has important implications for student's identity and integration (Malone & Barabino, 2008). This study uses a model of socialization and identity development to examine students' persistence intentions. Students who cannot forge integrate identities (when their STEM identity is successfully integrated with their academic, racial/ethnic, and gender identities), will fail to fully integrate with their major, and will leave STEM. Likewise, students who successfully integrate their identities will engage with their major and persist in STEM. This framework

provides a theoretical and methodological lens through which data may be interpreted to make meaning of students' experiences and intentions to persist in or leave STEM.

Overview of Study Methods

Qualitative tools are more appropriate than quantitative tools when trying to understand the influences on students' college experiences (Pascarella, 2006). While the quantitative tools can indicate a causal linkage between influencing factors and educational outcomes, qualitative approaches are necessary to provide the understanding or explanation of the processes and mechanisms underlying those causal linkages (Pascarella, 2006). The thick description that comes from qualitative methods presents the means through which experiences can be understood within the context of a particular setting or environment. Simply looking at comparisons of students before and after some intervention or interaction cannot tell us what influences the changes students experience during the process of that experience (Stevens, et al., 2007), therefore qualitative methods must be used to explore and understand how students are influenced and impacted by various interactions and experiences.

I am interested in how students make meaning of their experiences. As such, semi-structured, in-depth interviews will be used as the primary method of data collection. From the interviews I hope to learn about the participants' "thoughts, memories, experiences, and actions related to significant people and events that they deem have played central roles in their... experiences in science, that have framed their relationships with science, and [that have] shaped their perceived science identities" (Creasy Fowler, 2010, p. 9). What are the students' perceptions of belonging in the field? What challenges do they face on a day-to-day basis? What do they find most rewarding and most challenging about their selected field of study? What was their inspiration for pursuing STEM? And, what—if anything—causes students to

consider leaving STEM? This study will use the participant's voice to explore the social reality of the interviewees and the cultural scene (in this case, of URM status within a STEM major at community college) that he or she inhabited (Malone & Barabino, 2008).

Researcher Perspectives

As a woman in physics, I have experienced, first hand, the lack of diversity in science and the feelings of exclusion that often come from being the only woman in a class or laboratory. Though strides have been made in some areas (notably undergraduate Biology), many fields (such as Physics, Computer Science, and Engineering) continue to struggle with diversity. The scientific community is failing to cultivate the scientific and technical talents of all of its citizens. As a result, the scientific community lacks the varied perspectives, questions, and methods that a diverse community provides. As a teacher, I have witnessed students in the position of the only African American or the only Latina in class. I want to reach out to students so that they never feel the lack of inclusion that I felt, to instill in them a love of science and a sense of belonging within STEM that would carry them forward to achieve their goals.

At the time of this study, I was employed as a faculty member in a community college, where I served both as a physics instructor and as a faculty advisor for students pursuing physics and/or engineering. As such, I bring to the study practical experience, as well as knowledge and understanding of a community college STEM environment. I acknowledge that while these experiences are valuable in providing insight into the experiences shared by the student participants, they may also serve as a liability, biasing my judgment when interpreting the data. In addition to making my position, experiences, and motivation explicit at the beginning of the study and recognizing that each perspective has its role in inquiry, I am aware that must be careful not to take my perspective so far, that it no longer creates genuine meaning (Rosaldo,

1987). Members of the research community, subjects of the inquiry, members of the field of education, and those affected by the outcomes of the inquiry share the responsibility of ensuring the work is objective. In order to strengthen my credibility, I have engaged in ongoing self-reflection and have provided others (participants, peers, and advisors) the opportunity to critique my work.

Assumptions

Based on my experiences as an undergraduate woman in physics and as a community college instructor, three primary assumptions were made regarding this study. First, I assume that the student populations in STEM courses and programs do not reflect the diversity of the community nor the community college. This assumption is based on the lack of diversity seen in STEM at colleges and universities at both the undergraduate and graduate levels (Center for Institutional Data Exchange Analysis, 2000) and the lack of diversity seen in the STEM workforce (Carnevale, Smith, & Melton, 2011), combined with data showing transfer rates in STEM dominated by majority students (MacLauchland & Chavez, 2007). Second, I assume that the experiences of underrepresented students in community college STEM programs are different than the experiences of students from majority groups. This assumption is based on high attrition rates of high achieving minority students from two-year colleges (Pascarella & Terenzini, 2005) and the experiences I've had as an instructor and faculty advisor in physics and engineering. Finally, I assume that students' experiences in STEM programs at community colleges influence students' science identity development and institutional and major integration; and that these impacts can, in turn, explain students' persistence intentions. This assumption is guided by the literature presented in Chapter two.

Definitions of Terms

Identity

How one recognizes self in relation to one's social environment and the type of individual one is viewed as being at any given moment in time. Identity is contextual and can evolve during social interactions (Brown, 2004).

Meaningful Others

Family members, professional counselors, peers, academic advisors, and trusted faculty members. People who's acceptance matters to the individual (Carlone & Johnson, 2007).

Persistence

Students who continue as STEM majors throughout their undergraduate programs.

STEM identity

Someone with a STEM identity demonstrates *competence* in and successfully *performs* relevant STEM practices, *recognizes* oneself and gets *recognized* by others as a STEM person (Carlone & Johnson, 2007).

STEM majors

Students who are pursuing a degree or certificate in science, technology, engineering, or mathematics (STEM).

URM

Minority traditionally underrepresented in the STEM fields to include African American, Latina/o, Native American, and Pacific Islanders, as well as Asian American women.

See Chapter 3 for a discussion on the inclusion of Asian American women.

Summary

Community colleges are increasingly thought to play a critical role in the educational lives of STEM graduates, and in particular providing URM students with access to STEM degrees. At the same time, not much is known about the progress of these students through community college or the particular issues around STEM education in these institutions. Most research on URM students in STEM focuses on issues common to students in four-year institutions and graduate programs, neglecting the experiences of community college students. The findings reported in this study will provide insight to the experiences of URM STEM students in community colleges and how they are similar to or different from their counterparts in 4-year institutions.

The following chapter provides a review of the relevant research literature in the areas of URM in STEM, identity development, and persistence. In chapter three, the study design and methodology are described. The findings of the study are presented in chapter four. And, in chapter five, the findings are discussed in relation to the research questions and compared to the literature presented in chapter two. The study conclusions and recommendations for future research are also presented in chapter five.

CHAPTER 2

REVIEW OF LITERATURE

This literature review is divided into three sections. The first section examines existing literature addressing the experiences of URM students in STEM in higher education. The second section explores the concept of identity development within the context of the academic environment. The final section investigates institutional integration as a determinant of persistence in higher education. The chapter concludes with the presentation of a conceptual model—based upon the interconnectedness of student experiences, identity development, institutional integration, and persistence intentions—used as the framework for this inquiry.

URM student experiences in STEM

The Culture of STEM

There is a longstanding belief that mathematical and scientific ability is limited to a relatively small proportion of the population (Tobias, 1990). This belief is found both inside and outside science and engineering communities. One of the most significant outcomes resulting from this belief is that STEM attrition is regarded as both inevitable and appropriate. In other words, those who leave STEM fields do so because of their own academic limitations. Though this idea was rejected in 1997 with Seymour's and Hewitt's *Talking About Leaving: Why undergraduates leave the sciences*, which found that those who leave STEM majors do so for reasons that arise primarily from issues with institutional structure or STEM culture, this belief of inherent STEM abilities remains, contributing to the perception that mathematic and scientific competence is disproportionately concentrated in a small population of white males (Heylin as cited in Seymour & Hewitt, 1997) and that science and engineering are, to borrow a phrase from Margolis & Fisher (2002), "closed clubs." If a student perceives that the "club" (or major) is

closed to him/her because of his/her race, ethnicity, or gender, that student will encounter difficulties finding a community within the major, likely switching majors or even departing the institution (Astin, 1993).

Because STEM is well known as a “closed club,” many URM students enter the field aware of the traditionally unwelcoming culture and often enter armed with strong support systems, the knowledge and courage to look beyond the departmental facades, willingness to sacrifice one or more of their social identities, and a kind of perseverance not required in other fields of study (Chinn, 1999). While the contemporary culture of science includes a culture of collaboration, students often only see the competitive and academically intimidating cultures of science during their undergraduate experiences (Hurtado, et al., 2009), contributing to the chilly climate. In this culture of STEM, we now know there are complicated psychological and sociological factors that both promote and inhibit the persistence of students in STEM majors (Hurtado et al., 2009), so we must direct our research to understand these factors and their influence on student persistence decisions.

Studies examining the persistence of underrepresented minority (URM) students in STEM found that strong pre-college science experience, family support, teacher encouragement, intrinsic motivation, and perseverance are critical factors in student success (Russel & Atwater, 2005; Brown, 2002). Though these studies provide a starting point for understanding the factors necessary for URM students to be successful STEM majors, they could describe critical factors for students from any background to succeed in STEM. They also do not address the attrition of high achieving, well-prepared URM students that are interested in STEM majors (Grandy, 1998; NSF 2004/2007; Mendoza & Johnson, 2000). Therefore, we must ask: how do race, ethnicity, gender, and socioeconomic status complicate these factors (Carlone & Johnson, 2007)?

Science career attainment, and therefore STEM major persistence, is a social process (Lewis, 2003) and, therefore, researchers should examine every phase of the social processes employed by URM in STEM, and how these experiences lead students to persist in or leave STEM majors. A handful of education researchers have begun to answer this question using the concept of science and engineering identity development (Hurtado et al., 2009; Carlone & Johnson, 2007; Malone & Barabino, 2007; O'Connor et al., 2007; Hughes, 2001; Brickhouse, Lowery, & Shultz, 2000). The concept of social identity allows for deeper understanding of students' educational decision making (Lauder as cited in Robinson, 2003) and how it is impacted by institutional environment, perceptions of and experiences within STEM, and the cultural terrain encountered by students.

Underrepresented Minorities in STEM

The lack of research on racial and ethnic minorities in STEM represents a significant gap in the literature. Few studies in STEM education have examined why URM students choose to engage in or choose to avoid learning science. Furthermore, when examining the experiences of women of color in STEM research settings, Malone and Barabino (2008) found that the issues of race and ethnicity were more important to their participants than issues of gender, making the need for additional research in the area of ethnic and racial minorities in STEM quite urgent. Ong et al. (2011) point out that “race/ethnicity and gender function *simultaneously* to produce distinct experiences for women of color in STEM” (p. 176). Not only is there a general lack of research in the area of racial and ethnic minorities in STEM, very little of the research has dealt with student identity development. In his review of African Americans in science education, Bryan Brown (2005) called for research scholars to thoroughly explore the relationship between students' identities and its influence on science learning.

Scientific research on race, ethnicity, and gender is often conducted to identify and reinforce differences between groups of people (Lederman & Bartsch, 2001). Studies have been conducted to identify differences between men and women (Birke, 2001), differences between Whites and those with any other skin color (Kaplan & Rogers, 2001), or differences between the African American culture and the culture of science (Brown, 2005). What is less common in research on minorities in STEM is how members of these groups identify with their STEM peers, their STEM faculty, and/or with the field of science that they pursue. The process of identification, whether social or academic, is a process of finding sameness in difference (Holloway, 2004 in Malone and Barabino, 2007). To understand the integration processes of URM students in STEM, it is necessary to examine their methods of finding sameness in STEM and in higher education rather than naming, classifying, and categorizing their differences. This means studying the process of student social identity development and STEM identity development.

Identity Development and STEM Identity

College is a place of identity development, where students are exploring and redefining their identities as they explore the content and meaning of their college experiences. Each experience is filtered through students' identities to make meaning of the experiences and make meaning of their place within the environment that the experiences takes place, finding either sameness or difference. These findings influence the students' identities, either stabilizing or destabilizing identities, leading to identity development or revision. This process of identity development is particularly important for people who are traditional college age and in a phase known as an identity and identity confusion crisis (Erikson, 1968). However, identity is not limited to adolescents, rather, it is malleable through life and does not remain fixed, such that all

people go through phases of identity revision that are determined by one's competence and the people with whom one chooses to make important in life (Josselson, 1996). These revisions occur for all college students, of any age, when they experience tension or opposition between their academic experiences and personal identity, it is a natural part of the learning process. This tension is complicated by the multiplicity of identities that people maintain, such as gender, race, ethnicity, sexual orientation, and religion (Brown, 2004). When college students are exploring and redefining their identities, such as racial, ethnic, or gender identity, they are exploring the substance of their college experiences.

Because identity development involves the reflection of students' interactions with college curriculum and encounters with others, identity development impacts academic achievement (Rodriguez et al., 2004). This process is reflective of the individual, the environments in which they work, study, live, play, and the people with whom they surround themselves. At times, students will reach points when they cannot cope with the challenges to their existing identity, and they seek help from meaningful others who help them to navigate the identity conflict (Pizzolato et al., 2008). If STEM students can find these meaningful others within their school and major environment, they will learn ways of incorporating STEM identity without having to "give up" their culture (Rodriguez et al., 2004). If they cannot find those meaningful others in their school or major environment, positive STEM identity development is unlikely.

While identity development is an individual process, it is socially situated. Therefore STEM identity development is also socially situated and shaped by a process of refining and reinterpreting previous perspectives into more complex, personalized, and internalized positions. For example, many African Americans experience singular status (being the only black student

in a class of white students) in the science classroom. This singular status affects a student's sense of scientific self (Malone & Barabino, 2008). Furthermore, students' science identities influence how they engage in school science, depending on whether the students view themselves as the kind of person who engages with science (Brickhouse, Lowery, Schulz, 2000). So, being the only African American student in an introductory science course, for example, will impact how that student engages with the science curriculum, the science department, and perhaps even the college or university. The process for becoming a science person involves identity transformation or reconfiguration that includes acquiring and using the requisite knowledge, skills, and discourse necessary to become a member of the science community. How and whether URM students undergo this transformation process depends greatly on how they perceive their environment (Nora & Cabrera, 1996).

The challenge comes in when taking on science identities requires students to hold contradictory identities—two or more identities that are in opposition (Harding, 1991), such as being Hawaiian and being a scientist (Chinn, 1999). For example, Brickhouse, Lowery, and Schultz (2000) found that girls who violate gender expectations have more difficulty taking on science identities. This means that students' identities, particularly ethnic and gender identities, play an important role in the production or rejection of STEM identity. Because there is a multiplicity of ways in which students can be positioned within science, there are multiple ways in which STEM identity interacts with gender, class, and ethnicity (Hughes, 2001). Students are constantly positioning themselves within discourses and practices to create a recognizable and acceptable social identity.

Brown (2004) found that participation in high school science class creates intrapersonal conflict for ethnic minority students. These students had to balance the tension between

academic and personal identity. In his study, Brown (2004) used identity as a lens to examine how students experience education and school interactions. All identities are framed by deep-seated sets of meaning (Tonso, 2006) characterized by the context of common character, culture, behavior, and thought that groups conveyed through participation of everyday practices. The “diverse nature of our society enables students to maintain dual memberships in multiple cultural spaces” (Brown, 2004, p.813) but the introduction of new identities can create the potential for conflict.

If STEM identity is compatible with students’ other identities, STEM identity is easy to construct. If it is not compatible, STEM identity is uncomfortable and may be rejected. This rejection takes the form of disliking or possibly dropping out of courses or programs all together (Hughes, 2001). This process is not as simple as accepting or rejecting, rather it is a complex process of construction and reconstruction that involves different levels of identity conflict and confluence, and the stability of individual identities is determined by the stable positions students’ are able to find within the discourse and practices available in that context (Tsai, 2003). Tsai (2003) points out that little attention has been paid to how women manage their discipline environments and the process of identity conflict and resolution, resulting in a lack of understanding of what issues matter to women in their participation in science. I would extend this to say that little attention has been paid to any members of underrepresented groups, such that our understanding of what issues matter to URM students in their participation in science is limited. The science community may think that they are providing equal access and opportunities to URM students, but these students will not take up the opportunities until they can reposition themselves and reconstruct their identities within the discipline discourse (Tsai, 2003). Furthermore, our current understanding of what issues matter to URM in their

participation in STEM communities is inadequate. To be able to improve the participation of URM students in STEM we need to understand how they position themselves and how they are positioned by others in STEM

Often times the identities available to students are defined by the institution or discipline to which they belong. Each campus or discipline has a set of “enculturated, complicated, profession- and site-specific ways of belonging that encode ideologies of privilege” (Tonso, 2006, p. 274). In other words, while certain identities are praised above others, those identities are not available to everyone because of their gender, race, or ethnicity. As a result STEM identity production may be stalled because, though a student may think of her/himself as a scientist, and may perform as a scientist, s/he is not recognized as such. Not being identified as a scientist by others makes one suspect as a scientist, and essentially closes the door to the science club. The lack of recognition is a barrier to STEM identity production and therefore science degree attainment. As a result we must take cultural forms of identity seriously, not only because “they have enormous influence, but because they encode a remarkable understanding of what students face” (Tonso, 2006, p. 304) when trying to construct science identities.

The role that others play in identity development is significant. While STEM identity is composed of multiple factors, including science competence and science performance, recognition by others plays the most significant role in undergraduate STEM identity development (Carlone & Johnson, 2007; O’Connor, et al., 2007). Students who enter undergraduate science majors are there because they have demonstrated competence and performance of scientific practices. Whether they continue to construct a STEM identity is greatly reliant upon whether the competence, practices, and interests they demonstrate are recognized as valuable by those who hold power within the discipline. Seymour and Hewitt

(1997) identified that intrinsic interest in the discipline or career field provided the best foundation for survival in ones' major. But, O'Connor et al. (2007) argue that students arrive in the major because of their interests, and that the classification of those interests as either intrinsic or extrinsic is determined by the sponsorship of those interests by evaluators who determine if student interests match or are mis-matched with particular forms of science identities. To be a scientist or engineer, one must look like a scientist or engineer, talk like a scientist or engineer, and act like a scientist or engineer (Robinson & McIlwee, 1991). These attributes are established by the STEM community, and therefore the process of becoming a scientist or engineer has a gendered, raced, and classed history (Foor, Walden, & Trytten, 2007).

Certain kinds of interests are sponsored over and above others, with little regard as to whether those interests reflect the job skills required in the STEM workforce. For example, interests in competitiveness and mathematic problem solving are valued above cooperation and interests in exploring concepts through multiple perspectives, skills regularly used in the engineering workforce. Because URM students come from standpoints that are most different from the archetypal STEM identity, sponsorship plays a crucial role in their STEM identity development, and therefore science and engineering learning and persistence (O'Connor et al., 2007). Similarly, Carlone and Johnson (2007) found that students who are most different from the norm (mainstream white male scientist) were most likely to experience disruptions during their STEM identity development when there was a lack of recognition.

A couple of studies have examined the impact of programs designed to increase the participation of URM students in the STEM fields using an identity lens for analysis: Hurtado et al. (2009) examining the impact of undergraduate research programs on URM participation in science, and Rodriguez et al. (2004) examining the impact of high school bridge programs on

URM students. The Hurtado et al. (2009) study examines the impact of college level programs designed to improve the participation of URM students in the STEM fields, specifically the intervention efforts of undergraduate research programs. This study found that student participants cite their undergraduate research experiences as providing them with the opportunities to experience the collaborative culture of science, impacting their sense of independence and confidence in their ability to perform scientific inquiry, leading to positive identity development (Hurtado, et al., 2009). These research programs provided students with an opportunity to “feel like,” “act like” and “be recognized as” scientists (Hurtado, et al., 2009). Obviously, undergraduate research programs play an important role in the development of students’ science identities, but not all students have the opportunities of undergraduate research. Hurtado, et al.’s (2009) emphasis on undergraduate research programs, means there is still a need for a basic understanding how students experience undergraduate science education, outside of such programs. How do these students make meaning of their experiences? How does their participation in science education promote a sense of STEM identity and scientific self-efficacy?

The Rodriguez, et al. (2004) study demonstrated the importance of culturally responsive instruction on science competency and academic identity. Participants in this study indicated the importance of social interaction and culturally mediated activities on both their motivation and understanding. In similar studies at the college level, the positive impact of minority and social support systems is shown to be one of the most important factors in URM academic success (Gloria et al., 2005; Gloria, et al., 1999; Grandy, 1998). In the end, we still do not understand what about college minority and social support systems motivates students to enjoy science and engineering, and make a commitment to a STEM field (Grandy, 1998).

All of the above studies examine the process of science or engineering identity development either in the K-12 environment or on four-year campuses. Though there have been in-depth examinations of identity development in undergraduate science and engineering students, there is a distinct absence of how this development may or may not differ for community college students. As a matter of fact, the last decade has seen little to no research on identity development in community college students of any sort. Community colleges are important STEM pathways for many URM students, in particular women and students of color, yet their experiences in these environments are largely ignored in the literature (Ong et al., 2011). This is particularly troubling when it is well known that community colleges play an important role in providing access to higher education for URM students (Mendoza, et al., 2000).

Access does not always translate to achievement (Pascarella, Wolniak, & Pierson, 2003). To understand what impacts URM students' educational plans, and specifically their budding STEM pipelines, it is necessary to examine their experiences in STEM and at community colleges, and how those experiences influence their identity development. Community colleges have become the primary educational pipeline for URM students entering higher education. The lack of information on the successes and failures of students who begin their STEM educations in two-year programs presents a serious problem for an analysis of issues of persistence and departure of URM students in STEM (National Academy of Engineering and National Research Council, 2005). Recent studies like Valenzuela's (2006) inquiry into the experiences of Latina transfer students are a good first step, but the need for research into the STEM experiences of students at community colleges remains.

Persistence

Persistence in Higher Education

The issue of undergraduate academic attrition has been a focus of education research for over 30 years. The inequalities in persistence of racial/ethnic minorities, women, and women of color when compared to their majority counterparts has forced educators and researchers to take a closer look at education institutions and the experiences of the students they serve. The construct of social identity development provides a theoretical lens through which the complex social processes of academic persistence and science career attainment can be studied and understood.

One of the most widely discussed models of student persistence is Tinto's (1987; 1993) model of student departure, which focuses on integration as critical in a student's process of persistence. In this model, becoming fully integrated into the academic and social systems of an institution occurs when students have successfully navigated three stages: separation, transition, and incorporation. Separation involves students' abilities to somewhat disassociate themselves from their past communities. Transition is the intermediary stage following separation, when students have not yet adopted the norms of their new environment. Incorporation happens when students adapt to and adopt the prevailing norms and behavior patterns of their college or university community. Once incorporated, the students become integrated, and are likely to persist. Students who do not successfully integrate are in danger of departing. This model is rooted in Astin's (1993) construct of student involvement, whereby the amount of physical and psychological energy that the student devotes to the academic experience directly impacts their learning and personal development, and therefore their persistence. Tinto (1993) found that the quality of student effort is positively related to their involvement with peers and faculty, both

inside and outside the classroom. This model includes detailed discussion of the interaction between behavior and perception of students as they move toward greater integration with their social and academic environments.

The theoretical work of Tinto (1993) identified two specific variables that primarily influence undergraduate students' drop-out or persistence behavior: academic integration, defined as a student's perceived academic performance and intellectual development, and social integration, defined as the quality of a student's relations with his/her peers, faculty, and other people on campus. And, while these two variables may be complicated by the influence of background variables such as educational aspirations, socioeconomic status, or parental education attainment, students' departure or persistence decisions have more to do with their experiences as college students than with their pre-college experiences. Similarly, Espinosa (2011) found that "the college experience and college environment prove paramount relative to high school performance and family background characteristics" (p.231) in the persistence of women of color in STEM fields. Tinto's model has been applied and refined by many researchers (e.g. Hausmann, Schofield, & Woods, 2007; Nora and Cabrera, 1996; Tinto & Russo, 1994) producing a widely accepted construct of social and academic integration as a predictor of undergraduate persistence or departure. Tinto (1993) asserts that students who report are integrated into the "social and intellectual life of the institution" (p.50), taking advantage of academic and social support systems, participating in learning communities, or interacting with advanced students develop a sense of community membership within the college environment (Tinto, 1993). To understand how academic and social integration influence the student decision making processes we have to look beyond measures of integration to examine

the impact and influence of the interactions that students have with and within an institution. As Tinto (1993) writes:

The most important is the implied notion that departure hinges upon the individual's perception of his/her experiences within an institution of higher education. The model takes seriously the ethnomethodological proposition that what one thinks is real, has real consequences. As regards integration, the mere occurrence of interactions between the individual and other within the institution will not insure that integration occurs—that depends on the character of those interactions and the manner in which the individual comes to perceive them as rewarding or unrewarding. (p. 136)

While Tinto's model provides a means for institutions to evaluate their retention efforts by student integration levels, it does not illuminate for us how specific interactions impact students' perceptions and influence student decisions. This leads to an ongoing problem with much of the research on college impact and student persistence decisions that seeks to estimate the causal effects of some factors, interventions, or special programs: the frequent absence of information illuminating just why the intervention or program has the effect that it does (Pascarella, 2006).

There is a need to understand and explain the processes and mechanisms by which academic and social integration influence students' academic persistence decisions, to answer questions such as: What is it about academic or social support systems that motivate students to enjoy college? Through what processes does academic integration impact student career commitment? How does social support impact students' sense of belonging and self conception? How are the impacts of academic and social support upon students' persistence decisions complicated by major culture (Astin, 1993), stereotype threat (Steele, 1997), and/or cultural incongruence (Cole & Espinoza, 2008)? And, how might the average pre-college degree plans

of a community college campus influence individual student educational plans (Pascarella, Wolniak, & Pierson, 2003)? Research has not yet fully explained the processes and methodologies by which college culture, social interactions, and academic affairs impact students' educational intentions.

Tinto's (1993) model described ways in which students "experience" and "interact with" the campus, in other words how students perceive and behave towards their environment. Social identity provides a lens through which we can examine both student's perceptions and behaviors. Perceptions are developed through a process of identity construction and revision by which students filter their campus experiences: adopting, adapting to, or rejecting the cultural norms of the campus environment. Students then project this identity through their behaviors, which represent positions taken within the discourses and practices available on campus. The three stages through which students pass to achieve integration (separation, transition, and incorporation) are simply the reflection of the identity versus identity confusion crisis described by Erickson (1968). Each identity crisis is a time of intensive analysis and exploration of different ways of examining oneself, looking for personal sameness and continuity, paired with some belief in the sameness and continuity of some shared culture or image (Erikson, 1968). To understand how students persist in higher education, we must understand the identity crisis experiences through which they develop their sense of sameness or difference with higher education and the communities they encounter at their college. This process is one of ongoing identity reconstruction in which multiple identities are tried on, constructed, revised, combined, and incorporated into students' senses of self. The intersectionality of race/ethnicity, gender, STEM, and academic identities is the driving force behind academic and social integration. When students successfully incorporate the academic and social identities associated with

campus life, they become integrated. If students find that campus academic and social identities oppose one or more of their personal identities, students begin to disassociate from campus life. This integration or disassociate may occur within both the social sphere and academic sphere, or possibly only one or the other. Thus integration can happen on two levels—the major or programmatic level and on the institutional level.

I propose a model where integration and disassociation sit in opposition on a continuum of student association with higher education institutions (Figure 2.1). Those who are integrated like their academic work, envision future careers for themselves, are well connected with a network of friends, study with others, have information about career prospects, and seek assistance from peers, tutors, professors, and other campus resources (Croissant, 1992). Those who are disassociated do not have accurate information about and/or do not find future prospects appealing, are not well connected to a campus network of friends, often work alone, feel marginalized, and are uncomfortable giving up part of themselves, to become a part of the campus community. Between the two extremes is conformation. Students who have conformed see the benefits and opportunities made available through education, identify with a future career, or career prospects, but do not enjoy academic work and view college education as something to endure in order to reach the “real world” (Croissant, 1992). Students with Carlone & Johnson’s (2007) “disrupted identity” would likely be found here. These students have formed a STEM identity, but recognition as URM students often overwhelms their chances of being recognized as STEM students. Their negative feelings of not being included or difference prevent them from ever developing a sense of belonging in the STEM academic programs. These students generally believe that the theoretical teachings of higher education play little or no role in the workforce, and expect to learn what they really need to know once they move into

the workplace—college is simply a hoop they must jump through on their trajectory to the STEM workplace. Students who are well integrated are committed to their institution, their major, and their career prospects, and therefore are likely to persist. Students who have conformed are committed to their career prospects, but not necessarily their institution or their major. These students are committed to higher education but may depart their higher education institution, looking for an easier, faster, or less expensive institutional path towards their higher

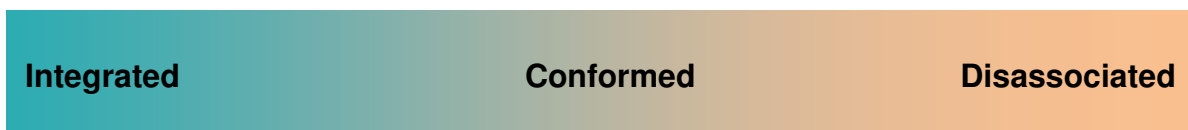


Figure 2.1: Integration Continuum

education goals. Students who are disassociated are not committed to higher education or the career prospects it has to offer and are likely to depart higher education. Where a student fits on this continuum is a reflection of her/his identity and how s/he makes meaning of her/his experiences.

While the Tinto model was developed to explain institutional departure, it could also be used to explain major departure. In this case the concepts of social and academic integration are applied to a particular department or major field of study such as the STEM fields. Using this model, students who are likely to persist in their major are well integrated intellectually and socially. They participate in study groups, hang out in the major's study lounge, join clubs and STEM student societies, develop an understanding of what their future career entails, and feel like active participants in their STEM courses. Students make observations, participate in activities and interact within an environment that reflects both the culture of the higher education institution, but also the culture of the field of study they are pursuing. Tinto (1993) points out that the process of student persistence is similar to the process of becoming incorporated into the

life of a community. Using this model, individuals who face difficulties navigating the stages of passage defined by the community (in this case STEM) may choose departure—switching majors—while those who successfully navigate the stages of passage are welcomed as members of the community, and likely persist, eventually graduating with a STEM degree. It is important to note that the difficulties faced by individuals are a reflection of the problems inherent in shifts of community membership (Tinto, 1993), not problems inherent to the individuals. Sorting through the different levels and types of institutional integration to differentiate what interactions impact students' decisions to persist within or change a major versus those that impact students' decisions to persist within or change institutions is difficult, and required a means for better understanding the students' experiences and the context and environment within which they have those experiences.

Persistence in STEM

Using the combined conception of student decision processes described above, it is possible to develop discipline specific conceptions of student persistence decision making. In the case of persistence in STEM, the model of STEM identity, developed by Carlone and Johnson (2007) for their research on successful women of color in science, provides an insightful model. Their science identity model identified an individual with a strong, well-developed, science identity as someone who demonstrates *competence* through knowledge and understanding of science content, who performs as a scientist through the use of scientific *practices* and tools, and who *recognizes* him- or herself as a science person and is *recognized* as a science person by others (Carlone & Johnson, 2007). As O'Connor, et al., (2007) point out, STEM identity is something both experienced by the individual (“I am a scientist”) and something ascribed by and maintained by others (“you are a scientist”). The Carlone and

Johnson (2007) study resulted in a grounded model of science identity that extends the model to emphasize the importance of the recognition that students receive from meaningful others (such as family, teachers, communities, and peers) exerts over the process of STEM identity development, and attempts to account for the dynamic role that race, gender, and cultural identities play in the recognition by oneself and by others as a person who does science. However, the Carlone & Johnson (2007) grounded model of science identity development only allows race, gender, and cultural identities to inform science identity, not the other way around. To truly reflect the dynamic interplay between the multiplicity of identities that individuals take on, it is necessary to allow all of those identities to inform and influence one another through an ongoing process of identity development and revision.

We know that while some students are successful integrating their ethnic and academic selves, others find that they can only do well academically if they mask their ethnic identity, while others feel that they can only maintain their ethnic identity by disengaging from school (Davidson, 1996). Seymour & Hewitt (1997) found that women in STEM would change their appearance to be less feminine and take on a persona of being “one of the boys” in order to stay in STEM, because a feminine identity was not accepted in the STEM environment. Orbe (2004) found that first generation students often ended up in an identity no man’s land, feeling like outsiders at school and at home. These students were unable to develop strong academic identities, yet the experience of higher education also degraded their identification with their home communities, such that they were trapped in Tinto’s (1993) transition stage. People are always positioning themselves and are being positioned by others either through a series of face-to-face interactions, over developmental time, or through the social histories of communities (Nasir & Saxe, 2003). This means that, “if students are to learn science, they must develop

identities that are compatible with science identities” (Brickhouse, Lowery, and Schultz, 2000, p. 443). The construct of identity (whether academic, ethnic, gender, or science) is not static, but rather multifaceted and dynamic (Nasir & Saxe, 2003). The ongoing process of positioning that occurs within the educational context has important implications for student’s futures, and the possibility of that person successfully finishing his or her degree (Malone & Barabino, 2008). Using a model of socialization and identity development takes the question of persistence away from the standard assumptions about ability (Croissant, 1992)—students who cannot forge stable STEM identities, despite their adequate or even exceptional aptitude, will fail to fully integrate with the institution and with their major, and will leave STEM.

A model for examining persistence of students in STEM

Robinson (2003) demonstrated that identity has a major impact on students’ intentions to persist at their institution and in higher education, relative to the effect of academic and social integration, finding that while Tinto’s (1993) model of integration adequately explained students’ persistence decisions, that identity was even more important in explaining persistent intentions, particularly when examining persistence in higher education, not just persistence at a particular institution of higher education. I propose that the two models, Tinto’s academic and social integration and Robinson’s interpretation of Erikson’s (1968) model of identity development are not exclusive, but rather work together to explain the processes by which students make their persistence decisions. Moreover, this combined model works not only to explain persistence in higher education or at particular institutions, but it can also explain student’s persistence intentions within major programs.

Here, borrowing from Malone & Barabino (2008), identity will be treated as something that is lived, recognized, and enacted (Brown, 2004) in four ways: (1) identity is produced in the

interactions between the individual and their social environment, (2) identity is contextual and therefore always subject to revision, (3) identity entails recognition from others, and (4) identity involves “possibility” and “attribution” (p.489). Furthermore, an individual’s identity is an amalgamation of selves that constantly being negotiated and are, at times, in opposition with one another (Harding, 1991). Furthermore, identity development is an ongoing process of interpreting and making meaning of interactions that either promote or degrade an individual’s affiliation with a culture, community, or environment.

To understand how students experience their undergraduate majors, a discipline or major identity that interacts with one’s racial/ethnic, gender, and academic identities will be studied. This model treats these four component identities as the majority inputs to the identity that

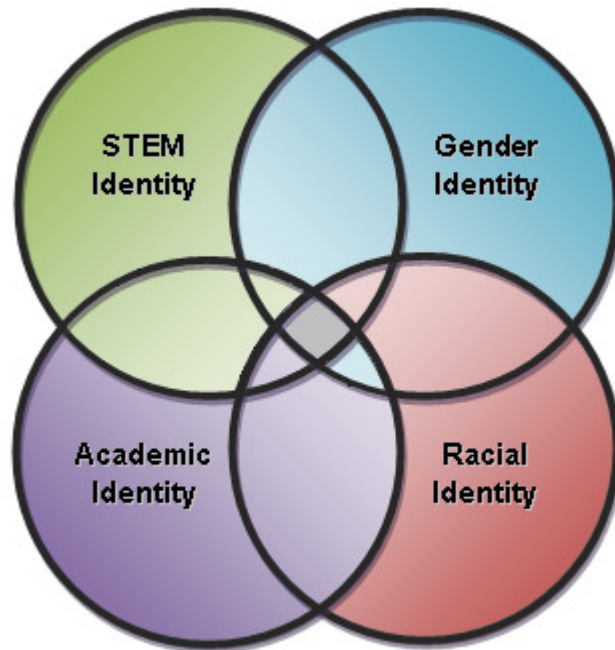


Figure 2.2: Integrated Identity

The discipline (STEM), academic, gender, and racial/ethnic identities are integrated with one another.

students portray within the context of higher education. Where these component identities overlap, students have managed to integrate identities. The more these identities overlap, the more integrated one's overall identity (Figure 2.2), the less they overlap the more oppositional, or spread apart the component identities and less integrated one's overall identity (Figure 2.3). Carlone & Johnson's (2008) science identity model will be used to understand how students experience the STEM culture and environment, and what impact, if any, STEM experiences at the community college have in the development of STEM identity. In this model, one's STEM identity is composed of 3 dimensions (Figure 2.4): performance, competence, and recognition.

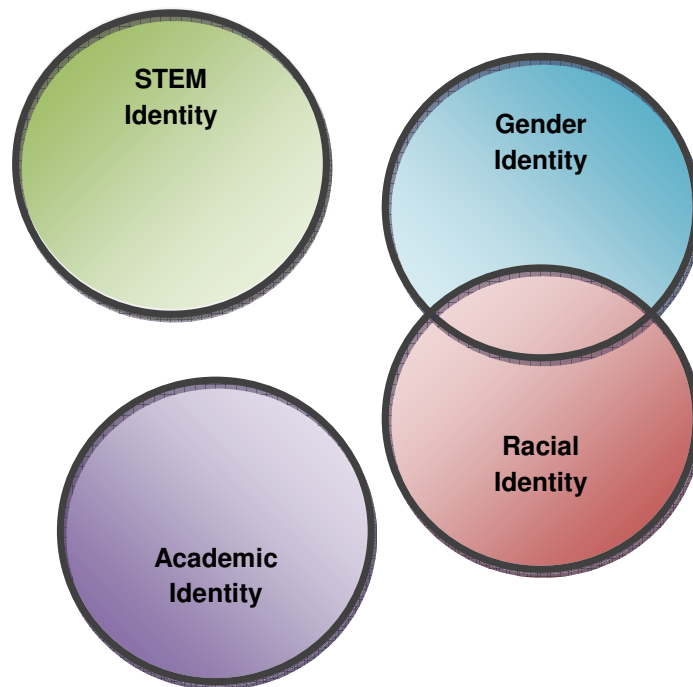


Figure 2.3: Disintegrated identity example

Not all of the component identities are integrated with one another. In this case the discipline (STEM) and academic identities are in tension with each other and the gender and racial/ethnic identities.

It is important to note that fostering science identity development involves more than focusing on individual factors such as increasing one's level of competence in science. It also involves social

factors, including socialization into the sciences and making meaning of science-related experiences, such that the individual not only feels like a science person, but also acts and is seen by relevant others as a science person. (Carlone & Johnson, 2008, p. 1192).

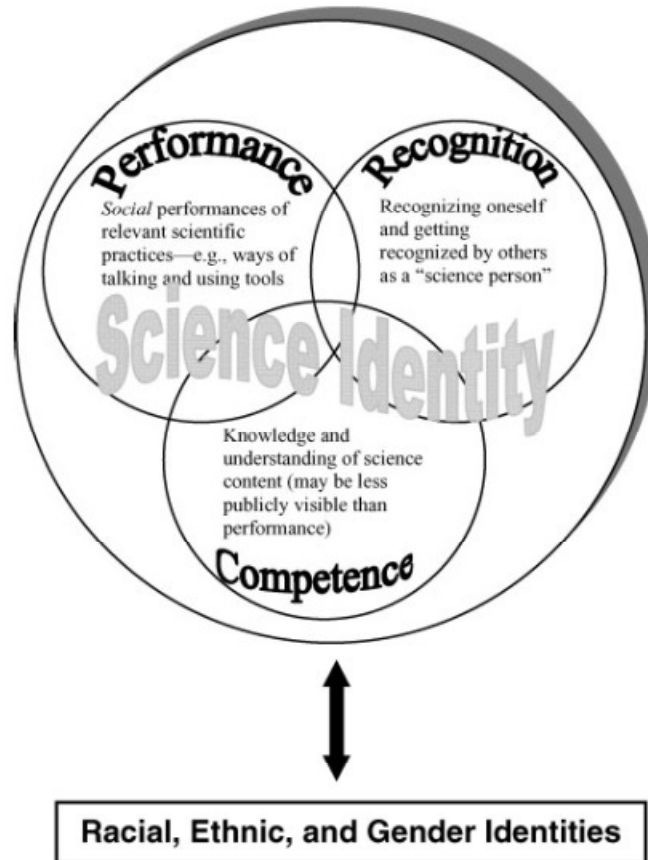


Figure 2.4: Science Identity (Carlone & Johnson, 2008, p. 1191)

Each revision to a student's identity informs and impacts that student's behavior within a particular context or environment. Interactions that promote positive identity development (in any or all components) moves students towards social and/or academic integration (Figure 2.5). When interactions result in a degradation or disruption to one or more component identities, students move away from integration and towards disassociation. Those who are well integrated within the academic and social environments of their college or university are likely to persist at

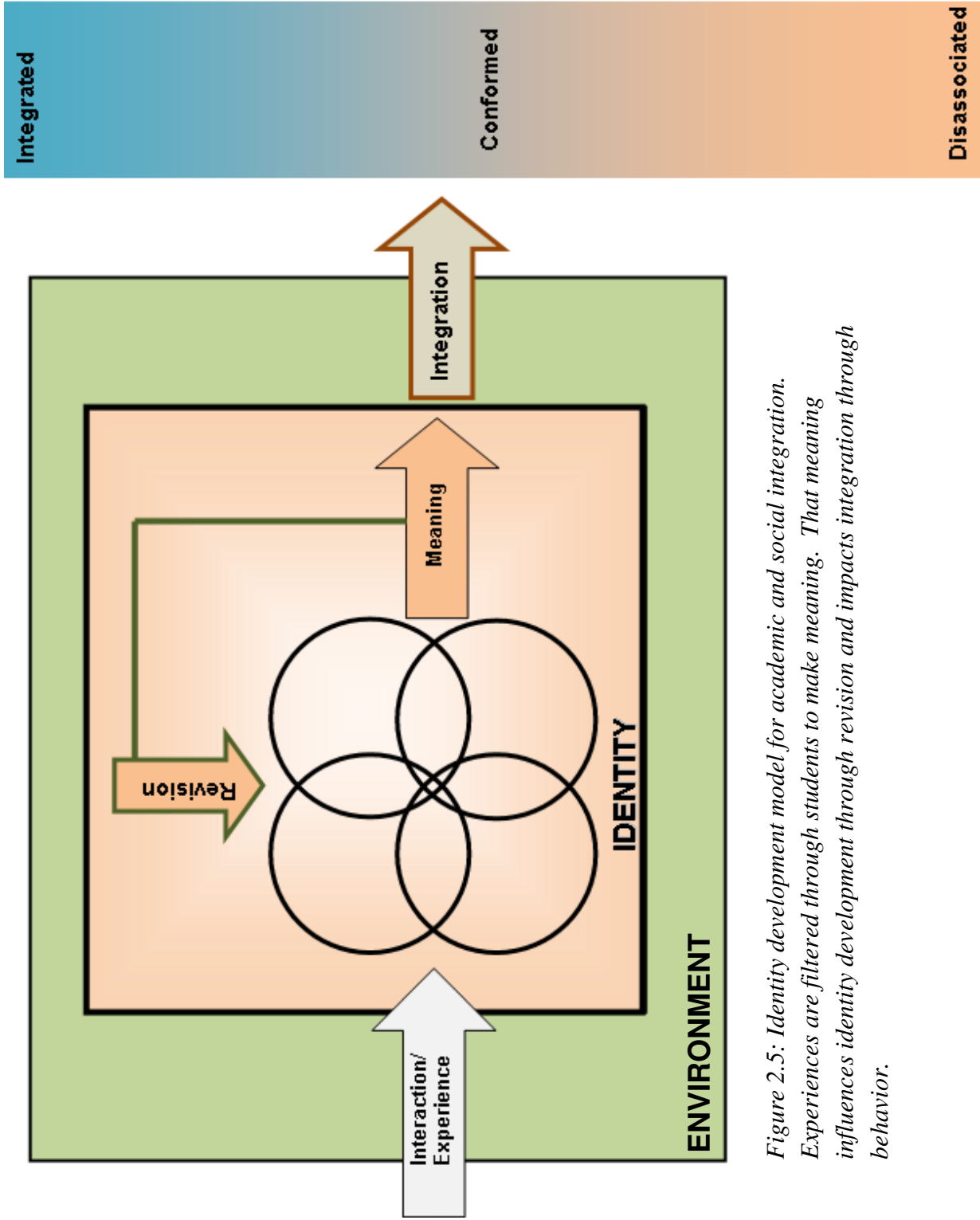


Figure 2.5: Identity development model for academic and social integration. Experiences are filtered through students to make meaning. That meaning influences identity development through revision and impacts integration through behavior.

that institution (Tinto, 1993), while those who do not integrate successfully are more likely to depart from the major or the institution, or possibly depart higher education all together.

One can imagine countless combinations of these component identities. For example, students who develop strong integrated STEM identities, leading them to integrate into their major, both socially and academically, are likely to persist within that major. Those who do not successfully integrate may depart the major (switching to another major). Or, if students find they must sacrifice some or all of their ethnic or gender identities in order to develop major identities, their overall identity becomes disintegrated, making full social and academic integration difficult, leading to disassociation. If students can find a way of understanding and interpreting their experiences that allow them to cope with and find a comfortable position within their disciplines' environments, their STEM identities are strengthened and they become more integrated into the discipline and institution. Disruption in identity development could lead to non-integration within a major, therefore leading student departure from the discipline. So, those with strong academic identities and weak major identities are likely to switch majors, but remain at the institution.

An examination of how the component identities overlap allows for the examination of how students make meaning of their experiences in higher education and a lens through which we can understand how those experiences influence their persistence decisions. Using a STEM identity lens will allow for the weighing of influence that interactions and particular individuals have on shaping the experiences of URM in STEM. With this lens we can work to understand each person and the social world that s/he perceives her/himself to inhabit (Chinn, 1999).

This conception of student identity and STEM identity is comprehensive and wide-ranging—allowing for the multiplicity of and interconnectedness of identities, the development

of new and revision of existing identities, and accounting for the impact of the cultural environment. Therefore, it can be used to examine the experiences of STEM students at any institution—public or private, four-year or two-year, Research I, technical, or liberal arts. This model will provide perceptual access to the students' social worlds where identity is lived, experienced, and produced through interactions with individuals, departments, and institutions.

Summary

This inquiry will look at community college STEM students' persistence intentions through and examination of STEM identity development and major integration. It is expected that students' will make meaning of their college STEM experiences through identity. Their perception of those experiences will inform identity revision and either encourage or discourage academic and social integration within STEM. Students who demonstrate a strong STEM identity, and integrated overall identity, will be well integrated into the STEM and campus communities and describe strong persistence intentions. This model will enable us to better understand those experiences, allowing us to learn how the community college environment influences STEM student experiences and persistence intentions. Since most studies have focused on students at four-year institutions and in graduate school, this study fills a gap in the literature by addressing community college student experiences in STEM.

CHAPTER 3

METHODS

This qualitative study invited eight community college STEM majors to share their experiences in STEM and in college in order to investigate the impact those experiences have on their intentions to persist in STEM, and how those experiences may or may not differ from their counterparts in four-year institutions. While many studies focus on outcomes (how many students actually persist in or leave STEM), this study will focus on the multiple facets of these students' lives that eventually lead to persistence or the decision to switch majors. In general, this inquiry will provide the rich descriptions that enhance our understanding of the experiences of URM community college STEM students in ways a quantitative study cannot. As such, semi-structured, in-depth interviews will be used as the primary method of data collection to explore and understand how students are influenced and impacted by various interactions and experiences. This chapter outlines the methods of inquiry utilized in this study.

A case for qualitative methods

Though research often refers to a STEM pipeline, there is no “uniform” pipeline (Stevens, et al., 2008). In other words, aside from specific degrees earned by students, there is not a single path that all students follow to become scientists and engineers. Some students will begin their pipeline during the K-12 years, others will begin their pipeline in college. Some students will flow through a two-year college before entering a four-year college, while others will enter the workforce before flowing into college. Some students will participate in support programs, some will participate in undergraduate research, and some will balance their academic life with work and/or family obligations, leaving little or no room for any participation beyond the classroom. If we want to understand the experiences of students in STEM education, we

must examine all components of potential pipelines, not only the traditional four-year college path. This is particularly important when studying the experiences of URM students, who are the least likely to follow the traditional STEM pipeline, so often studied over the years.

A review of research focused on the experiences of students in STEM confirms the use of qualitative methods to provide insight to how students make meaning of their experiences and, therefore, insight into the impact of institutional policies and cultures. This collection of research included a number of case studies (e.g. Valenzuela, 2006; Foor, Walden, and Trytten, 2007; Stevens, et al., 2007; Hurtado, et al., 2009; Yohannes-Reda, 2010) designed to explore culture through the experiences of study participants. All of the studies reviewed included some form of interviews including structured interviews (Fleming, Engerman, & Williams, 2006), ethnographic interviews (e.g. Fleming, Engerman, & Williams, 2006; Carlone & Johnson, 2007; Hurtado, et al., 2008; Stevens, et al., 2008), interviews in pairs (Hughes, 2001), group interviews (Rodriguez, Jones, Pang & Park, 2004), one time interviews (Hurtado et al., 2008), surveys and interviews (Croissant, 1992), or longitudinal interview studies (e.g. Brickhouse, Lowery, & Schultz, 2000; Fleming, Engerman, & Williams, 2006; Tonso, 2006). Many of the studies included observations (e.g. Brickhouse, Lowery, & Schultz, 2000; Tsai, 2003; Tonso, 2006; O'Connor, et al., 2007), some for a single day, others for an entire term or more. These studies represent a variety of qualitative, and in particular ethnographic, approaches used to understand the development of students as scientists and engineers, primarily through the examination of their science and engineering identities.

Foor, Walden, and Trytten (2007) employed the used of case studies and individual experiences as lenses through which STEM culture could be examined. Because qualitative methods provide the flexibility to respond to the data as part of the discovery process, they were

able to examine the effect of institutional policies on the life and experiences of an individual. They use the story of a single individual to see the larger social and cultural forces operating in the engineering education society. While quantitative measures generally focus on the majority (those who are first-time, full-time students that graduate within six years of starting), individual interviews, like their interview of Inez (Foor, Walden, & Trytten, 2007), allow for the study of the outliers, the underrepresented students that STEM fields want to attract and retain in their effort to diversify the field (Foor, Walden, & Trytten, 2007).

Fleming, Engerman, and Williams (2006) used a combination of structured and ethnographic interviews to understand why students leave engineering. The initial interviews with students were structured, to probe issues concerning identity, skill development, and current knowledge during student's second term (before they decided to switch majors). Ethnographic exit interviews were then used as follow-ups to further explore the variety of issues and motives that led to students switching. This method allowed the researchers to investigate not only their predetermined topics, but also go into issues arbitrarily introduced by the participants, allowing the researchers to discover what people did and why, before they assign meaning to the participants behaviors and beliefs (Fleming, Engerman, and Williams, 2006).

In a much larger study, O'Connor, et al. (2007) used a variety of ethnographic methods. In addition to the use of interviews, the researchers also shadowed participants, observed key spaces and activities, and analyzed documents produced by the institutions to understand the environment or context for participant experiences. O'Connor, et al. (2007) use a person-centered framework to design ethnographic interviews that encourages participants to "actively reflect on and evaluate their life experiences" and explore the "significant and meaningful aspects of the world of the individual" (Hollan & Wellenkamp as cited in O'Connor, et al., 2007)

and how they are motivated to act within the contexts of their environments. These case studies provide the researchers with a means for examining similarities and differences in experiences. In this case, how the students identify with the social and cultural worlds of engineering education and prospective world of engineering work provided a deeper understanding of the broader culture they were studying (O'Connor, et al., 2007).

Distinct from the others, Tonso (2006) became a “quasi-participant observer” in her study of engineering identity. To unearth identity terms and their meaning for engineering identities enculturated on college campuses, she participated as a student in design classrooms and on student teams, attending weekly class meetings and out-of-class team meetings. Through her extensive field notes, she was able to produce ethnographies of the teams and classrooms, and conduct an analysis to locate patterns of similarities and difference. The observations, in conjunction with individual interviews, allowed her to unearth identity terms and gather information on what those terms meant to students. By becoming a participant observer, Tonso was able to identify terms used by students, they might not have offered up in interviews. She used the interviews to understand how student define and organize those terms into categories for being engineering students on campus. Through the help of student interviews, she could then map the terms to find meaning, and use them to understand the culture of engineering education on campus (Tonso, 2006).

Like the other studies, Hurtado, et al., (2009) employed a phenomenological approach, examining student perspectives within structured programmatic experiences. Their examination of undergraduate research programs looked at the experiences students had within these programs and what role those experiences played in promotion of a sense of STEM identity and scientific self-efficacy. The use of qualitative methods in this study is practical because the

study is examining *how* students interpret and experience the process of becoming scientists. Their study, and in particular their use of focus groups, provided them a way to find the meanings constructed by students participating in this program, creating a look at how URM students experience science.

Methodology

This study uses qualitative methods, like those described above, as part of a multicas e inquiry to examine the STEM identity development of community college students. A combination of semi-structured ethnographic interviews combine with participant observations provides insight into the context of the environment, culture of science and community colleges, and experiences of URM STEM students. Employing these methods as part of a case study approach allows for the discovery of connections and relationships between URM students' experiences in STEM in community colleges and their STEM persistence decisions. The case study approach is particularly suitable for this study because of its ability to elucidate processes of events, interactions, and experiences to discover characteristics that will shed light on an issue (Yin, 2006).

Case studies are particularistic, descriptive, and heuristic (Merriam, 1998). This study would examine a particular situation: being an URM STEM student in community college. The case study approach would allow me to get a close, first-hand understanding (Yin, 2006) of the environment that community college STEM students experience, to provide a thick description of URM community college students in STEM and portray the experience of these students as completely as possible and reveal all of the complexities of the situation. The goal of the study is to understand or shed light on previously unknown relationships (Merriam, 1998) between the college environment, STEM culture, and URM STEM persistence decisions. The case study

approach allows for, and requires, conducting data analysis throughout the data collection process (Yin, 2006). The uniqueness of the case study “lies not so much in the methods employed...as in the questions asked and their relationship to the end product” (Merriam, 1998).

Conducting a multi-case study and relying upon multiple data sources, enhances the external validity of the study (Merriam, 1998). The data sources will allow for the triangulation of data and the production of a holistic understanding of the situation by establishing “converging lines of evidence” (Yin, 2006, p.115) that make clear the experiences of URM community college students in STEM, and how their interactions with the institution, the campus community, and their off-campus world impacts their STEM identity development. By employing a multitude of data sources and using of member-checking, this interpretive study will produce a rich, thick description of the community college STEM environment and allow for the development of a grounded conceptualization of URM community college student STEM identity development process.

Setting and Participants – Nature of Sample

Participants were selected based upon their status of being students in STEM majors in community college, with a particular focus on URM students. In other words, the study used a “unique sample...based on unique...attributes...of the phenomenon of interest” (Merriam, 1998, p. 62). More specifically, a non-random, convenience sample was chosen for interviews and observation (Merriam, 1998) based upon student volunteers recruited through on-campus advertising (hard copy and electronic) as permitted by the community colleges. Requirements for participation were that students were (a) U.S. born citizens, (b) STEM majors, and (c) had completed at least one quarter of coursework at their current college.

To recruit participants, paper fliers and electronic advertisements (Appendix A) were provided to STEM Instructors and campus programs that specifically targeted URM students such as campus multicultural offices, clubs for minorities and women in STEM, and minority support programs like MESA (Math Engineering Science Achievement). The participants recruited through campus advertising then suggested someone else who may be interested in participating, producing a snowball sample (Seidman, 1998). In addition to the participants recruited through advertising, two participants volunteered for the study after learning about it through discussions on the campus where I was teaching at the time. Both of these students were enrolled in one of my courses prior to the study. To protect the students and myself from perceived conflicts of interest and coercion, the students did not participate in the study until at least 6 months after completing the courses that I taught.

The participants in this study include four women (three African American and one Asian American) and four men (three African American, and one Pacific Islander). The inclusion of Asian American women as an underrepresented minority group may seem questionable because of their overrepresentation in STEM degree attainment. However, as members of a gender minority in STEM and an ethnic minority with respect to the US population, they continue to be outsiders in STEM (Ong et al., 2011). Gender differences among Asian American students in STEM parallel the differences of White women and men (Huang et al., 2000). In her study of Asian American women in STEM Vogt (2005) participation rates for Asian American women as a percent of all Asian American students were: 20% in the School of Engineering and 22% in the College of Computer, Mathematical, and Physical Sciences at her study site.

The participants attended one of three community colleges in the metropolitan region of a large west coast city. The area is good for STEM and is home to a number of public and private

science, engineering, and technology entities. The following information about the colleges comes from the colleges' websites. All three of the colleges report full-time equivalent enrollments of about ten thousand students. More than 40% of the students enrolled in each college were attending for the purpose of transfer. All three colleges have large international programs, enrolling more than 1000 international students on each campus. Finally, the three colleges report that students of color make up 30 – 50% of their enrollments. Active recruitment of participants took place on the most diverse and most urban of the three campuses, resulting in two thirds of the participants coming from the same campus. A summary of the participants is provided in Table 3.1. More extensive participant profiles are provided in chapter three.

Table 3.1: Student participant characteristics

Participant	Ethnicity	Gender	Age	Major	Prior College Experience
Giles	African American	Male	30's	Electrical Engineering	Prior 4-year and multiple CC
Joan	Asian American	Female	30's	BioEngineering	4-year STEM degree and STEM AA-T
Jocelyn	African American/Filipino	Female	20's	Mechanical Engineering	Running Start
Kenneth	Chamorro (Pacific Islander)	Male	20's	Civil Engineering	Non-STEM major at CC and certification
Mary	African American	Female	20's	Engineering	Non-STEM major at a 4-year school
Rishona	African American	Female	>40	IT (Certificate)	Prior CC experience
Shane	African American	Male	>40	IT (Certificate)/Engineering	Non-STEM masters
Tyrone	African American	Male	30's	Mechanical Engineering	

Data Collection

Observations

To highlight the attributes of the social world in which URM students experience STEM on community college campuses, I must go to the site of the participant (Creswell, 2003). Observations provide information and a perspective that interviews cannot, either because participants are reluctant to share the information or, perhaps, are unable to identify or articulate it (Maxwell, 2005). There are many aspects of social life that can be seen and felt only by witnessing the lives of the participants (Lofland & Lofland, 1995). Observations provide rich data that produce intimate familiarity with the environment and settings and an opportunity to participate in the minds of the study participants. The observations present an opportunity for first-hand experiences with participants, allowing the researcher to better take in the students' perspectives of the college campus and department environments, the community college student experience, and ongoing challenges and obstacles facing URM students both in STEM and at community college. This process also creates an environment in which aspects or topics unanticipated by the researcher may be brought to light (Babbie, 1995), providing a rich resource for the content of one-on-one interviews. These observations were conducted using strict protocol (Appendix B) to collect descriptive and reflective field notes in parallel and record information as it is revealed (Creswell, 2003). The primary goal of the observations is to inform the one-on-one interviews.

Interviews

Interviews were the primary source of data collection and were essential to understanding students' experiences, motivation, sense of self, and commitment to STEM. Interviews allowed the participants to describe experiences and interactions on campus from their perspective,

giving voice to their perceptions. It is important to understand how students perceive events, because how they make meaning of interactions is what gives insight to their identity, identity development, and their sense of integration on campus and within a major.

To conduct individual interviews, I employed an ethnographic approach, learning from participants rather than studying the participants (Spradley, 1979). The use of ethnographic methods connotes a focus on understanding the meaning of actions, events, interaction and experiences to the study participants. The intent of the interviews is to not only understand how the student participants interact with the social and cultural world they encounter as STEM students on community college campuses, but how they *perceive* those interactions—to shed light on how those interactions influence the participants’ self efficacy, major commitment, identity development, and educational and career goals. This method of data collection involves “a conversation between the interviewer and the interviewee that requires both active asking and listening and yields exploratory, descriptive and explanatory data” (Gasiewski et al., 2011, p.15). The semi-structured approach allows the researcher to remain focused on the research questions, but also allows the interviewer to “respond to the situation at hand, to the emerging worldview of the respondent” (Merriam, 1998, p. 74).

Productive interviews are those where the participants are at ease and talk freely about their viewpoints, including ideas and feelings that reveal the respondents’ perspectives (Bogdan & Biklen, 2007). As such multiple interviews were conducted with participants to allow me to establish a rapport with the participants and put them at ease. The interview protocol for this study was developed with guidance from the research literature on the experiences of URM students in STEM, and is shown in Appendix C. The interviews were conducted in a manner of semi-structured conversations that focus on students’ experiences in STEM classes and in other

contexts (in high school, at home, at work, on campus, in non-STEM classes) with relevance to their decisions to enter and continue in STEM majors as well as their level of social and academic integration at the college.

One to three interviews were conducted with each participant with questions influenced by the literature on science and engineering identity, identity development, and college persistence (Appendix C). The first two interviews took place before the participant observation (if one was scheduled), each lasting anywhere from 45 – 90 minutes. During the first interview, background information was sought to create a basic profile for each participant; this background information included age, field of study, year in school, and work and family history. The remainder of the first interview was focused on developing an interest in STEM and subsequent educational and career goals (Hurtado et al., 2009), enrolling in community college, and STEM/college experiences over time.

The second interview dove deeper into STEM/school experiences described in the first interview as well as racial experiences and climate of inclusion at their college and within their field of study. The final interview occurred after the participant observation. This interview included an observation debrief and provide the opportunity to ask focused interview questions to clarify responses during earlier interviews (Appendix C) and from the observation data (Appendix B). The final interview lasted 60 minutes to 90 minutes. Interviews were digitally recorded and transcribed verbatim.

Analysis Procedures

The objective of the coding process is to make sense out of the data, dividing it into segments, labeling the segments, examining for frequency in responses, and organizing the codes into themes (Creswell, 2003). This process was based in Colaizzi's (1978) phenomenological

method: (1) get a sense of the whole, (2) extract significant quotations, (3) formulate meaning, (4) identify themes, (5) create an exhaustive description, (6) formulate the fundamental structure of the phenomenon, and (7) use member checking to validate the findings. In analyzing the data, I performed two coding cycles. The first cycle followed a three step coding process. The first step in the process was pre-coding, or reading through the data while jotting notes that struck me as interesting (Saldana, 2009). Reading through the transcripts without a formal coding structure allowed me to honor the participant's voice (Saldana, 2009) in order to acquire a sense of the whole (Colaizzi, 1978). This process provided a foundation upon which to conduct the second and third review of the data.

In the second review of the data, participant responses were coded using a structure based on the conceptual model, using a holistic approach that allowed simultaneous coding. My interpretation of the data was purposefully filtered through the lens of the conceptual model, which structured the study in the first place (Merriam, 1998). There were four primary level codes: Identity, Campus Environment, Integration, and Persistence. In the initial coding each of the primary codes had one or more sub-categories (Figure 3.1). NVivo software was used during the coding process to organize the data. The software organized the coded data into bins, called "nodes," while maintaining their link to the full transcript. After the significant statements are extracted, they were re-read to begin to formulate meaning (Colaizzi, 1978).

The third review of the data used an open coding method (Creswell, 2003). The data was analyzed through a line-by-line analysis, used science identity, institutional integration, the culture of STEM, and persistence, and my notes from the first review of the data as a guide for developing categories of cultural meaning or domains (Carlone & Johnson, 2007). This process produced more than 50 additional codes. These codes were then compared to the initial codes,

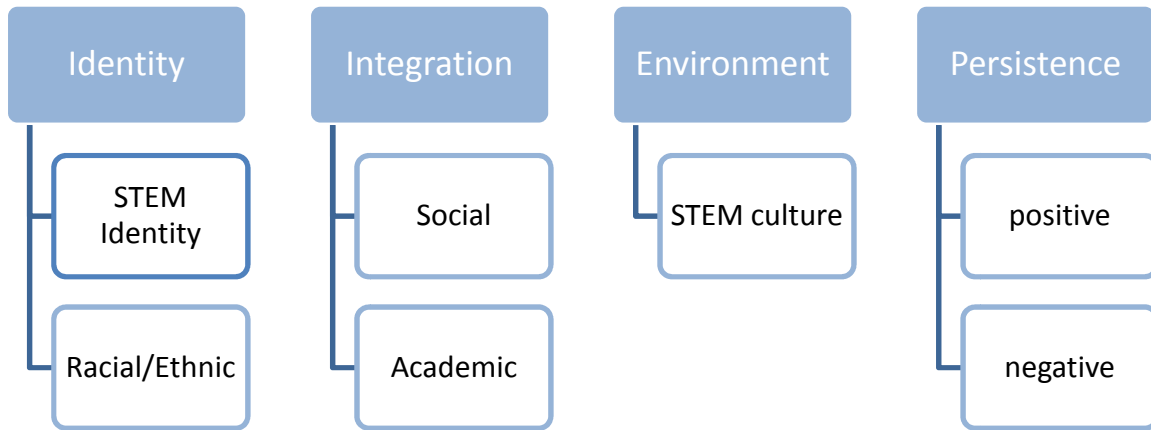
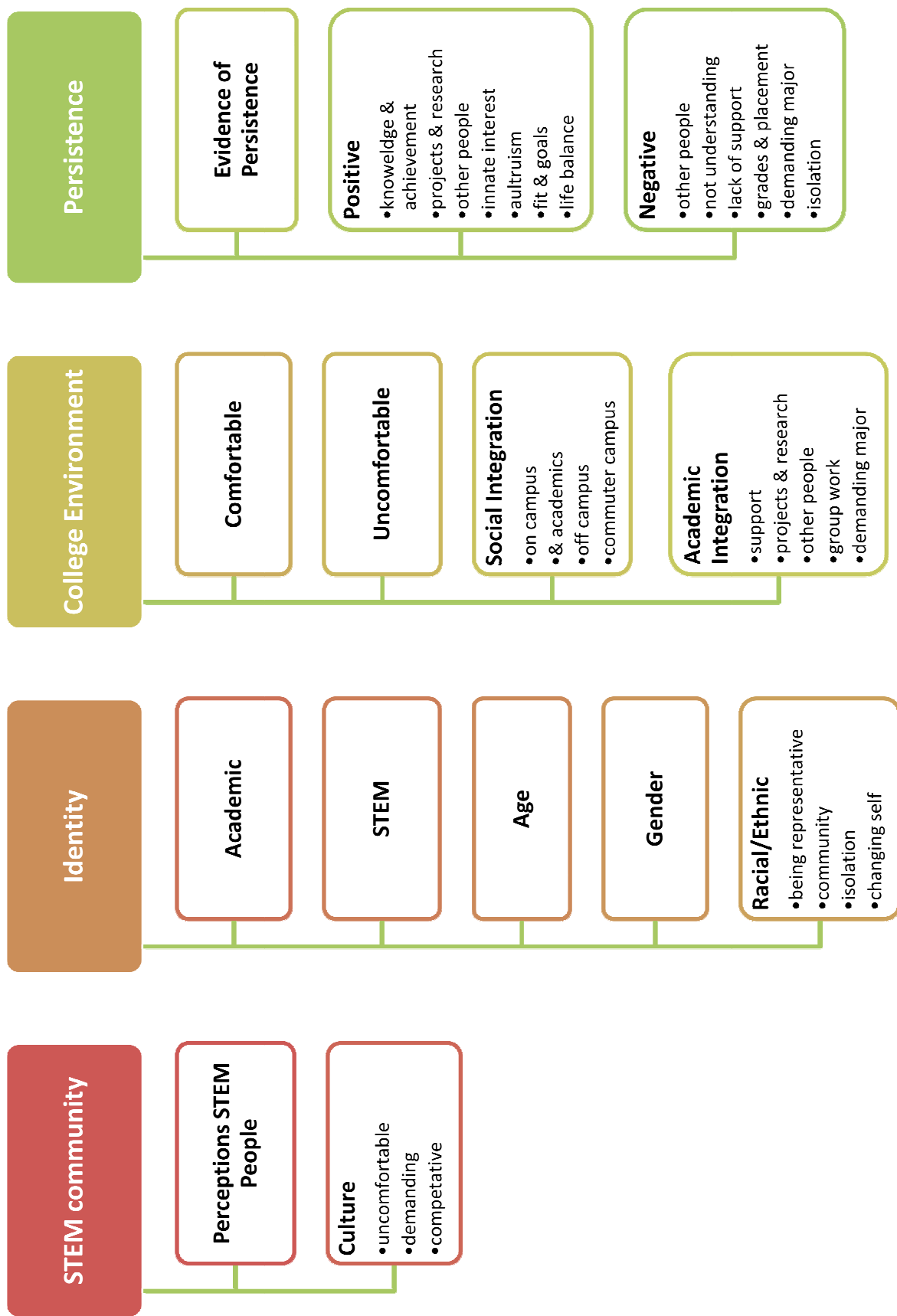


Figure 3.1: Initial Coding Structure

taken from the conceptual model, and overlapping codes were then merged and organized into the final coding structure shown in Figure 3.2. The final code structure has four primary codes: STEM community, College Environment, Identity, and Persistence. Because the concepts of identity, integration, and persistence are interrelated, simultaneous coding was allowed.

At the conclusion of the coding process, the data contained in each NVivo 9 node was printed and re-read to identify exemplar quotations for each code. The second cycle coding examined the data within the nodes and exemplar quotations using axial coding, during which data was constantly compared, merged, and re-organized (Saldana, 2009), organizing the formulated meanings identified during the first cycle into themes (Colaizzi, 1978). Three major themes emerged: Guidance & Support, Altruism, and Inclusion.

Figure 3.2: Final Coding Structure



The final step was to examine the nodes and the three emergent themes, using the conceptual model, to answer the research questions:

1. What are the developmental experiences of community college STEM students?
2. How do URM community college STEM students perceive their own identity?
3. How do URM community college STEM students describe their academic and social integration and persistence intentions?

I was interested in identifying overlapping themes and categories mentioned by the participants to better understand what contributed to the development of STEM identity, institutional integration, and persistence intentions of URM STEM majors, with the goal of gaining some understanding of what influence the community college environment may play in the trajectory of each. These themes were integrated into an exhaustive description (Colaizzi, 1978) and the essential structure of the phenomenon was constructed.

Validity

This study is ethnographic, designed to elicit student reflections upon their experiences in STEM in community college. STEM identity is self concept, therefore depending upon self-report data and individual reflection, and as a result interviews are most appropriate to collecting this data. The structure of three interviews and the passage of time over which the interviews occur allows for checking the internal consistency of the reflections and self-report data provided by the interviewee (Seidman, 1991). Data coding and analysis will begin with the transcription of the first set of interviews and continue throughout the study. As dominant themes begin to emerge, this information may be taken back to the field for further clarification and to check the validity of any developing researcher hypotheses (Seymour & Hewitt, 1997).

Establishing reliability and trustworthiness of a qualitative study presents many challenges due to the nature of the data. To further enhance the validity of this study, member checking was employed. Participants were invited to review and edit the transcripts to ensure that the information represented their perspectives, experiences, and viewpoints. In this case the reliability comes from “taking the data and interpretations back to the people from whom they were derived and asking them if the results are plausible” (Merriam, 1998, p.204). Having the informants evaluate the result of the analysis, to ensure it represents their original experiences, is the final step in Colaizzi’s (1978) phenomenological method. This process took place by following up with the participants via e-mail, forwarding a copy of each transcribed interview and a copy of the draft analysis section (Chapter 4) of this paper. The e-mail included a statement to each interviewee requesting feedback or corrections to the original transcripts and chapter. As a result of the member checks, there were no changes from the original transcripts and only a few minor changes to analysis portion of this paper. In addition to member checks, peer debriefings were employed to increase the credibility of the study.

Summary

This study uses ethnographic interviews, supplemented by participant observations, to examine the experiences and persistence intentions of community college students in STEM through the lens of STEM identity development and institutional integration. Data were collected from eight student participants attending three community colleges in the metropolitan area of a major west coast city. This chapter outlined the qualitative methods used in the collection and analysis of data for this inquiry. The following chapter presents the participant responses and major findings of this study.

CHAPTER 4

ANALYSIS & FINDINGS

The purpose of this study was to understand the role community colleges play in the decisions of students from underrepresented groups to pursue degrees in STEM fields. Questions about what contributes to participant's selection of STEM major, background, and college experiences were asked to help identify characteristics and experiences that were common among the students interviewed, using a semi-structured interview method. It was hypothesized that a qualitative study using guided semi-structured interviews of community college STEM majors could provide some insight into the role that the community college plays in their major experiences, their identity conception, and in their decisions regarding major persistence and transfer. This hypothesis is situated within a conceptual framework that looks at the interconnectedness of identity, environmental context, and campus engagement and their influence on students' major persistence intentions.

This chapter begins with a brief description of the participants in this study. The remainder of the chapter presents excerpts of the participant's responses, organized in two ways. First, participant responses to questions are assembled and presented using the conceptual model described in Chapter 2. Next, the findings, or "integrative themes" (Saldana, 2009), that emerged from the data to connect and relate the components of the conceptual model are presented. These themes represent trends in identity, integration, and persistence that are generally applicable to the student participants, regardless of major, institution, gender, ethnicity, or other "localized concern" (Lofland, 1974, p.103).

Participants

The participants' ages ranged from 20 to over 50 years old. All were born in the United States and were unmarried at the time of the interviews. Four of the eight attended high school in the same region as their community college; three are military veterans; and eight have prior college experience. Four of the participants started their intended STEM degree path in developmental mathematics. At the time of the interviews the participants' degree progress and degree paths represent the broad spectrum often found at community college (Vaughan, 2006). Eight of the participants were pursuing transfer degrees (7 of those in engineering), and two were pursuing certifications in Information Technology (IT). Three of the students were in their second quarter of attendance (for their current degree major), two were about half complete with their major required coursework at the community college level, three were applying for transfer, and one had already transferred to a nearby 4-year school. About half of the students received some financial aid, government assistance, and/or scholarships. All participants were assigned pseudonyms to ensure confidentiality for the individual participant and to maintain the anonymity of the colleges.

Participants' Profiles

Giles (30's). Totalling nearly four and a half hours, the three interviews with Giles were the most detailed of the sample. Originally from an African American neighborhood in a large Midwestern city where he attended a multiethnic high school, Giles followed his brother to the area. About to start his final quarter as an electrical engineering major at the community college, Giles identifies as Black American. When describing his upbringing, he describes his family as

Basically all middle class, so you had a lot of technicians in there. Like my grandfather was one of the first Black Americans back home to be certified as an electrician. So I

grew up basically working with [electricity] and TV. And, a lot of my family too [were] plumbers, lawyers, stuff like that. So I didn't grow up with, you know, the stereotypical, like, background of, like, a Black American.

At the time of the interviews Giles had recently obtained a work study position in the physics lab, where he tested and fixed laboratory equipment. Giles has attended multiple schools in different states, including a total of three community colleges in the local area. Giles intended to transfer to an HBCU, where he feels the school will better understand his learning style.

Joan (30's). Joan completed two interviews, each lasting about an hour. When asked about her background, Joan first mentions that she was born and raised in Hawaii. Her place of origin plays a large role in her cultural identity, possibly more significant than her Okinawan and Korean heritage. As she put it, "Hawaii definitely leaves a stamp on people." Joan holds a Bachelor of Arts in Psychology and a Bachelor of Science in Cellular and Molecular Biology from a state university, and a certification in Veterinary Technology from another community college in the region. Joan returned to the community college to take prerequisite courses for engineering. In the process of applying for graduate school in Bioengineering, Joan hopes to follow bioengineering with a doctorate in veterinary medicine. Joan is very involved on campus, working in the tutoring center, participating in clubs, and working as a peer tutor for calculus and engineering physics courses. Joan has loved science since she was young, saying "how can you not be interested in science? I mean, I don't understand how you cannot want to know about biology, I mean, that's us, it's our bodies, it's how you interact with the world. That explains life."

Jocelyn (20). The three interviews with Jocelyn took a total of two hours. The youngest participant in this study, Jocelyn participated in the Running Start program and graduated from

high school in 2009. Originally accepted to a large, east coast university, a mix-up regarding housing led her to return home and begin her engineering degree at the community college. The youngest of 7 children, five of Jocelyn's siblings have attended college, with two holding degrees in STEM. One of her brothers, an aerospace engineer, plays an important role as academic mentor and motivator. Of African American and Filipino decent, Jocelyn primarily identifies as African American. Jocelyn decided on a mechanical engineering degree because of a passion for cars. As she describes it:

You know how you see in the movies like when they see something like beautiful to them and they're just like in slow motion? ... That's how I, it's kind of weird like, I see a car and it might be going like 80 miles per hour but it might look like to me it's going like 2 miles per hour and I'm just like following it.

Kenneth (28). Kenneth participated in one, hour-long interview. Kenneth grew up in the local area and attended his community college directly after high school to play soccer. At the conclusion of his three years of soccer, he started looking for a trade and earned a certificate in automotive mechanics from a school in the Southwest. After three years as a mechanic, and at the urging of his girlfriend, Kenneth decided to return to community college to become a mechanical engineer. While in community college, Kenneth interned with a mechanical engineering firm, and decided to change his major to civil engineering as a result of that experience. Kenneth completed his community college coursework and has transferred to a nearby university, where he is pursuing his civil engineering degree with an emphasis on environmental engineering. Kenneth identifies as Chamorro-Caucasian mix and emphasized the important role that his girlfriend has played in his STEM experience, "she was like no, you can do it, you know, she gave me a lot of support so it helps out a lot."

Mary (20's). The three interviews with Mary took about two hours, total. I was also able to observe Mary during her Chemistry class. Mary identifies as African American and was adopted by white parents. After high school, Mary attended a large Midwestern public university for two years. After encountering problems due to a disability, Mary returned home to live with her family and began attending community college. While at university, Mary “tried on” many majors, but they never fit. When she returned to school at the community college she did so as an engineering major because

I don't know it just seems to fit more than the other ones do. I don't know like why. I like math. I like figuring things out. I like research. I like being careful and looking things up and like, I don't know, working on little tiny pieces of things ... I don't know... It just feel like -- I feel like it will work.

At the time of the interviews, Mary was taking precalculus and chemistry. After passing the chemistry prep course in the previous quarter, Mary was struggling with Chemistry and decided to audit the course. She attended the course daily, worked on homework assignments, and spent most of her study hours on chemistry, even after changing to audit status.

Rishona (50's). In addition to observing Rishona during her math class, I conducted three interviews with her, each lasting 40 – 60 minutes. An African American woman, Rishona grew up in a large Midwestern city. After high school, Rishona joined the army and served as a mechanic in Hawaii and Korea. After leaving the service, Rishona followed a loved one to the region, where she has lived for the last 25 years. She has quite a bit of work experience, including work as an automotive mechanic, a pharmacy assistant, and most recently as an internet and cable installer. After a work accident, Rishona was no longer able to work as an installer, and has returned to school to earn a certificate in Network and Systems Administration.

“I have been drawn to this field for as long as I can remember...The more I know about PCs, the more I want to learn about them.” Rishona is the oldest participant, and the only participant not pursuing a transfer degree. She is receiving state support and housing assistance and is not quite a full-time student, taking the maximum credits allowed by the state programs.

Shane (40's). The three interviews with Shane each lasted 60 - 90 minutes. In addition to interviews, I was able to observe Shane while studying in one of the college's common areas, in the STEM building. An African American man, Shane is a military veteran and holds a Master's degree in psychology and counseling. After being laid off by a local school district, Shane is receiving funding from an unemployment program to change his career. As part of the program, Shane must work toward a professional/technical certification. While completing the requirements for a certification in Information Technology (IT), Shane is also completing courses for an engineering degree. After completing his certificate, Shane hopes to work in IT while continuing his studies in environmental engineering. Shane began his engineering path in introductory algebra, part of the college's developmental education program, and has progressed through precalculus 1. Pursuing both a professional/technical certification and a transfer degree, Shane often comments the difference between the “broad spectrum of students in the IT program” versus the lack of diversity in the STEM transfer courses.

Tyrone (30). The three interviews with Tyrone totaled about two and a half hours. Tyrone is the lone student participant from his college. An African American from a large Midwestern city, Tyrone joined the Navy directly out of high school, where he served as a nuclear machinist for 6 years. His interest in math and experience as a mechanic led Tyrone to pursue a degree in Mechanical Engineering a few years after separating from the service.

I love math. I love numbers. I love anything with numbers...that's my biggest passion and I love to check the machinery ... I did the research on it and just having to find out that it was the job for me.

Tyrone receives financial support through his VA benefits and the National Science Foundation S-STEMS scholarship. Though Tyrone started his engineering path in pre-algebra, the time of the interview Tyrone had only three pre-engineering courses left to take at the community college and was applying for transfer to one of the large state universities. Tyrone is very involved on his campus, speaking at events for the college foundation, participating in the physics and engineering clubs, and tutoring in the math learning center.

Participant Responses Organized by Conceptual Framework

A summary of the conceptual framework employed in this study is provided before the presentation of findings. This framework provided the lens for interpretation of the participant responses. To understand how students experience their STEM majors, a STEM identity that interacts with one's racial/ethnic, gender, and academic identities was studied. This model treats these four component identities as the majority inputs to the identity that students portray within the context of higher education. Where these component identities overlap, students have managed to integrate identities. The more integrated these identities, the more integrated one's overall identity (Figure 2.2), the less they overlap the more oppositional the component identities and less integrated one's overall identity (Figure 2.3). In this model, three dimensions (Figure 2.4): performance, competence, and recognition (Carlone & Johnson, 2008), were used to study the STEM identity.

Each revision to a student's identity informs and impacts that student's behavior within a particular context or environment. Interactions that promote positive identity development (in

any or all components) moves students towards social and/or academic integration (Figure 2.5). When interactions result in a degradation or disruption to one or more component identities, students move away from integration and towards disassociation. Those who are well integrated within the academic and social environments of their college or university are likely to persist at that institution (Tinto, 1993), while those who do not integrate successfully are more likely to depart from the major or the institution, or possibly depart higher education all together (Tinto, 1993).

The components of the conceptual framework formed the basis for the coding scheme. The first analysis of the data used a holistic approach, organizing data into the different components of the conceptual framework (Figure 2.5). The primary level codes were Identity, Campus Environment, Integration, and Persistence. In the initial coding each of the primary codes had one or more sub-categories. The identity code had four sub-categories: STEM identity, academic identity, gender identity, and racial/ethnic identity. Campus environment was broken into three sub-categories: Comfortable, Uncomfortable and STEM environment. Integration had two sub categories: academic and social integration. And, finally, Persistence had two sub-categories corresponding to data that contributed to increased persistence intentions (positive) and data that contributed to a weakening of persistence intentions (negative). The first analysis of data allowed for simultaneous coding. Participant responses are presented here, organized using the first cycle coding structure. The second analysis of the data examined participant responses in more detail using pattern coding to search for major themes from the data, within and across the primary codes. These themes are presented later in the chapter.

Identity

This study focuses on the development of the participants' STEM identities and their compatibility or dissonance with the participants' racial/ethnic and/or gender identities. "Identity is not just something an individual feels; it is not even what an individual does... science identity is accessible when, as a result of an individual's competence and performance, she is recognized by meaningful others" as a science person (Carlone & Johnson, 2007, p. 1192). While the participants discussed both STEM competence and STEM performance, the participant's perceptions of positive or negative recognition provided the most information regarding identity conception. The section explores participants' STEM identities and, in particular the recognition dimension, which is most helpful in explaining the differential experiences of the participants and makes visible the interactions between the participants' STEM identities and their ethnic/racial and gender identities (Carlone & Johnson, 2007).

All of minority participants expressed an intrinsic interest in STEM. For most, this was not expressed as a passing comment, but more of a testimonial to their love of math, science, or engineering; STEM was part of who they are and what they love. While some examples were provided in the participant profiles, perhaps the most eloquent declaration came from Giles.

You know, if you look at a flower and you're like, 'This is the best looking rose I've ever seen,' the beauty, like how it opens up when the sun comes. That's how I look at robots... looking at the [the robot] every day I worked there, was like a gardener looking at the most beautiful rose he or she had like ever seen.

I begin with the topic of intrinsic interests, because this intrinsic interest is the first step toward formation of a STEM identity. Kenneth explained when it started to happen for him:

[It was] one of those things where you are trying to take something apart that is more complicated than it should be and you think to yourself ‘I could design something way better than that.’ That’s when I started thinking I could actually be an engineer.

This intrinsic interest produces those first glimpses of a STEM self, the self recognition described in the science identity model developed by Carlone & Johnson (2008). Being someone who *likes* STEM leads people to consider the possibility of becoming someone who *does* STEM. For these students, clearly, loving science is as much of who they are, as their gender, their race, or their sexual orientation.

Student participants provided multiple examples of experiences that contributed to the solidification of their STEM identity. Most of these experiences were related to the performance of relative STEM practices and knowledge and understanding of STEM content (Carlone & Johnson, 2008). Achieving success within the realm of STEM knowledge and performance boosted students’ STEM self efficacy.

A few of the participants begin their STEM stories with accounts of recognition by significant, non-STEM, persons. For two participants, this recognition sparked an interest in engineering that they had not had previously. Giles, for example, describes how he first considered engineering after an encounter with a grocery store clerk:

One of the people actually who suggested that I go on to that field happened to be a guy, a black male working at the grocery store. I forgot his name, but you know, I used to come in there and buy stuff and he ask me...he was like, ‘Are you going to be a engineer?’ And I was like, ‘I don’t know, you know I’m 15. You know, like I’m still trying to go dating.’ So when he kind of said that, I told my mom. And like my mom, she began to kind of push it on me.

After high school, Giles did not revisit the idea until participating in a program in Africa, when “they ask me to figure out stuff and things like that...they needed me to actually figure it out, and so I moved out here and said I’d do engineering or die.” In Kenneth’s experience, becoming an engineer was an idea first planted by his girlfriend. He describe how she said,

‘Why don’t you do engineering’ and I was like oh, I never thought I was smart enough to do the math, just I couldn’t...I don’t think I’d be able to do that...my girlfriend’s, kind of, push got me back into school. So, I came back to [this] Community College, taking all of the prereqs for engineering.

While interest in STEM was often sparked by others or experiences as a child, these interests were then fed through a combination of course, projects, and teachers encountered on their academic path (K-12 and college). When asked about their best learning experiences, participants generally described a class during which they felt enlightened, learning a lot, and gaining understanding or clarity.

When Kenneth describes his best learning experience, a course in astronomy, he explained that there was nothing special about the class presentation or laboratory activities. For Kenneth, what made the class a great learning experience was all about the knowledge and understanding he gained, “It was interesting learning about the solar system and I’ve always been, like, a sci-fi person. I like Star Trek and all that stuff so it was just fun for me because I was interested in it.” Jocelyn described her favorite class, a math course, similarly, saying she loved it because the instructor “made everything interesting and...then he really broke everything down really well.” When asked what about the class made it her best learning experience, she explained “He never really did too many activities. He just pretty much just talk and he’d show short cuts for this and that... [making] math...a little more easier.” Mary

described a similar enthusiasm for the subject of math, “It was so much fun just to think math. Think about math, explain math, talk about math.” For Joan, her favorite classes did not just feed a desire to learn more content, it corrected years of not understanding, becoming a transformative experience, solidifying her mathematics identity:

'Cause, like, I took calculus in high school, I took it again at the university and it was like 'I don't get this.'... And now, 'cause the way they explain it, it's just, it's so clear... So, now I feel that math is more one of my stronger subjects.

In each of the instances above, the student's passion for STEM was fed by the courses they took, building their competence, and therefore their STEM identity (Carlone & Johnson, 2008).

For some students, their best learning experience was both a chance to excel and an enlightening experience, like that described by Giles, who completed a course project based on a design he discovered for a 300-year-old Japanese robot:

My best learning experience was my dynamics class... It was my best experience because it was the first time I [picked] something. I took on an idea of like a presentation and I stood strong with it and I got it done. It was said to be one of like the best. In the process, I learned the relationships between equations and it helped me to, in my mind, to finally see where my strong points are going to be in, like, my field. It's going to be understanding, like the relationships between the equations that I'm working with... because it wasn't a set presentation like you couldn't go look online, you had to use the skills that you have learned in the class...you had to come up with it. And it turned out to be really, really...it was really fun.

Meeting the challenge contributed greatly to the Giles' recognition (both self recognition and recognition by meaningful STEM others) (Carlone & Johnson, 2008). Tyrone's best learning

experience involved overcoming a challenge encountered on a project during his precalculus class.

I was kind of discouraged during the course because I was working with somebody who was like part of my group for a financial project, a precalculus project that we were to turn in about a couple of weeks before or a week before finals. And unfortunately, my partner, he... didn't like give me a heads-up, say, he's dropping the class and with him dropping the ball like that... And my instructor was like, 'Well, you're on your own now.' I was like, 'Well, what can I do? I mean can I jump in with somebody else?'... [She said] 'You just got to make sure you pick up your work.' I'm just like shoot. I was kind of discouraged with that. Then she came to give me a little bit of confidence and with the work that I had currently on hand was good, which I felt about wasn't substantially enough, but when I finished the whole project, and I turned it in, make sure all the Math was on point and the essay is the introduction, body, conclusion, the whole report was just is still as I can be. Now, I'm praying it will be something good and when I come to find out, it got like a 97% on that project. I'm just like...that's pretty good. And she's like... 'You actually did very well on your project then. You lost your partner, and now you still managed to do well. I'm happy to give you this grade. It's so thoroughly done.'

Tyrone stepped up to the challenge and succeed, and, as a result he received valuable recognition from his precalculus instructor.

Many participants discussed the importance of recognition, particularly in the form of grades on their STEM confidence. Mary's story may best describe the ups and downs that come

with grades. When asked about challenges or negative experiences, anything that might make her feel discouraged, she says, without hesitation:

Bad test scores, knowing that there is a test, studying really hard for tests, feeling like I'm not absorbing things. Like, it starts to become, like, this panicky thing where I was just like 'I'm doing something, it's not doing anything' just keep you in kind of terrible cycle. She also explained that she feels like she is the only one who feels that way, but that the feelings of doubt brought on by exams can be countered by success in other areas of class:

I can do, like the homework and stuff, I get like in the high B range homework...I could explain things to people when they asked me about chemistry...Like when I can do the homework, then I'm totally okay, I can do this, I know this, and it good. But there are other times when it is like, no.

Or, as Joan explains "It's a roller coaster in some classes. You hit the, I understand, the little high and you're like, 'life is good'. And then, you're on to the new subjects and you're like, 'I don't understand'." Later in the interview she explains further, "grades take the fun out of everything. They do 'cause you're so focused on trying to make sure that you get a grade that's acceptable to somebody else." Even though she laments grades, Joan explains that her STEM confidence has increased overall "cause I am able to be successful."

Most of the participants mentioned academic success in their STEM classes as important to their personal STEM confidence, some students described how academic success was important to recognition by their classmates and peers. For example, Kenneth described how students had "to prove yourself first, before you get accepted into White—or Caucasian—study groups." Giles tells a similar story about trying to recruit a classmate as a study partner. He was

continually turned down until the student witnessed Giles achieving high marks in class. Giles had been helping students build bridges for their engineering class, he explains

There's one person I particularly helped, he came in second place. So, this guy, we'll call him 'Guy D'. Guy D saw that and realized, you know that, 'if I talk with Giles'... So he comes up on Saturday and he was like, you know, 'we can just study Physics, but can you also help me with my engineering project?'

In other words, the participants describe the need to earn their place in the STEM community. Many of them also described the need to be better than their classmates in order to maintain that membership, particularly the women. Jocelyn explains that women are "probably not going to get a lot of help from the guys because maybe they don't really want us to be here, I mean, it's a male dominated field but if you do just as good as them, if not better, [you'll be fine]." The supposedly meritocracy of STEM departments results in underrepresented students having to work to gain acceptance from their peers and faculty and to maintain membership in the STEM community (Ong, Wright, Espinosa, & Orfield, 2011; Ong, 2002).

Identity Integration

While academic success contributes to a strong STEM identity, all of the minority students described experiences in which the lack of recognition, embodied by feeling excluded, the inability to find study partners, or the discomfort they experienced in class or in teacher's offices, impacted their STEM experience. This section explores how individual students experience interactions based on students' identity domains (Brown 2004). In other words, race and ethnicity affect recognition, both self recognition and recognition by others, thereby influencing identity integration.

While many of the students described prior experiences that demonstrated dissonance between their STEM or academic identity and their ethnic/cultural identity (such as being called an Uncle Tom because of an interest in education—Shane; not fitting in with their ethnic community after attending college—Kenneth; honors classes not being cool in high school—Mary), the interactions and environment that participants gave the most weight to were those on campus. Jocelyn described such an experience in her Introduction to Engineering course:

Because I remember the first day walking into my engineering class and I remember walking in and there was a lot of white males, a whole bunch of international students and I walked in and like, everybody was just looking at me and I'm just like, am I not supposed to be here? What's going on? Why is everybody looking at me while I'm walking in? And then even when I was walking to my seat, everybody was still looking at me, I'm just like, are you amazed? Do I have something hanging out of my nose, what's going on? I don't know, and I was just like, man, now I feel kind of uncomfortable but I guess I might as well get used to it because I'm not going anywhere.

Mary's experience in chemistry is not unlike Jocelyn's experience in engineering. When asked if she has a study partner for chemistry, Mary explains "Not this quarter because I never really connected with anyone." She goes on to explain "I mean there's all sort of -- there's Black people here. There are Asian people here, Latino people here and they're everywhere, you know. But, since they're not in the sciences, I'm the only Black person in my class, in my chemistry class." Shane laments the difficulty of trying to find study partners each quarter and went on to explain that the great diversity of students in his developmental mathematics course and his IT program was missing from the STEM transfer classes. "Well, like I said, just in walking around the halls here, especially at the [STEM] building, hardly any Black people." In

his precalculus class Shane feels like “the Albatross” & “the old guy” noting that the other students are all young traditional students (right out of high school) or young Asian international students.

Race and ethnicity is not only a barrier when trying to interact with other students, but it also impacts interactions with faculty and staff. Shane explains that his Science and Math instructors are the “least pleasant to interact with” and assume that he is “incapable of thinking.” Mary explains “I’ve had people act like I was wasting their time and I’m not smart enough to be in their class, but they don’t actually say it.” Giles was the most direct stating that

I never felt more uncomfortable in a classroom situation or in life as what I do a lot of time and some of these classrooms here. And that's, I think that's like due to... I think that those teachers need to go to some of those like, ethnic, you know, classes or stuff like that... But honestly and truthfully, a lot of these teachers, they really need to go to like those classes and realize how much they really are creating, a very serious problem.

They are making like the minority students, you know, uncomfortable.

As they try to improve their STEM practice and expand their STEM competence, the feelings of non-inclusion and discomfort make it difficult for minority students to obtain recognition from meaningful STEM others and maintain their self recognition as a STEM person. Jocelyn makes this clear when telling a story about an interaction with an Engineer during a campus event

I feel like, there are times when I’m like maybe this won’t be it for me because sometimes I feel like maybe I can’t handle a lot of people because like, like yesterday, we had an engineering meeting here.... and we got to talk to different engineers and stuff like that and then I remember talking to this one guy... but the way he like came off, he felt really snooty and just, like he was just rude. And, I was just like, I’m just asking

questions because I'm just trying to figure out what's going on and I don't know if he's having a bad day or what it is? But I don't know and sometimes I feel like I can't deal with people. So, sometimes I'd be like I don't know if this is something I could do.

When they have encounters like those describe above, I was curious to learn how students deal with the experiences. Many of them simply try to 'get over it.' As Jocelyn explained "but then, in the world, you have to deal with anybody in whatever it is, it's like you got to get over it." Or, as Kenneth explained "I guess I would say I'm more on the moderate side because I don't over react to stuff." But, getting over it can be tough.

When students reach a point when they cannot cope with challenges to their ethnic/cultural identities encountered in their college experience, they seek help from meaningful others (Pizzolato et al., 2008). Mary described the importance of finding "Find some other minority people to hang out with and to commiserate with because you are going to be alone." But sometimes, even that is not enough. A few months after our interviews in an email, Mary described

This morning I had a conversation about race and education with a colleague (another student of color). We discussed how we constantly have to validate our selves and fight against the stereotypes we are pushed into. The classes I take are extremely difficult intellectually and emotionally because of how race interacts with my academic experience. I like math, so I continue to do school but the academic culture is exhausting.

The culture that she describes is the environment in which she experiences STEM. That environment contributes to a tension between her STEM and racial/ethnic identities.

Environment

The community college environment is unique, and vastly different from most 4-year schools—public or private. First, community colleges provide open enrollment, serving all those that seek education, be it high school or GED, continuing education, English language education, professional or technical education, or working towards transfer to a 4-year college or university (Vaughan, 2006). As Shane describes it, “This college is exponentially more diverse” than other colleges he had attended. The many missions of a community college result in a diverse campus, but this diversity does not necessarily translate to diversity within academic programs.

As Shane explained earlier, there is a shift in diversity and culture when moving from the developmental education courses to the STEM transfer classes. This shift is similar to the shift students experience upon transfer to a four-year college or university (Valenzuela, 2006). Other students describe a similar divide between their STEM courses and their general education courses. Jocelyn explains that while the campus is very diverse, she often feels isolated because “you don’t really see too many of us doing what we’re doing.” When asked why there were so few women and minorities in the STEM majors, Giles answered, “Oh. That's actually an easy one. It's [the] social atmosphere.” While many campuses today look diverse, the consistent theme of alienation experienced by students of nontraditional backgrounds in their campus environments is symptomatic of a deep underlying problem (Smith & Wolf-Wendel, 2005). For Giles, the social atmosphere in STEM at his community college influenced his decision to transfer to an HBCU:

I have to hold it in and crack jokes about how like uncomfortable at times like I really am... It's not everyone of them. But you know a good strong like percentage of the

students, I always personally am very uncomfortable with. So that really plays a big part in my, me dealing with school.

And, while it is not the only factor in Jocelyn's decision to apply for transfer to a college in Georgia, she does mention that "I mean, I know there are more people like me, that's doing the same thing as me."

For Joan and Mary, who both attended large universities before attending community college, they describe the community college environment as much more comfortable and welcoming than the university. While the university environment was competitive: "you're all fighting for the next level of graduate school or whatever" (Joan), the community college is less so.

In both places, there are still those people who come to you, and ask 'how do you think you did?' People who want to talk about the test, [but] that's not comfortable...you know building yourself up, trying to build yourself up by making other people feel bad. I don't want people to be scared, you know what I'm saying? ...it's definitely less competitive here and I like that. I like that idea. Without being necessarily just not academic or just way too easy or something, it's just... we're not like running a race. I don't need to say 'I know and understand more than you.' (Mary)

Mary also explains that her race and ethnicity are

not as big of a deal as they were [at the university], which is nice. I feel like it's more—more equal than it was there. It's less tense here because [the university is] very -- it could be hostile sometimes but it was more it was tense and here it's not really tense because it's ordinary gay people, ordinary black people, it's whatever...it happens.

Even Giles, who has often been very uncomfortable at his school, says

I think that the difference is like [at this college] is that people are more open to listen to me, to make the changes that are like necessary. I think that that's like the major difference between like other schools. I feel that other schools I've been at really truthfully, they don't...it's not that they don't care but they don't see the reason why things need to change because nobody is speaking up about it.

Tyrone, the only participant from his college, had a very different experience than the others. He describes

I think I have been seen as an equal in my time of being there in terms of interacting with the teachers, [getting] the help I need and maintain a very good level of professionalism. I didn't seem like I was shown out or ostracized in any sense. I feel that the equal treatment there has been very valid in my experiences of being here.

While it is easy to focus on the negative experiences and feelings the participants have regarding their campus environment, most of them described finding space on campus where they were comfortable. Most of the participants spent a significant amount of time on campus, even though many of them commuted quite a distance. All of the participants felt that being on campus was important to their learning. Shane worked in the STEM building common space where he would see fellow students or faculty

Because quite a few of the math teachers are on this floor. Just going from their offices to like this administrative area... people walking by [say] 'Hey, how's it going? Do you have a question? Now, you're like you're scratching [your head], [you've got] that look in your eye.' And to have that resource is a tremendous thing.

Rishona described a similar environment in the hallway outside her math class: "I, like, went around the corner [and] found another spot and it was open so I was really glad and then my

teacher walked by he was doing a walk about you know.” Tyrone mentioned other resources like the computer lab “if I need to get some homework done or I need to take advantage of the resources of the school, I would stay here and use the resources of the school like some computer programs.” For Mary, campus represented the space where she could study. She needed to “get out of house you know it’s like get on campus because that’s really important to my, I don’t know, being focused in school.” Giles spent most of his free time in the Physics lab because “everybody there [taking], like, engineering or science class at some in point in time, they have to cross through there.” Each of the minority participants described one or more spaces where they felt comfortable studying, meeting with friends, or conducting group work. Being on campus creates the opportunity for students to engage with the campus, but the level of engagement is influence by the ways in which the college environment (social and academic) interacts with a student’s identity.

Integration

The ways in which students connect with the campus community, academics, and their selected major can vary from student to student. Recall that identity is contextual, open to revision, and produced by interactions of the individual with their environment (Brown, 2004). Nora and Cabrera (1996) found that perceptions of prejudice negatively impacts the ability of minority students to adjust to the realms of college, and dominates African Americans’ institutional commitments (Cabrera et al., 1999). Interviews with minority community college students in STEM indicate that perceptions of prejudice negatively impact social and academic integration and, in turn, major commitment.

The most significant impact to college integration seen in this study was on social integration, specifically in academic group work. Participants discussed group work within two

contexts: (1) assigned group work such as laboratory or course projects, and (2) study groups. Most students describe their experience with assigned group work focusing on the initial process of group assignment. In the experiences of the student participants, instructors often left groups to form on their own. For students who already felt excluded because they were only woman, only minority, or only Black student in class, finding a group was challenging. In some cases the experience was extreme, such as this one, described by Joan

I felt very shunned aside as being one of the only girls in the class and all the guys were just being all cliquish. And then the teacher made...them like...choose like, there were like four team leaders and they all got to choose the people they wanted to work with, so I felt like being on the playground and you are the last person chosen again.

This feeling of being excluded from groups was also described by Giles “so, like a lot of times, like, students will have lab work, they really, you know, they tend to click and leave me out.” The inability to infiltrate peer study groups that do not contain other minorities is common to minority STEM majors (Justin-Johnson, 2004). Kenneth explained that when groups are not assigned, “I guess, the minority students always kind of hang around each other like our study groups or my study group, we have me, an Indonesian girl, an Ethiopian girl, a Nepali girl and that’s like our study group and that’s maybe 99% of the minorities in the class.” In addition to feeling left out of groups, participants described groups in their STEM classes that were competitive rather than cooperative. Kenneth explains that when working with minority students,

It would be less competitive just because like we’re all trying to help each other. So, like, if we don’t understand something, someone else will take the time to explain it to you

and then there's no sarcasm or anything afterwards like, "oh, you didn't understand that?"

STEM climate, including issues of exclusion, invisibility, a sense of belonging, and microaggressions (like the sarcasm described by Kenneth) are characteristics common across the college spectrum for minorities in STEM (Ong, 2002).

The second aspect of group work that the participants discussed was study groups. Every participant identified study groups as important to their academic success. Mary explains how a study group or study partner helps her stay focused "we just sort of study in the same space. That's helpful because it's like I feel like I have to do work if I'm with somebody else, I can't just goof off." Shane comments that with his study partner "it seems like almost inevitably, he has troubles with things that I don't have troubles with and we can kind of hash something out." Having a study group was so important to Joan that she started a club just to create a study group. "The Calculus Club, the reason I started that was actually, I was trying to just have a study group." Not only did her Calculus Club become a study group for math, members also studied physics and engineering together.

While all the participants describe the importance of having study partners, most of the minority students expressed difficulty finding people to study with. For some of the students, the problem was logistical, related directly to the community college campus environment. High demand for courses meant that they filled rapidly, and even the waitlists were full by the second day of registration. As a result, students cannot always continue through a course sequence together and study groups dissolve. For example, Mary had a Chemistry study partner during her fall quarter Chemistry Prep course, but "the reason that we're not ...that I don't have a study buddy is because she didn't get into chemistry class." For other students it was the challenges

associated with attending a commuter campus. Shane explains, “most of the people in my class have...they have jobs...so sometimes it’s kind of hard to solidify somebody to study with.” Joan elaborates, “Well, at the community college, 'cause a lot of people have, you know like, kids and families and stuff, so it's not always easy to get together and meet with people.” When Mary compared the community college to her previous experience at a large university she explained the university was different

because there would be clubs and there’s like the engineering dorm. And, I don’t know, it just seems like the people sort of gravitate to each other and hang out because they actually live there. But here, it’s sort of like, ‘oh, I think you’re cool. That’s cool. Okay, bye, see you later. See you tomorrow at class’...Yeah or they’re—they’re friendly and they’re like, ‘okay, let’s go home’ and home is like two hours away...

In other words, finding social integration on a community college campus is a challenge simply because community college student have lives and responsibilities that take them off campus—so that they spend more time off campus than on (Astin, 1993).

While the logistics of community college were important, it seems that the minority participants were more bothered by the exclusion they felt within the STEM major itself. For example, Giles describes how “studying alone has personally...or having to like study alone I think has had the biggest effect on more like my progress.” Jocelyn explains it this way,

people usually work or go try and work with the people that looked more like them and stuff like that because they feel more comfortable to interact with them rather than somebody else that looks more different than them...[so] you got to figure out who you can really work with or you’re just going to be alone.

When asked if things would be different had she attended the university she first applied to, she states “I probably would still feel like I was isolated, by myself, even though there’s more people that’s like me... I feel like the people down there weren’t doing what I was doing either.” In other words, feeling alone and excluded is not a result of the college, the campus diversity, or the local community so much as it is a result of the decision to major in STEM. Being the “only one” in courses or group can impede identity integration because that person is ‘one’ rather than “brought into a community of practice where one is automatically part of ‘we’” (Malone & Barbino, 2008).

For Giles, this constant feeling of being excluded, and being “only one,” lead him to seek out other African American students in engineering and become a peer mentor. At his first community college, he reached out to Tyrone. For Tyrone that meant finding someone with whom he could relate. He explains it like this

I’m the only black guy here, as a minority in just a field of Asian students, the whites, and a whole lot of people, but there are very few people of my kind that I would be able to associate with. For some reason, I don’t know why... It’s always good to know somebody or socialize with somebody from the same place as you, you can...It’s just a funny thing how you and the other person, if you’re from the same area, that you can relate thoughts and experiences.

Because Tyrone “had the light of Giles to help me out, to kind of guide me,” he was inspired to reach out to someone else in the engineering pipeline at his college. “So, I’m kind of helping with him along the way. And, I tell him the experiences I go through; I help him with Calculus and socialize.” At his current community college, Giles was mentoring a couple of students,

including Jocelyn. Though Jocelyn has a brother who is an engineer, having a peer mentor has been important to her. When asked how she deals with discouraging moments she explains

I always talk to Giles. Sometimes, I don't know, it's hard to talk to other people because I feel like sometimes they just don't get it because they don't do what I do, because they're not headed where I'm headed so I don't know, sometimes it just feels different. But with Giles, I can talk about it because he's going through it, he went through it and he's been there, done that.

Minority support has a very important effect on STEM ambition and commitment to STEM degrees (Grandy, 1998). Giles, and Tyrone, reached out to other African American students to help them integrate, academically and socially, on campus.

Because there were so few minority students in their classes, minority peer mentors were hard to come by. Many participants found minority support in other ways. Mary found a place of belonging in the college's Multicultural Office. Shane built social connections through tutoring at the math learning center. Joan started the Calculus Club to facilitate her social integration.

While group work dominated the data on integration, there was one other topic brought-up by nearly all the students in the study: lack of, or poor academic advising. As Giles put it, "The biggest problem, too, is... I don't know if you're going to ask, but it's proper advisement." Only three of the participants did not dwell on issue of advising: Mary and Rishona, both of whom participate in TRIO (Federal outreach and student services programs designed to identify and provide services for individuals from disadvantaged backgrounds), and Tyrone, a National Science Foundation S-STEMS (NSF scholarship program) scholar. These students received regular advising as part of their participation in those programs. One of the first challenges with

advising seemed to be lack of adequate resources to meet the needs of the college. The challenge with academic advising seems to be finding someone who will do more than just point students to academic planning sheets, but can assist with information regarding prerequisites, learning about what courses meet the major requirements at the school to which the participant wants to transfer, or simply knowing what electives they should take.

Joan's difficulties with advising were because "I don't really fit the mold of students at Edmonds so they didn't really know what to do with me." Joan was bounced from one academic advisor to another. Though Joan's school has faculty advisors that specialize in STEM advising, she was never recommended to a faculty advisor. Jocelyn, on the other hand, couldn't seem to find anyone who knew about the engineering degree tracks.

I was trying to figure out like by myself because when I was asking like the advice in the offices and stuff, it's just like they would give me this sheet of paper of the different AAs, whatever, and they said, follow this guide. And then like I'm following it but I'm like, I feel like it's not helping me like this is...I don't know if this is really what I need for my courses but they're just telling me, oh follow this, follow this so you can get your AA to transfer or whatever. And I was just like, something is not right but I'm taking these classes and I was just like, I really feel like I'm behind or something because something just didn't feel right.

The most common response to poor advising was to take matters into one's own hands. However, without the proper guidance, students often ran into problems. For example, Jocelyn ended up taking the wrong physics course. For Jocelyn and Tyrone, the key to advising was Giles. In both cases, he helped them with their course planning, and put them in contact with someone at their colleges who could provide engineering specific academic advising.

Eventually, one of Joan's instructors was able to provide the academic and transfer advising she needed. In all of these cases, the students found their way to academic advising independent of their college advising center. Problems with advising suggest that students who do not have, or cannot find, a network of support are excluded from the institutional knowledge necessary to successfully navigate their STEM degree and transfer to a 4-year institution (Marlone & Barabino, 2008).

Many of the participants also indicated regular use of academic support services including tutoring offered in the college tutoring center or math learning center and/or tutoring provided through TRIO and S-STEMS. As Joan explains, tutoring was key to her success, "The Tutoring Center was awesome because that's where I went first to get help. We had some really amazing tutors... that really helped me 'cause math was so poor for me." Tyrone expresses similar reliance upon tutors, but explained that the availability of tutoring has decreased as he has progressed. "It's a little bit more harder to find that extra help [for] my studies—for engineering. I don't think there's anybody to find who would tutor dynamics, engineering dynamics... the hours I've been taking extra help has been dramatically cut." Giles had run into a similar problem at his school. "On my level, there's not really any help like you...if you can't get it from like the teacher." Mary encountered challenges with finding tutoring when tutors simply did not show up to work.

They're suppose to be chemistry tutors but you go there and say 'I need help with chemistry' and they look at you like, 'Oh, I do math. I want to go check the schedule and see if the chemistry person is here' and then you can already check the schedule yourself, they're suppose to be someone there but they're like, 'Yeah, they just didn't come today, so sorry.'

Mary and Rishona, through TRIO, and Tyrone, through S-STEMS, were able to find additional tutoring when the college tutoring and math learning centers could not provide it.

For the minority participants, academic and social integration was heavily dependent upon interaction with a peer mentor (Tyrone and Jocelyn) or participation in a specific support program (Tyrone, Rishona, and Mary). The students that did not have the benefits of either a peer mentor or support program had to find ways to become part of the STEM academic and social community—through the formation of clubs (Joan), campus jobs (Joan and Shane) or multicultural study groups (Kenneth).

Persistence

The participants were asked about the academic tough times, when they got bad grades, had a negative experience with an instructor, or were overwhelmed by their degree path. There were generally two things that helped them through those discouraging moments: people they care about, and their personal resolve to meet their goals. Tyrone discussed his experience when considering a switch of majors. Having always excelled in mathematics, Tyrone was “knocked down” by his first engineering course, Engineering Statics.

The very first time I took Statics, Engineering Statics. I knew it's all...like a lot of it is applied [math]... I felt very confident, very comfortable in what I was capable of doing in terms of that work, but when it came to applying that Math, it turned out to be a completely different story and I was struggling and I am not doing so well. I got 1.1 in my Statics, the first time I took it, and that really discouraged me... I started to have second thoughts about redirecting my career in terms of engineering 'cause I was like, oh my gosh, I can't believe that this Math that I've done so well in is now, for some reason, I can't put it to good--I can't put it to the right use in terms of my career. I mean, I could

do numbers and any calculations, formulas, this and that, but then, the application of the material, that's where I was having a challenge at.

While all the participants admitted to fleeting thoughts about switching majors when frustrated, Tyrone spent a couple of weeks seriously considering it:

And so, I kind of just talked to people and listened to other people who maybe had some struggling and I talked to maybe some other students of other school as well... They do have struggles as well. So, they said not to be down and discouraged and just keep progressing and there's eventually light at the end of the tunnel, just learn from your mistakes, study your notes carefully, and get the extra help. And that's what I definitely did.

In particular, Tyrone mentions talking with Giles, "he has definitely been there to, kind of, throw some words to live by, from his experiences. 'Cause he's also a black man as well." For Tyrone, having someone to talk to, who has been through what he was going through, was important to overcoming the challenge that he was facing. With the support of his friends, help from his instructor, and some additional tutoring, Tyrone earned a 'B' in engineering statics the second time around, and demonstrated one of the strongest and most integrated STEM identities at the time of the interview. Peer support networks and mentoring are critical to long-term student success (Hurtado et al., 2007; Ong et al., 2011).

Joan, unlike Tyrone, did not look for the encouragement of others when she was discouraged, instead she focused on her goals and hardened her resolve. When she got frustrated, she remembered that

It's, a means to an ends, 'cause these ideas, these are my techniques and tools that are going to allow me to do what I really want to do... What I really want to do is, you know,

make something and in order to make it, then I'm going to have to know this material that I'm actually struggling with at the moment.

Rishona, expressed similar resolve in times of discouragement:

I've been keeping the dream alive for a long time. I've been waiting for the opportunity to come back to school. There are so many things that I worked through to get to this point that I'm glad to be here and I look forward doing more... that's what makes you get up and go no matter what's going on, just remembering your dream.

Individual drive plays an important role in minority persistence in STEM (Valenzuela, 2006).

For Jocelyn, her drive was more closely tied to her racial/ethnic identity, explaining that when she feels like an outsider, she remembers something Giles told her: "just prove people wrong and prove people you have a real reason of being here and you're not just an extra body." Jocelyn is using her position as a member of underrepresented groups to empower herself (Carlone & Johnson 2008).

To further understand what is required to persist through the rigors and challenges they face as STEM majors, the participants were asked to imagine giving advice to a new student. Some of the participants continued on this idea of personal drive, as well as the importance of one's sense of self. Giles would advise a new minority STEM major to have patience.

Because they're going to deal with social problems in a place where you feel like you shouldn't have to. Science and math for us has been like our escape. So, we don't feel that when we're getting to it, we'd run into the same social problems that we would any place else being like, you know, who we are. So, my advice for them is just have patience, and work through it. And, never be afraid to like speak up. Especially if you're

having a problem with like your lab partner. If you're having a problem like, you know, like the class, never be afraid to speak up.

Shane provided encouragement when giving advice: “Yes, you can do it. You guys could do everything and anything... Don’t be discouraged, you can do it. The world needs as many engineers as they can, man and woman, black, white, whatever.”

The other key piece of advice the participants offered was to go see someone who can offer the academic advising and support needed to navigate the STEM degree path.

I know that the best person to go to, it’s this [counselor]. And he’ll give you papers, it’s those that tells you all the classes you need to take, and then how they match up with a university...it was like a packet for all the different types of engineering degrees.

(Jocelyn)

The importance of advising was emphasized again and again by the participants in this study.

Tobias (1992) found that poor advising contributed to student departure from STEM.

For the minority participants, their advisors should also be able to provide guidance and support by relating their own experiences as a minority in STEM (Grandy, 1998). Mentors and peers within the institution play key supporting roles that lead students to academic and social integration, influencing persistence.

People like myself, people like [the counselor], who are able to deal with students of color and the students of color are comfortable coming and talking to us, and especially, like I talk to [the counselor]. It's comfortable coming to talk to him about the problems that like they're facing and coming out with some kind of solution for them that helps them to move forward (Giles).

While finding someone to provide academic advising in STEM was important, the participants discussed other relationships in college and off campus. Shane's advice was to "get involved in as much stuff as possible." When asked what he meant by that he said

Go see [the counselor], go talk to...find out if any of your math teachers have any kind of involvement with engineering, your physics instructors, any of the people in this same building, going to start to look at organizations like the IEEE... maybe even find somebody that's an engineer, uncle Bob and take him out for coffee and pick his brains because I mean, they're going to give you the real deal.

Shane said he would encourage a new student to integrate with his/her major both on campus and off campus, both socially and academically. While many factors may influence persistence, developing "meaningful relationships with people, programs, and services that [will] benefit them" (Yohannes-Reda, 2010) was key. Mary recommended the new student visit the Multicultural Center:

The multicultural center is just a fabulous place of support and love. Everyone there is just like, 'OK, if you want to do this, scholarships for this. If you want to do this, here are service learning things that relate to this. If you want to do this, I'll proofread your papers'... they are there for you.

In addition to emphasizing the importance of learning and understanding concepts, Tyrone gave social advice as well, specifically related to interacting with the large number of international students in Engineering.

Don't be timid. Don't be afraid to socialize. And, brace yourself for a different reaction that you might receive from some of the other students. Because, basically, from where you're from, it's definitely not where they're from. I like socializing and sometimes, you

just got to kind of think twice before you really speak to somebody else whether it may seem...I don't know. Sometimes, they may take you the wrong way or they don't understand you clearly or just something maybe... There always tend to be a language barrier at times with other people. So, the best thing to do is just to kind of brace yourself for that matter and not be intimidated by their reactions or don't feel like you are less than them or not necessarily more than them.

As a woman in STEM, Joan explained "I feel like it's harder. It's more isolating to be a female and in a class of all guys, yeah." She would give women more encouragement, and when things get tough, remind them that "sometimes it's just the person who's standing at the end of the finish line that actually succeeds." Joan was not the only female participant to express the challenges faced as both a minority and as a woman in STEM. All three of the women majoring in engineering (Joan, Jocelyn, and Mary) described the challenges they faced as members of two underrepresented groups—ethnic minority and female—an experience common to minority women in STEM (Ong et al., 2011; Malcom, Hall, & Brown, 1976). Joan also recommends that minority students

Look at the demographics of the school. Because you might not be...they may not be comfortable going to a school where there is very few [minorities] 'cause I didn't realize how important it was until I started working and I was the only Asian in every single workplace I was in. And then it's because you don't have that shared common background and you don't respond to this same external stimuli the way other people do. It can be...it feels like you're constantly varying who you are so that you can fit in with the rest of the group, so that can be stressful... make sure that wherever you're going to

go to next, if it fits your needs 'cause you don't realize that's important until it's not being met.

Joan's advice emphasizes the importance that the college environment has on identity, and integration. Students who only see STEM or academic identities available to them if they change or give up some part of themselves experience a negative input to their persistence intentions (Croissant, 1992). In other words, to persist, students need to be in an environment that allows them to be themselves and engage with their work. They need a college environment that can provide "comfort zones" (Brandt, 2008), where they can feel safe as both a member of underrepresented groups and of the STEM community. Jocelyn too, recognized the challenges that STEM students face, and wanted to make sure that new students know

there are some sacrifices you need to make, you need to believe that you can really do this through the rough times because there's going to be a lot. And know that, when you're going through those times, that there's always going to be something...there's always going to be a reward at the end of it, so just do it.

The chilly environment that underrepresented students experience in STEM constantly challenges their identity integration and impacts their level of and types of participation in the STEM community.

Overview of Findings

In the third analysis of the data, particular attention was given to emergent themes (Bogdan & Biklen, 2007) that appeared to influence students' identities and academic resolve. This section focuses on three major themes that emerged from the data within and apart from the conceptual framework used in the initial coding the data; meaning that passages representing these themes were often simultaneously coded to both identity and environment or identity and

persistence intentions. The three emergent themes represent the conceptual overview of the participants' experiences and provide a means by which to interpreting the data (Merriam, 1998). When interconnected, these themes represent the relationships between the components of the conceptual model (Creswell, 2003), specifically the ways in which identity is expressed and persistence intentions are formed while situated within the context of environment, therefore influencing a student's perception of integration and motivation to persist. The three major themes are: Guidance & Support, Altruism, and Inclusion.

Finding 1: Guidance & Support

All of the students emphasized the importance of guidance and support. When Jocelyn first returned to the community college, she didn't know what she was supposed to be doing, until she ran into Giles.

He actually hunted me down in the hallway because of something I asked in class that he was recording. And after I met him, he pretty much put me on the track of all the classes and courses I needed to take. So now, I have them all written down and I actually planned them out like what quarter I'm going to take all the classes that I needed to take and get over with to get done. So yeah... Yeah, and then he actually told me that I wasted a quarter because he said I'm supposed to be taking 200 and I was like 'see, I don't know that stuff' so it's just like, ah, 'I'm glad I met you because I had been lost.'

While all the participants discussed the importance of academic advising and support at the community college level, Tyrone expressed concerns about finding academic support after he transfers,

That's the one thing that I'm going on about there is...to be able to have the access of help in terms of homework, research, just anything that will allow me to be successful. I

love that, readily available to me and that's the one fear I must have is...will I have there as I do here?

Tutoring, study groups, and other campus resources are important pieces of the support systems that help minority students succeed after transfer (Valenzuela, 2006). Guidance and support is not only important to academic interaction and success, but guidance through the sociocultural environment of school and STEM is important to identity formation, specifically how to combine and integrate the multiple, sometimes conflicting, identities that the participants have. Mary explained wanting to find minorities in the field:

I want to know about their experiences and be a little bit prepared and know that there's someone out there that's like me... And if I have that, I feel like that will go a long way to know that I'm not the only one going through this right now.

For the minority participants

The challenges had been more internal... the fear that I can't do it... It's those things of like, Shane do you not think that you can do this math and science?... When I was going to school the first time, again, I was always interested in science but I was like, science is like...science is like the outside stuff. That's for those people and I didn't necessarily see myself as one of those people. (Shane)

But when he's been able to talk "to other professors and especially in the engineering depart[ment]... you actually get to talk to an engineer that might be a mechanical engineer, chemical engineer, or what have you and they can kind of give you a play-by-play and this is my life," he is reminded that he can do it. While URM STEM majors come from a variety of experiences and backgrounds, it is their experiences at the college that have the most impact on their STEM identity development (Carlone & Johnson, 2008), persistence intentions (Jackson,

Gardner, & Sullivan, 1993), and, in particular, their integration into support networks (Croissant, 1992).

Finding 2: Altruism

One theme that did not clearly fit within the context of the conceptual framework was altruism. Nearly all of the minority participants expressed a sense of altruism. They wanted to become engineers, technicians, and teachers and they wanted to change the way we think about energy, the way we treat disease, or the way we learn. Each of these students had a clear vision of what they would do with their degree. “One of my goals, in the long run, is to work with, like...the newer sources energy and like development of biogas and, you know this clear energy sources” (Tyrone). Jocelyn explains how she tells her friends “when I become a mechanical engineer...I’ll build an engine that doesn’t burn gas.” Kenneth’s interests include sustainability, wanting to work in “wastewater treatment... or sustainable transportation/city planning.” These altruistic goals are part of what drives these students forward in their STEM degree programs and provides a positive input to their STEM persistence intentions. Joan explains

think about why you're taking the classes. I mean, not just in terms of the major but what you want to do with that major. Because...the material is very difficult and if you don't have something pulling you forward, then it's easy to give up.

Many wanted to make a difference through their engineering. Shane wants to be a part of something bigger than himself. He explains “I want to do something really important. I want to work in alternative energy.... to change things, change the way we interact.” Rishona explains that she wants to “be the one that tells you how to do it, helps you if you get stuck.” Joan wants to save lives,

In emergency and critical care if there's a death every single shift you work and sometimes the deaths are reasonable and sometimes they're not but there is always a death and it's frustrating because you can't fix it at that point. There's nothing you can do to save him... But if I were going to regenerative medicine, I think I could save lives.

Altruism was not just part of their career goals, but part of their daily activities. Tyrone found great satisfaction and motivation as a tutor:

If anybody needs a little bit of extra tutoring on the side, I will help them out or if I'm, you know, during my working hours, I work as a tutor between 5:00 to 7:00 Monday through Thursday in the Math Learning Center so I tutor mathematics... I obviously enjoy that, to help other students with their math.

Of all the participants, Giles spent the most time describing how he wanted to help. He talked about helping others navigate the Engineering degree path in this story of helping a friend:

When I first got a hold of him it's like earlier like this year, his confidence was broken. He just, you know...and [my advisor] has sent him to like to me like talk with so, you know, I kind of...I knew where he was coming from. So I kind of, you know, work on him and it took only a month for him to gain like confidence back and then from there he just...he saw my relationships that was telling him about. And so it gave to him like a little bit more confidence like you know.

He talked about becoming a community college professor "I will actually like to, if I could do it, teach at a community college. The reason being is that, I think that that's the best place to teach students like the fundamentals." He even talked about social justice

You don't hear about engineers or physicists standing up against like social injustice. I had another physics teacher. He was like one that like, you know, he was an advocate for

civil rights and not just civil rights but human rights. But you just don't hear about that. So, you know, it's like you feel like you're like I want to be, you know I want to fight for civil rights and things like that. You really don't hear about, you know, engineers, like, doing that... I feel this way so I [am taking] engineering because I feel like I should make social change.

Espinosa (2009) found that underrepresented students who place importance on making a contribution to science or finding a cure to disease were more likely to persist. Carlone & Johnson (2008) found some students create an Altruistic STEM identity, which does not line up with the traditional research identity, but allows students to integrate their STEM identity with their identity as members of underrepresented groups.

Finding 3: Inclusion

When participants were asked what knowledge or skills they felt were needed to be successful in STEM, two of the most common responses involved working with others: teamwork and communication. Yet, within the STEM environment, these two factors created some of the biggest challenges for the participants, often because they did not feel included. Mary put it this way, saying when she sees that

You're the only girl in the class, you're the only black person, or Latino person in the class, you know it's like so you sort of get—get a feel for that just—just on your journey to it and then when you get there you're probably gonna be like, 'Oh, this is uncomfortable.'

Many of the students explained that they knew what they were getting themselves into. For example, Jocelyn said

My brothers already informed me about it a little bit, because they said...well they're guys, but they were saying that you don't find too many African-American going into [engineering] and then you barely find a lot of women going into it. And, being on both, I knew that I was just going to get myself into something. But, I know this is what I wanted to do so I mean, just whatever.

Though they knew what they were getting themselves into, they may not have realized how extreme the singular status & feelings of exclusion could be. Based on her current experiences at the introductory level, Mary expressed concerns about what was to come:

I'm just sort of worried about...how am I supposed to advance if I'm—I'm female. I'm not going to be in like all of the boys clubs...and I'm black. And so, people are going to look at me and it is like, 'oh, you're the affirmative action hire'...I'm just going to have to be like, you know, I'm just going to do my work and it'd be awesome. But then at the same time, it's like, I'm going to have to prove the mental capacity of the African-American race, you know what I'm saying? And I'm worried about that because it's not fair that is put on people because I'm the only black person there or the only woman there, you have to prove everything.

Students described how they had to constantly earn and maintain membership to the STEM community (Ong, Wright, Espinosa, & Orfield, 2011; Ong, 2002). A couple of students explained how academic achievements would help faculty and peers see them as invested members of the STEM community. Giles described this in a story about finding a mentor in the engineering department: “[There was a] problem that was calculus based, that like...nobody solved, [and] I nailed it. So...that made him like, [say] ‘I’m going to start focusing on Giles.’”

Jocelyn told a story about an African American friend who was having trouble working with other students in his physics class:

They weren't really trying to work with him like when they're doing like group stuff, at first, they weren't trying to work with him because they...I guess they were assuming that maybe he didn't know what he was doing...[but] he pretty much showed them that he knows what he was doing and...I guess they changed their outlook on him.

Kenneth discovered, when he interned with a mechanical engineering firm where he was one of two minority interns, that the

people that I worked with, [I] would say a good majority of them, had this attitude that they knew everything about everything and this really bugged me... I don't know if that mentality was because maybe of superiority complex [or] something.

He explained how the engineers he worked with acted as if they were members of some sort of exclusive club, one in which they did not make him feel welcome. That experience was enough to convince him that he needed to switch majors, landing on civil engineering instead.

Kenneth's experience as an intern resulted in decreasing his identity integration, what Carlone & Johnson (2008) called a disrupted identity. By switching to civil engineering, Kenneth was able to recover and re-integrate his identities. Giles feelings of non-inclusion were much more damaging to his identity integration. A year after the interviews, in an email, Giles explains,

I recently acquired a new mentee, and based on his story being the only black male in his classes at [a large university], it was so difficult for him that he has decided to quit college. It is hard to relate to other engineering majors.

Giles had transferred to a 4-year institution, but had decided to switch his major to mathematics.

Those who felt most excluded had the weakest identities and were least persistent. This was true for Kenneth within Mechanical Engineering, and for Mary and Giles within engineering all together. Reviewing the stories of the participants, it is easy to see how inclusion plays a role in persistence. Those students who were most integrated, academically and socially, on campus had the strongest STEM identities and strongest degree resolve. Even though Kenneth sometimes felt excluded from groups, for example when “I get in a group where I am the only minority, you can kind of feel it a little bit just because...or during the work, yeah, you just kind of feel...a little kind of left out,” throughout his experience in engineering at the community college, and later at his 4-year school, Kenneth was always able to eventually find a group of minority students to study with. Joan demonstrated a strong identity integration which gave her the confidence to create study groups (like the Calculus Club) when she needed a network of support. She became a full member of the STEM community at her college, made clear in her enthusiasm here:

Plus having, you know, people to hang out with, the classmates and the people in the tutoring center and my friends who are in the math classes, just doing the math and being fun when you're hanging around people and you're working on the same problem, sometimes you get stuck and sometimes you can help someone and sometimes they can help you.

Students who can find a way to become integrated (included) in the STEM culture through a network of friends and studying with others are able to establish strong STEM identities. The participants that displayed the strongest social and academic integration had the strongest identities and expressed the strongest persistence intentions. Tyrone provided many examples of his inclusion on campus and within the STEM culture. He had a mentor in the

engineering department, was involved in the physics and engineering clubs, spoke on behalf of the college foundation, acted as a peer mentor to incoming students, worked in the tutoring center, and even spent some of his free time in the student center where “We have a lot of groups that come through like you’ve have a bunch of students play hacky-sack or [people] invite anybody else that would want to join the clubs or anything that happens around school.”

An important distinction to make is the difference between academic and social inclusion on campus versus, academic and social inclusion in STEM. Mary was active with the Multicultural Center, TRIO, and the Disabilities Office, but did not find other STEM students to study with. Giles sought out other African American students in engineering to mentor, but struggled to find study partners in his classes each quarter. Shane had great experiences with his classmates in IT, but felt like an “Albatross” in the science building. Even if students are socially and academically integrated on campus, if they feel excluded within STEM, there is an impact to persistence—specifically major persistence. Jocelyn described her experience in engineering this way, “Just because I feel like...they make you feel isolated” (Jocelyn). Non-participation is as much a source of identity as participation (Danielson & Linder, 2009), thus feeling excluded and isolated from STEM can impact STEM identity as much, if not more so, than inclusion can.

Chapter Summary

This chapter examined the experiences of community college students majoring in STEM examined through the lens of a conceptual framework that looks at the interconnectedness of identity, environmental context, campus engagement and major persistence intentions. The data provides some insight into the characteristics and experiences that were common among the students interviewed. While the experiences of the student participants varied, overall the findings revealed relationships between the components of the conceptual model, specifically the

ways in which identity is expressed and persistence intentions are formed while situated within the context of the community college and STEM major environment. Guidance and support was a significant input to academic and social integration for all participants and influenced identity integration for some participants. Altruism emerged as an important part of STEM identity and persistence intentions of participants. Finally, isolation was important to STEM identity development and overall identity integration, academic and social integration, and ultimately informed participants' persistence decisions. Chapter five will link the research findings and conceptual model to the research questions. It will provide an in depth examination of key elements which emerged and discuss how those themes are either consistent or inconsistent with the review of related literature.

Chapter 5

DISCUSSION

The purpose of this study was to examine the STEM culture on community college campuses in order to understand the role the community college environment plays in students' academic and social integration on campus and their major persistence intentions. The study was conducted with the goals of understanding: (1) how the community college environment influences STEM student experiences and persistence intentions. (2) What academic and social integration looks like for STEM students at community college? (3) Through what processes does academic & social integration impact STEM student major/career commitment? (4) How are the impacts of academic and social support upon students' persistence decisions complicated by major culture, stereotype threat, and/or cultural incongruence? (5) How participation in science education either promotes or impedes a sense of STEM identity and scientific self-efficacy in URM students? And, (6) how do these students make meaning of their experiences?

To achieve these goals, the study examined a particular situation: being an URM STEM student in community college. The method of inquiry was a phenomenological approach designed to elicit a clear and complete understanding of *how* URM students experience STEM in community colleges. The previous chapter examined the experiences of community college students majoring in STEM organized using a conceptual framework that connects identity, environmental context, campus engagement and major persistence.

This chapter examines how the participants interpret their experiences during the process of becoming scientists, engineers, mathematicians, and technicians at their community college, and is guided by the following research questions:

1. What are the developmental experiences of community college STEM students?

2. How do URM community college STEM students perceive their own identity?
3. How do URM community college STEM students describe their academic and social integration and persistence intentions?

The chapter begins with a discussion of the findings in relation to the three research questions, which is followed by an analysis of the conceptual model. The chapter concludes by outlining the implications of the study and suggestions for future research.

Discussion of Findings

Question 1

What are the developmental experiences of community college STEM students?

Identity development is a process by which people define themselves as a member of a particular community, in a particular context, and interacting in a particular way (Tan & Calabrese Barton, 2007). Identity is a social construct that cannot be independent of the context in which it takes place because identity is filtered through the eyes of the one experiencing the event or situation. Thus, identity formation is embedded within the social context in which it is developed (Creasy Fowler, 2010). Looking at how URM students manage their academic environments and the processes of identity conflict and resolution provides insight into what issues matter to URM students in their participation in science (Tsai, 2003). The eight participants in this study come from varied backgrounds, entered community college via different paths at different points in their education trajectories (Table 3.1), and enrolled in community college for different reasons, yet they describe shared experiences within the context of the community college, in particular the need for and use of student services and academic group work.

Student Services and Support Programs

While the level of interaction with the campus varied among the participants, the importance of community college student services and support programs was made clear during the interviews. Every participant in this study had sought help from one or more student support services at their college. The most common services sought were academic advising (Giles, Jocelyn, Joan, and Shane) and tutoring (all participants). Other services and programs include services for students with disabilities (Mary and Rishona), counseling (Rishona, Jocelyn, and Giles), TRIO (Mary and Rishona), and MESA (Shane, Giles, and Jocelyn). Tinto's (1993) model attributes college persistence to students' experiences within the academic and social systems of the institution. If the student's interactions are positive, the student will become integrated into those systems, the student's institutional commitment will be strengthened, and the likelihood of the student persisting at that college is greater. Likewise, negative experiences would impede institutional integration, weaken institutional commitment, and decrease the likelihood of the student persisting. As such, one would expect that students interactions with student service programs would play an important role in the development of students' academic and major (in this case STEM) identities.

Academic advising teaches students how to become active members of the educational institution by providing guidance and assistance with the selection of academic programs and courses to support the achievement of life and career goals (National Academic Advising Association, 2006). Tinto (1999) urges that academic advising must be an integral part of the first-year experience. For the participants in this study, interactions with academic advising were particularly important during the first academic term of the students' enrollment. Participants went to academic advisors seeking help developing an educational plan and assistance with

transfer to a four-year institution. For the participants in this study, few were able to find the assistance they needed. Poor or improper advising created a barrier to participants' success and academic integration. For example, Jocelyn's frustration at receiving a planning sheet when she knew that "there's a lot more to it than just that" resulted in both students taking classes not required for their degree plans because they did not understand course numbering. STEM degree plans contain precise course sequencing, such that taking the wrong class one quarter means increasing the time to degree by a term or more.

For Rishona and Giles, a lack of academic advising resulted in improper placement in the mathematics sequence, resulting in academic probation for Rishona and hampering the academic progress of both students, by increasing their degree path length by a term. Not knowing how to navigate college to achieve their academic goals, or feeling like they are in over their head during their first quarter of mathematics negatively impacted their academic and STEM identities. Joan and Shane, however, were advised to begin their mathematics sequence one level below the course they tested into, to ensure they would be fully prepared for their majors. Joan explains "and I was advised not to take calculus and start at the pre-calculus level again. And that was painful because it meant that I should start off at a much lower level and take more schooling but it would turn out to be a really, really good decision." Likewise, Shane was happy to "take a step back to go forward." For Shane and Joan, the confidence that proper placement produced positively impacted their academic and STEM identities as well as their academic progress.

All of the participants discussed making use of campus tutoring services. Walk-in tutoring services play an important role in retaining STEM majors (Heidel et al., 2011). According to the participants, academic tutoring was particularly effective for those in

developmental and introductory college level mathematics. Participants indicated that the tutoring services offered by the college became less effective as they progressed into higher levels of mathematics and their STEM major courses. Giles, Tyrone, and Mary all described instances when they attempted to get help from their college's learning support centers, only to find that none was available. Because, community colleges lack more advanced students to provide tutoring in advanced courses, Tyrone and Giles both mentioned that if they are unable to get help from their instructor, there was nowhere else to go. For students like Giles and Mary who are unable to find peer support through study groups, the lack of available tutoring contributes to feelings of non-inclusion. Issues related to upper level tutoring in STEM subjects was not found in the literature.

For minority students, academic advising and student services can be especially important in mediating the stress they experience as a result of their minority status.

In particular, quality co-curricular experiences assist students in developing personally and academically, adjusting to the environment, and affiliating positively with the institution. Yet if student service organizations are ethnically divided without significant interethnic and intraethnic group collaboration, students' involvement is also likely to be segregated or at least strained. (Jones, Castellanos, & Cole, 2002).

Feeling different can cause students to lack a sense of belonging (Tate & Linn, 2005).

Participants in this study indicated that this is true, not just in the classroom, but also in their interaction with student services. Giles indicated a need for the tutoring center to have people who are able to "work with...people of all colors." And, that increasing the diversity of the student services staff in STEM would result in an increase in minority students in STEM. Giles statement indicates that social interaction and culturally mediated activities are important to his

motivation (Rodriguez et al., 2004) and success. If unable to find the support required from campus-wide services like the tutoring center or advising center, the students in this study relied upon minority support programs.

The URM participants in this study received support from the Multicultural Center, the Office for Students with Disabilities, TRIO, MESA, LSAMP (Louis Stokes Alliances for Minority Participation), and WiSE (Women in Science and Engineering). These programs helped students to find a place of belonging. These support programs represent “comfort zones” where students develop relationships and networks of support in places where they can be at ease, without having to explain themselves (Brandt, 2009). These comfort zones nurtured students’ racial/ethnic identities, and provided a place to socialize, share experiences, and receive advice from people who shared a similar worldview. These spaces are “place[s] of support and love” (Mary) and help to counter the singular status URM students experienced in their STEM courses.

Singular status of URM students in STEM courses

Being the only Black student in chemistry (Mary), the only Black student in Math (Shane), the only Asian woman in engineering (Joan), or the only Black student in engineering (Jocelyn, Tyrone, and Giles) is a daily reminder of one’s status as a minority. The singular status that students in this study described produced feelings of alienation from the STEM community. The constant reminder of difference (Tate & Linn, 2005) is a lasting experience that impacts students’ identity integration.

Feelings of isolation & non-inclusion affect students’ identities and influences how they engage with STEM (Malone & Barabino, 2008; Brickhouse, Lowery, Schultz, 2000). While all of the URM participants described feeling excluded within STEM, for Giles and Mary these

experiences were particularly significant, impacting their identity development and major integration. Their constant struggle to find membership in the STEM community informed their major commitment.

Academic group work

The significance of group work cannot be understated. The student participants were quick to identify experiences with group work as either their best and/or worst experiences in college, both important to and presenting significant challenges to their success. The participants often discussed the difficulty in forming study groups or meeting with project groups because of the nature of the commuter campus (Astin, 1993), but other aspects of group work emerged as more important. In particular, Kenneth and Giles described difficulty becoming full members of groups that were primarily Caucasian; Joan and Kenneth described feeling uncomfortable with class group formation processes; and Jocelyn, Giles, Kenneth, and Shane described feeling excluded from some study groups (Gasiewski et al., 2011). All of the participants expressed a desire to have a study group, while nearly all of the URM students (seven of eight) expressed frustration finding or establishing study groups. Peer study groups are key to students' sense of belonging (Hurtado & Carter 1997), and therefore their identity development, academic and social integration (Gasiewski et al., 2011), and persistence intentions (Sandoval-Lucero et al., 2012). Peer study groups represent more than just academic support, they represent a resource where students can learn about professors, course options, or support services. Such *information networks* are closely tied to integration and persistence (Karp, Hughes, & O'Gara, 2008).

Summary

Many of the developmental experiences that the participants in this study discussed were those *outside* the classroom, including encounters with academic advising and tutoring services

and the challenges and benefits of student group work. The non-inclusion experienced by the URM students in the classroom and relative to student study groups and academic group work were paramount to all other experiences on campus. In general, these students shared feeling uncomfortable, unsettled, excluded, or isolated. Solorzano, Ceja, & Yosso (2000) describe these experiences as a result of microaggressions and emphasize their cumulative effect. In this case microaggressions had a collective effect on identity development and stabilization, institutional integration, and major persistence of three students (Mary, Giles, and Kenneth). The support network provided by minority support services and programs were important to countering the non-inclusion felt by many of the URM students (Grandy, 1998) and helping students manage feelings in response to microaggressions.

The participants in this study indicated a handful of interactions that were important to their community college STEM experience. These include: tutoring, academic advising, group work, and the singular status of URM students; all of which are consistent with the literature (Brickhouse, Lowery, & Shultz, 2000; Heidel et al., 2011; Hurtado & Carter, 1997; Malone & Barabino, 2008; National Academic Advising Association, 2006; Tinto 1999; Tate & Linn, 2005). Issues related to the lack of proper advising and upper level tutoring availability for STEM students in community college are missing from the literature and represent a gap warranting further study.

Question 2

How do URM community college STEM students perceive their own identity?

There is a multiplicity of ways in which students can be positioned within STEM, which means there are multiple ways in which STEM identity interacts with race/ethnicity and gender (Hughes, 2001). Recall that identity is produced in the interactions between an individual and

her/his environment; is contextual; entails recognition from others; and involves “possibility” and “attribution” (Brown, 2004). People go through phases of identity revision that are determined by one’s competence and the people with whom one interacts (Josselson, 1996). Understanding the STEM identities of the students in this study requires examination of the way in which they describe their interactions with STEM content and with people in STEM within the context of the community college.

STEM Identity

All of the URM participants conveyed intrinsic interest in STEM. The passion that these students have for mathematics, engineering, and computers was made clear again and again in the data. STEM is a part of who they are, and defines them as much as their gender, ethnicity, or age. Intrinsic motivation is critical to student success in STEM (Russel & Atwater, 2005), but only provide the starting point for STEM achievement. For seven of the eight URM participants, their desire to pursue STEM degrees was enhanced by a sense of altruism. For the students in this study, altruism was expressed in two forms. The first was a desire to use their science, engineering, or technical skills in direct service of humanity (Carlone & Johnson, 2008)—everything from helping individuals with computer problems (Rishona), to sustainability (Kenneth), to clean energy (Jocelyn, Shane, Tyrone), to disease detection and cures (Joan). The second form of altruism was the drive to support the STEM learning of other students. Joan, Jocelyn, Tyrone, and Giles all put a great emphasis on tutoring in official capacities (through the Learning Support Centers) and in unofficial capacities (for friends or other minority students). Giles’ desire to become a professor to provide the learning experiences and create a learning environment that is welcoming to students of color continues to drive him forward in STEM, in the face of various challenges.

For the students in this study, an intrinsic interest in STEM and a desire to serve others forms the core of their STEM identities. That identity was either strengthened or challenged as they progressed through their educational trajectories. Increasing competence, made apparent through grades, improved understanding, and the personal achievement often associated with course projects, served to strengthen that identity. While competence and self recognition were important to students, recognition by meaningful others seemed to outweigh both in the STEM identity development process. Recognition by others was greatly influence by race/ethnicity and gender.

Racial/Ethnic Identity

The strength and stability of these students' STEM identities waivered over time as a result of their experiences within their STEM programs. Maintaining a strong STEM identity and integrated overall identity seems to be a daunting task for some of the participants, primarily as a result of their feelings of isolation and exclusion. Many of these students were unable to obtain or maintain recognition as a STEM person (Carlone & Johnson, 2008) because of their race/ethnicity and gender. Racialization, communicated through experiences of invisibility, lack of recognition and resultant isolation (Marlone & Barabino, 2008), impeded their identity development, specifically their identity integration.

Most of the URM students entered their STEM majors aware of the unwelcoming culture of STEM, and all of the URM participants emphasized the importance of finding other minority students as a support network. URM students in STEM require a kind of perseverance not required in other fields of study (Chinn, 1999). As Mary explained, the STEM culture is exhausting because of the way that race interacts with her academic experience, and sometimes finding a "shoulder to cry on" is what helps her keep going. Sticking together becomes a source

of security and helps them to maintain their sense of racial and ethnic identity (Fisher & Hartmann, 1995). Finding a group of other minority students, particularly within STEM, can provide a sense of relief, knowing that “I’m not the only one going through this” (Mary). Peers within STEM are a source of support for choosing classes, lending books, tutoring, and working on assignments (Yohannes-Reda, 2010)

Very few of the participants were able to find a minority peer group within their classes. While community college campus may be very diverse, the STEM degree programs still lack the diversity needed for minorities to feel comfortable and or supported on their degree path. As such, minority support programs are particularly important in aiding URM students with their identity stabilization by providing those “comfort zones” where they can be at ease without having to explain themselves (Brandt, 2008). Jocelyn’s, Giles’, and Shane’s comfort zone was the MESA director’s office; Mary’s the Multicultural Center; and Rishona’s TRIO. These programs became primary sources for advice, tutoring, and opportunities (Yohannes-Reda, 2010).

Gender Identity

For the women in this study, gender identity was talked about, but always within the larger context of being a URM. In other words, for the women of color in this study, their experiences as women and their experiences as persons of color were simultaneous and not easily distinguished. Rishona described her worst fear “would be that [her] race *and* [her] gender could be issues to some employer or some workplace situation” in the future (my emphasis). When Jocelyn walked into her Engineering class that first day, she was the only woman *and* the only African American in the room. When considering her future work place, Mary asked “how am I supposed to advance if I’m—I’m female...*and* I’m black. And so, people are going to look

at me and it is like, oh, you're the affirmative action hire." it is clear from the data that the intersection of gender and race/ethnicity impacts the experiences of these women of color (Ong et al., 2010) in community college STEM programs. Though Malone and Barabino (2008) found that issues of race and ethnicity were more important than issues of gender for women of color in STEM, it is not clear how the interplay between these two identities impacts STEM identity development and identity stabilization for the women of color in this study.

Summary

Their deep passion for STEM and altruistic ambitions formed a strong foundation for the STEM identity development of the URM participants. Their experiences in STEM in community college provided input to either confirm or challenge that identity providing constant feedback to the identity integration process. People are always positioning themselves and being positioned by others through a series of interactions (Nasir & Saxe, 2003). In the cases presented here, recognition by others, often described through feelings of inclusion or non-inclusion, appeared to be the most important factor in the formation and integration of the students' identities, which appears to be intimately connected to the students' social integration. The significance of recognition is consistent with the literature on STEM identity in other institutions (e.g. Carlone & Johnson, 2008; Hurtado et al., 2009; Malone & Barabino, 2008). The feelings of discomfort were because of the participants' status as URM students. Similar to studies at four-year and graduate institutions, the women in this study described challenges associated with being members of two underrepresented groups simultaneously (Ong, et al., 2011). Students who felt the most excluded and most uncomfortable (Mary & Giles) had the least integrated identities (Hughes, 2001), while those who were most socially integrated displayed the most

integrated identities (Tyrone, Joan, and Kenneth). The lack of recognition is a barrier to STEM identity production (Carlone & Johnson, 2008).

Question 3

How do URM community college STEM students describe their academic and social integration and persistence intentions?

Students' intentions to persist in STEM fluctuate over time (Schultz et al., 2011).

Exploring the processes that are linked to students' persistence decisions and intentions provides an understanding of students' educational outcomes. Feelings of difference impact students' sense of belonging. The feelings of isolation and exclusion described by the URM participants indicates a lack of participation in the STEM community (Tate and Linn, 2005). Instances of exclusion based on social identities such as those described by students regarding laboratory or class group work, hamper integration with peers (Gasiewski et al., 2011). Students' whose experiences are dominated by how they were positioned within STEM—disrupted STEM identities (Carlone & Johnson, 2008)—were least likely to integrate with their major and least likely to persist in their chosen field (Mary and Giles). Those who were able to participate in or form study groups had more integrated identities, an increased sense of belonging (Hurtado & Carter, 1997; Espinosa, 2011), and were more likely to persist (Joan, Kenneth, and Tyrone).

Academic Integration

Academic integration was promoted in two ways: through projects and research. Joan, Giles, Tyrone, and Kenneth all described their experiences with course projects as exciting, satisfying, and providing important insight into their future careers. For many, the importance of projects was directly tied to the recognition that came in the form of grades or instructor and peer feedback. Competence resulted in increased recognition by meaningful others (Carlone &

Johnson, 2008). Academic excellence lead to institutional integration when students like Shane were invited to tutor in the math learning center and Joan was invited to become class tutor in calculus and physics. As a result of academic excellence, Tyrone was recognized at his college when he was asked to speak at banquets held by the college foundation. Recognition of academic excellence can lead to a strengthening of not only the competence component of STEM identity, but also the practitioner and recognition components as well (Carlone & Johnson, 2008).

Of all of the URM students, only Giles had any research experience. Describes as “an amazing experience,” Giles explained that there have “only been a few times to which I've been in a situation like that and I've learned that amount.” Research gave Giles confidence, sharing that he had no doubt that he “would be good in the field.” During his internship, Giles not only achieved excellence as a learner, but he became an effective STEM practitioner (Carlone & Johnson 2008). While the research internship contributed to Giles commitment to engineering, it did not necessarily increase his integration with STEM. Croissant (1992) would classify Giles as assimilated: fully committed to engineering, but not fully committed to the social network of the academic world. The lack of positive relationships in STEM at his college prevented Giles from fully integrating with the institution.

Social Integration

Relationships are fundamental to the success of these participants. Considerations of staying or leaving were often resolved through sharing experiences and receiving advice from peers (Reyes, 2011). Tyrone described contemplating a change of majors over a period of two weeks and stated that it was the specifically the advice of his peers, including Giles, that convinced him to continue with engineering. Whether this sharing takes place in programmatic

settings (such as the MESA director's office or the Multicultural Center) or in peer relationships (like those between Giles and Tyrone or Giles and Jocelyn), mentoring creates a sense of belonging (social integration) that increases persistence (Reyes, 2011).

While the participants described well established, supportive social networks outside of STEM, the relationships most important to their major integration and major persistence were those within STEM at the community college (Grandy, 1998). For example, Jocelyn put it best when she explained that "it's hard to talk to other people because I feel like sometimes they just don't get it because they don't do what I do, because they're not headed where I'm headed." While it helped to have an aerospace engineer for a brother, it was Giles who provided Jocelyn the most support because "he's going through it, he went through it and he's been there, done that." STEM integration requires that students are connected with a network of friends, study with others, have information about career prospects, and seek assistance from STEM people (Croissant, 1992). While Non-STEM support networks may provide general support, by their non-STEM nature they do aid in STEM integration.

The students with the strongest major integration were those with the most integrated identities and the strongest persistence intentions. In particular, Joan and Tyrone described their social peers groups as not just including, but primarily consisting of other engineering students. They studied *and* socialized with other STEM students. Tyrone explained that most of his friends had already transferred, but he continued to see them on a regular basis socially. On the other end of the spectrum, Mary, Jocelyn, Shane, and Rishona shared that their peer groups did not include any STEM people. Those peer groups also tended to be established off campus.

Even though most of the students' social networks were situated off campus, all of the URM students spent significant time on campus. Community colleges are known as commuter

campuses, where students spend little time on campus outside of the classroom (Astin, 1993). Surprisingly, the participants in this study spent most of their time on campus—for some more than 12 hours a day. Part of this time was spent working (primarily as tutors), and the remaining time studying. All of the students described certain spaces where they spent most of their time: in the STEM building common area, the physics laboratory, the computer lab, the library, or the cafeteria. Many of the students explained that being on campus kept them focused (Mary and Shane) and provided easy access to resources like tutors or special computer programs (Tyrone, Rishona, Shane, Joan, and Jocelyn). The three most integrated students, with the strongest identities, and the strongest persistence intentions (Kenneth, Tyrone, and Joan), spent most of their time in campus STEM spaces. Being on campus is clearly important to these students, and, it seems, shows a relationship with identity formation and STEM persistence.

STEM Persistence Intentions

At the time of the interviews, all of the URM participants verbalized strong persistence intentions (e.g. “Engineering or die” (Giles) and engineering “fits more than other [majors]” (Mary)). It is clear, however, that those intentions waiver (Schultz et al., 2011). At the time of the writing of this paper, both Mary and Giles had decided not to pursue Engineering, though they both decided to stay within STEM. Even those with the strongest persistence intentions in STEM described experiences where their commitment waived. Tyrone considered switching to math after a poor grade in his engineering statics course and Kenneth switched from mechanical to civil engineering after a negative internship experience. Mary, Giles, and Kenneth all attributed their interactions with others in STEM as the reason why they decided to change majors. Tyrone attributes his persistence to the encouragement and advice he received from his peers and mentors in STEM. Relationships in STEM create a sense of belonging that increases

the likely hood that students will persist (Reyes, 2011). The lack of relationships in STEM, epitomized by feelings of non-inclusion, contributes to a feeling of not belonging, which negatively impacts persistence intentions (Tate & Linn, 2005). While other factors, such as academic achievement and family support may impact persistence intentions, *relationships in STEM* were critically important (Gasiewski et al., 2011) to the students in this study. Social integration in STEM provided a bridge to integrate the multiple identities of the students in STEM. Those without social support and connections in the major had the least integrated identities and the weakest persistence intentions.

Evaluation of model

Identity development is an ongoing process of interpreting and making meaning of interactions that either promote or degrade an individual's affiliation with a culture, community, or environment (integration). Each revision to a student's identity informs and impacts that student's behavior within that particular context or environment. Interactions that promote positive identity development moves students towards social and/or academic integration (Figure 2.5). When interactions result in a degradation or disruption to one or more component identities, students move away from integration and towards disassociation. Those who are well integrated within the academic and social environments of their college or university are likely to persist at that institution (Tinto, 1993), while those who do not integrate successfully are more likely to depart from the major.

Overall, my identity development model for academic and social integration is effective. When examining the experiences of the participants in this study, the interconnectedness of identity, integration, and persistence within the college environment were made clear. For example, students like Mary and Giles described how their racial/ethnic and gender identity gave

them singular status in their STEM classes, which impacted their integration through an inability to find study groups, and eventually informed their decisions not to continue in engineering.

In the identity development model is incomplete. The model assumes that individual interactions or experiences are the inputs to the identity development process, which then informs one's institutional integration. The model does not clearly account for the way in which integration can influence identity development. Specifically, integration influences the environment in which the identity development processes are taking place. Students who are fully integrated into the STEM community have a network of support to help them make meaning of their experiences in STEM, while those who are not fully integrated do not necessarily have that same help understanding what those experiences may mean to who they are and who they will become. For example, Joan and Tyrone both experienced singular status in their STEM classes as a result of their racial/ethnic and gender identities. However, because they managed to integrate with the STEM community by forming and participating in study groups and student clubs on campus, the negative impacts of singular status on identity development (like those experienced by Mary and Giles) were countered by the positive impact of their peer networks of support (Karp, Hughes, & O'Gara, 2008). A more complete model would allow for feedback between institutional integration and identity (Figure 5.1).

Conclusions

While the commuter campus nature of community colleges presents challenges to students trying to participate in group work, it was the overall feeling of exclusion, based on race/ethnicity and gender, that most impacted these students' experiences in STEM in community college. Participation in student groups—both formal and informal—is very important to social integration within the STEM culture. Those who felt isolated or not included

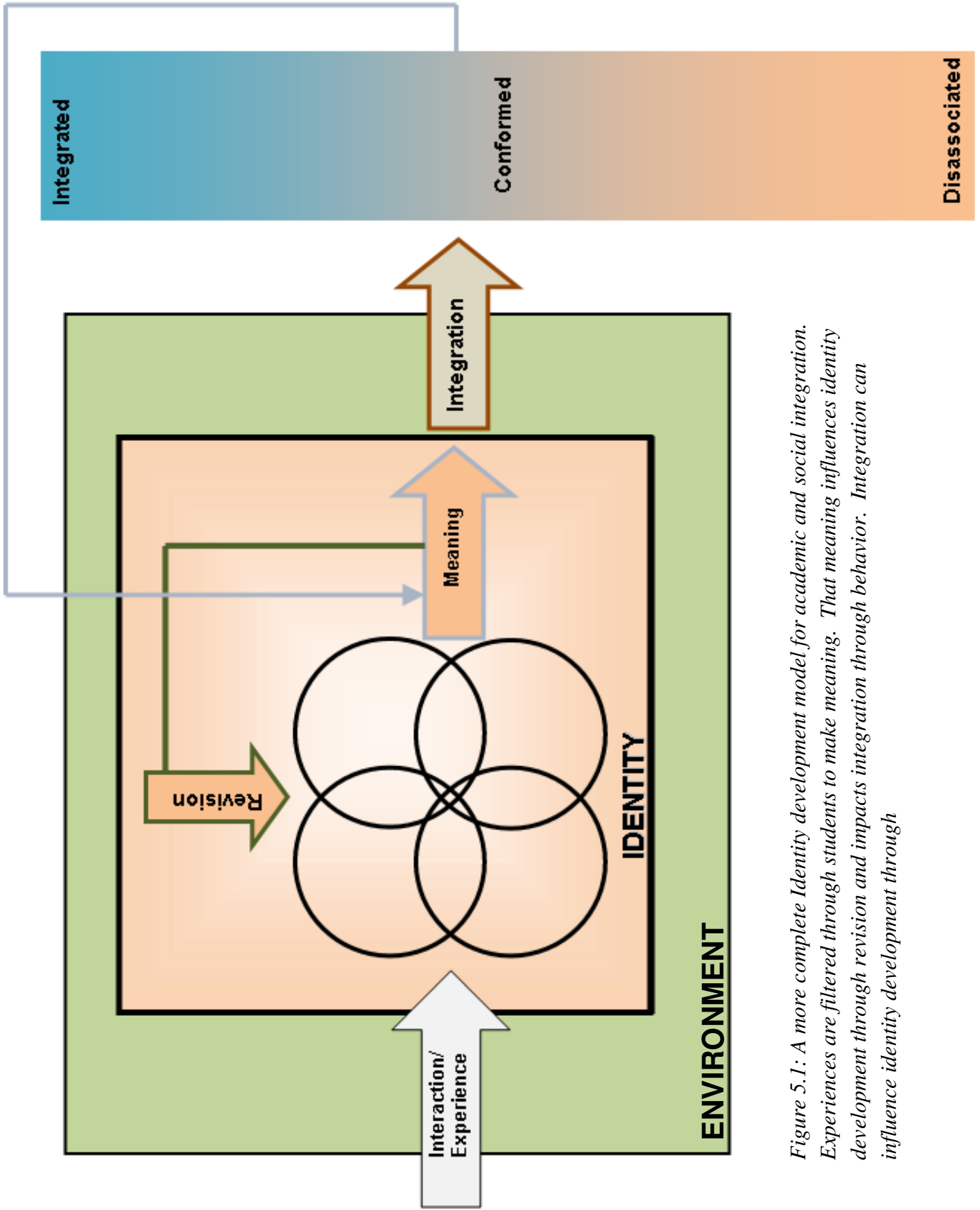


Figure 5.1: A more complete Identity development model for academic and social integration. Experiences are filtered through students to make meaning. That meaning influences identity development through revision and impacts integration through behavior. Integration can influence identity development through

were least integrated and most likely to switch majors. However, students' intrinsic interests in STEM seem to encourage students to remain in STEM even when they choose to switch majors.

Intrinsic interests in STEM form the core of students' STEM identities. Altruistic goals motivate students to engage with course material while course projects and research have the greatest impact on academic integration. For the students in this study, academic integration was not significantly impacted by race, gender, or culture while at the community college. However, social integration was critically shaped by all three factors, primarily resulting in feelings of exclusion for URM students within the STEM environment.

The experiences of URM STEM students in community college are not dramatically different than the experiences of URM STEM students in four-year institutions. The singular status and feelings of exclusion and isolation described by the URM participants in this study indicate that the STEM culture in community college is still "chilly" (Malone & Barabino, 2008; Wasburn & Miller, 2006; Seymour & Hewitt, 1997: National Council for Research on Women, 2001) for most URM students. And, though community colleges serve a diverse population, that diversity is not necessarily seen within STEM degree programs.

However, the participants in this study often described their classes as cooperative, stating that they have not experienced much competition in their STEM classes. The two students who had previously attended large public universities described the community college environment as "less competitive" than the university (Joan), and "mostly cooperative" (Mary) indicating that the community college STEM culture may not be *as* "chilly" a climate as those encountered at other institutions.

To understand the experiences of these students within the context of the STEM environment, we must understand the relationships they have with people in STEM at the

college. A lack of relationships in STEM indicates a lack of integration and appears to have a powerful impact on students' persistence intentions. Those who have strong relationships with others in STEM rely heavily upon those relationships for support. Students in this study relied upon the shared experiences of and advice from other URM STEM people to make meaning of their own experiences in STEM. Relationships with people in STEM at the community college were critical to the success of and persistence of the students in this study.

Identification of Researcher Bias

Bias refers to ways in which data collection or analysis are distorted by the researcher's theory, values, or preconceptions. It is clearly impossible to deal with these problems by eliminating these theories, preconceptions, or values...in qualitative research, the main concern is not with eliminating variance between researchers in the values and expectations that they bring to the study but with understanding how a particular researcher's values influence the conduct and conclusions of the study. (Maxwell, 2009, p.243)

My experiences as a woman in STEM, as an undergraduate student, as a graduate student, and as an instructor provided the motivation for this study. As a graduate student, my feelings of isolation lead me to leave my PhD program after only two years of study. As a Caucasian woman, my experiences differ from those of minority students in STEM; however I experienced feelings of isolation and exclusion, similar to those described by study participants, as a result of my status as a gender minority in STEM.

Openness and awareness of bias was required during interactions with the student in this study. My experiences as a member of an underrepresented group had a direct impact on the questions that I asked during the interviews, for example questions about group work and

competition. In an attempt to minimize the influence of my bias, I communicated with researchers in the area of science identity (in particular Heidi Carlone and Angela Johnson (Carlone & Johnson, 2008) and Sylvia Hurtado (Hurtado et al, 2009)) while developing my interview protocols to ensure that my interview questions were well informed and connected to the research. Finally, my personal and professional concerns regarding the academic success of URM students in STEM motivated me to probe deeper to understand the complex factors that impacted the persistence intentions of URM students in STEM majors.

Limitations

While every endeavor was made to explore the participants' complex identities, academic and social integration, and persistence intentions, the findings from this study may be limited to the participants in this study and may not generalize to others. While the participants in this sample represent a diverse collection of background characteristics and life experiences, the STEM experiences of the participants in this study may not represent other community college STEM majors, and a different sample may have provided different information. This study simply represents a small slice of the experiences of URM STEM majors in community college. By presenting a thickly described multi-case study, this inquiry provides a glimpse of the larger social and cultural forces operating in the STEM and community college communities, and some of the ways in which URM students interact with and make meaning of that world. The interpretations, findings, and conclusions are based on the researcher's interpretations. While this provides a lens through which to examine the data, it is imperative for readers to engage in their own form of analysis while reading the study.

Implications for Practice

If we want to attract and retain students from underrepresented groups, we need to better understand how they experience the process of becoming scientists (Hurtado et al., 2009). Only through this understanding will higher education institutions and STEM disciplines be able to design and implement programs that will bring talented URM students into STEM major programs of study. In this study I have identified some of the experiences common to community college STEM students and how those experiences impact URM student identity development, institutional integration, and persistence intentions. The findings of this study indicated that guidance and support, inclusion, and altruism are important factors in URM student success. While further studies on the experiences of URM community college students in STEM are warranted to confirm and expand on the findings, changes to improve the retention of URM students in STEM can be made now. Community colleges can strengthen academic advising through training to ensure that advisors are familiar with the different STEM degree programs and course plans, and procedures to ensure STEM students are directed to those advisors who specialize in STEM degree programs can be put in place. Tutoring services provided by academic learning support centers can be made more robust by recruiting former students to make tutoring available to students in advanced STEM courses. Institutions can play an important role developing peer groups for academic and social support through programs like MESA and WiSE to combat the isolation and exclusion felt by many URM students in STEM. Finally, community colleges can be proactive about recruiting students in to minority support programs to ensure that supportive advising and mentoring takes place throughout their time at the college.

Implications for Future Studies

While this study provides some insight to the experiences of URM students in STEM in community college, there is a long way to go before we can truly understand the experiences of these students as they negotiate their STEM educational trajectories in community college. There is a need to further study student services such as academic advising and tutoring at the community college and the influence these services have on students throughout their time at the institution. A significant number of the participants in this study started their STEM degree path in developmental mathematics and experienced challenges with regards to mathematics placement. The role that mathematics placement and developmental mathematics plays in the experiences of URM students in STEM at CC is not clear and merits study. Not only is a more complete understanding of students' experiences at the community college necessary, but studying students transitions to four-year schools is also needed, in particular the process of transfer. Where do students find information on four-year institutions, the application process, financial aid, etc? What factors do URM STEM majors consider when choosing four-year institutions? A longitudinal study that begins with students in their first quarters as STEM majors in community college and follows them through graduation and, where applicable, through the transition to a four-year institution is warranted.

Concluding Remarks

My ultimate goal is to increase the representation of URM students in STEM. It was my hope that this study would shed light on previously unknown relationships between the college environment, STEM culture, and URM STEM persistence decisions to expand researchers' and practitioners' knowledge of the complexities of student experiences in STEM in community college. Ideally, this study will assist organizations as they develop, implement, and adjust

programs to create welcoming and supportive environments for a diverse STEM student population.

Additionally, I hope that by taking part in and reading this study, the student participants will discover strength in their personal stories and are encouraged by the stories of others. As a graduate student in STEM, I believed my feelings of isolation were unique and that the problem with fit was because I lacked interest and/or ability in STEM. I found myself leaving one STEM program for another, carrying with me a love of science, but unable to find a place where my passion, knowledge, and ability seemed to fit. It was not until years later that I understood the impact of social and cultural forces on my experience and my decision to leave my STEM PhD program. The passion for STEM described by the student participants reminds me why I pursued science as a young woman and the reasons why I now teach science in community college. At the conclusions of the interviews a few of the participants questioned whether their participation in this study was worthwhile because they were not “typical” students. I hope that we remember the beauty of diversity is the many perspectives and experiences that we bring to our fields, and that it is the non-typical students, researchers, practitioners, and instructors that propel science, engineering, and technology forward.

References

- Augustine, N. R. (2005). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Retrieved September 28, 2009 from <http://www.commerce.senate.gov/pdf/augustine-031506.pdf>.
- Astin, A. W. (1993). *What matters in college? Four critical years revisited*. San Francisco, CA: Jossey-Bass.
- Babbie, E. (1995). *The practice of social research*. (7th ed.). Belmont, CA: Wadsworth.
- Birke, L. (2001). In pursuit of difference: Scientific studies of women and men. In Lederman, M. & Bartsch, I. (Eds). *The gender and science reader* (p. 309 – 322). New York, NY: Routledge.
- Bogdan, R. C., & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods*. Boston, MA: Pearson Education.
- 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, 441 – 458.
- Brown, B. (2005). The politics of public discourse: Discourse, identity and African-Americans in science education. *The Negro Education Review* 56(2/3), 205-220.
- Brown, B. (2004). Discursive identity: Assimilation into the culture of science and its implications for minority children. *Journal of Research in Science Teaching*. 41, 810 – 834.
- Brown, S.W. (2002). Hispanic students majoring in science or engineering: What happened in their educational journeys? *Journal of Women and Minorities in Science and Engineering*, 8(2), 123-148.

- Cabrera, A. F., et al. (1999). Campus Racial Climate and the Adjustment of Students to College: A Comparison Between White Students and African American Students. *Journal of Higher Education*, 70(2), 134–160.
- Carlone, H. B., & Johnson, A. (2008). Understanding the science experience of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, 44(8), 1187 – 1218.
- Carnevale, A. P., Smith, N., Melton, M., & Georgetown University, C. (2011). STEM: Science Technology Engineering Mathematics. *Georgetown University Center On Education And The Workforce*.
- Center for Institutional Data Exchange Analysis. (2000). *1999 – 2000 STEM retention report*. Norman, OK; University of Oklahoma.
- Chinn, P.W.U. (1999). Multiple worlds/mismatched meanings: barriers to minority women engineers. *Journal of Research in Science Teaching*, 36, 621 – 636.
- Chubin, D. E. & Malcom, S. M. (2008). Making a Case for Diversity in STEM Fields, on *Inside Higher Ed*, taken from: <http://www.insidehighered.com/views/2008/10/06/chubin>.
- Cole, D., & Espinoza, A. (2008). Examining the academic success of Latino students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Student Development*, 49(4), 285 – 300.
- Colaizzi, P., 1978. Psychological research as the phenomenologist views it. In Valle, R., King, M. (Eds.), *Existential Phenomenological Alternative for Psychology*. Oxford University Press, NY, pp. 48-71.

Creasy Fowler, M.D. (2010). *Schooling girls in a rural community: An examination of female science identity and science career choices*. Unpublished doctoral dissertation.

Retrieved April 5, 2012 from ProQuest Dissertations and Theses database.

Creswell, J. W. (2003). *Research Design: Qualitative, quantitative, and mixed method approaches*. Thousand Oaks: Sage Publications.

Croissant, J. L. (1992). Identity and commitment: Information, rhetoric, and the recruitment and retention of female engineering students. *Proceedings of the Annual Technology Literacy Conference*, Alexandria, Virginia.

Danielsson, A.T. & Linder, C. (2009). Learning in physics by doing laboratory work: towards a new conceptual framework. *Gender and Education*, 21(2), 129-144.

Davidson, A. (1996). *Making and molding identities in schools: Student narratives on race, gender, and academic engagement*. Albany, NY: State University of New York.

Erikson, E. (1968). *Identity, youth, and crisis*. New York, NY: Norton.

Espinosa, L. (2011). Pipelines and Pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review*, 82(2), 209 -240.

Espinosa, L. (2009). Pipelines and pathways: Women of color in STEM majors and the experiences that shape their persistence. Unpublished doctoral dissertation. Retrieved 23 April 2012 from ProQuest Dissertations and Theses database.

Fisher, B.J., & Hartmann, D.J. (1995). The impact of race on the social experience of college students at a predominantly white university. *Journal of Black Studies*, 26(2), 117 – 133.

- Fleming, L., Engerman, K., & Williams, D. (2006). Why students leave engineering: The unexpected bond. *Proceedings of the American Society for Engineering Education Annual Conference*, Chicago, Illinois.
- Foor, C. E., Walden, S. E., & Trytten, D. A. (2007). "I wish that I belonged more in this whole engineering group:" Achieving individual diversity. *Journal of Engineering Education*, 96(2), 103 – 115.
- Gasiewski, J., Herrera, F.A. Mosqueda, C.M., Hurtado, S., Change, M. (2011). The pathway to loneliness: When institutional support really matters for STEM graduate students. Retrieved 17 March 2012 from <http://www.heri.ucla.edu/nih>.
- George, Y. S., Neale, D. S., Van Horne, V., & Malcom, S. M. (2001). In pursuit of a diverse science, technology, engineering, and mathematics workforce: Recommended research priorities to enhance participation by underrepresented minorities. Retrieved October 18, 2009 from http://www.aaas.org/programs/education/about_ehr/pubs.shtml.
- Gloria, A. M., Castellanos, J., Lopez, A. G., Rosales, R. (2005). An examination of academic nonpersistence decisions of Latino undergraduates. *Hispanic Journal of Behavioral Sciences*, 27(2), 202 – 223.
- Gloria, A. M., & Robinson Kurpius, S. E. (2001). Influences of self-beliefs, social support, and comfort in the university environment on the academic non-persistence decisions of American Indian undergraduates. *Cultural Diversity and Ethnic Minority Psychology*, 7, 88-102.
- Gloria, A. M., Robinson Kurpius, S. E. R., Hamilton, K. D., & Wilson, M. S. (1999). African American students' persistence at a predominantly White university: Influences of social

- support, university comfort, and self-beliefs. *Journal of College Student Development*, 40, 257 – 268.
- Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education*, 69(6), 589 – 620.
- Hausmann, L. R. M., Schofield, J. W., & Woodes, R. L. (2007). Sense of belonging as a predictor of intentions to persist among African American and white first-year college students. *Research in Higher Education*, 48(7), 803 – 839.
- Harding, S. (1991). *Whose science? Whose knowledge? Thinking from women's lives*. Ithaca, NY: Cornell University Press.
- Heidel, J., Ali, H., Corbett, B., Liu, J., Morrison, B., O'Connor, M., & ... Ryan, C. (2011). Increasing the Number of Homegrown STEM Majors: What Works and What Doesn't. *Science Educator*, 20(1), 49-54.
- Huang, G., Taddese, N., & Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education*. Retrieved October 18, 2009 from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000601>.
- Hughes, G. (2001). Exploring the availability of student scientist identities within curriculum discourse An anti-essentialist approach to gender-inclusive science. *Gender and Education*, 13, 275 – 290.
- Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinoza, L. L. (2009). Diversifying Science: Underrepresented student experiences in structured research programs. *Research in Higher Education*, 50, 189 – 214.

- Hurtado, S.H., & Carter, D.F. (1997). Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging. *Sociology of Education*, 70(4), 324-345.
- Josselson, R. (1996). *Revising herself: The story of women's identity from college to midlife*. New York: Oxford University Press.
- Jones, L., Castellanos, J., & Cole, D. (2002). Examining the ethnic minority student experience as predominantly white institution: A case study. *Journal of Hispanic Higher Education*, 1, 19-39.
- Justin-Johnson, C. (2004). Good fit or chilly climate: An exploration of the persistence experiences of African-American women graduates of predominantly White college science programs. Unpublished doctoral dissertation. Retrieved 23 April 2012 from ProQuest Dissertations and Theses database.
- Kaplan, G., & Rogers, L. J. (2001). Race and gender fallacies: The paucity of biological determinist explanations of difference. In Lederman, M. & Bartsch, I. (2001). *The gender and science reader* (p. 323 – 342). New York, NY: Routledge.
- Karp, M.M, Hughes, K.L., & O'Gara, L. *An exploration of Tinto's integration framework for community college students*. CCRC Working Paper No. 12, taken 12 April 2012 from http://ccrc.tc.columbia.edu/DefaultFiles/SendFileToPublic.asp?ft=pdf&FilePath=c:%5CWebsites%5Cccrc_tc_columbia_edu_documents%5C332_615.pdf&fid=332_615&aid=47&RID=615&pf=ContentByType.asp?t=.
- Lederman, M. & Bartsch, I. (2001). *The gender and science reader*. New York, NY: Routledge.
- Lofland, J. (1974). Styles of reporting qualitative field research. *The American Sociologist*, 9, 101-111.

- Lofland, J., & Lofland, L. H. (1995). *Analyzing social settings: A guide to qualitative observation and analysis*. Belmont, CA: Wasworth.
- MachLachlan, A.J., Chavez, L.F. (2007). *Abstract: The Long and Crooked Path to a Bachelor's Degree in Science, Technology, Engineering, and Mathematics for Underrepresented Students in California: What is the Role of the Community Colleges?* Taken 18 April, 2012, from <http://cshe.berkeley.edu/research/communitycollege/index.htm>.
- Malcom, S. M., Hall, P. Q., & Brown, J. W. (1976). The double bind: The price of being a minority woman in science (No. 76-R-3). Washington, DC: American Association for the Advancement of Science.
- Malone, K. R., & Barabino, G. (2008). Narrations of race in STEM research settings: Identity formation and its discontents. *Science Education*, 93(3), 485 – 510.
- Margolis, J. & Fisher, A. (2002). *Unlocking the clubhouse: Women in computing*. Cambridge, MA: MIT Press.
- Maxwell, J.A. (2009). Designing a qualitative study. In L. Bickman and D.J. Rog (eds.), *Applied Social Research Methods* (pp. 214-253). Thousand Oaks, CA: Sage.
- Maxwell, J. A. (2005). *Qualitative research design: An interactive approach*. (2nd ed). Thousand Oaks, CA: Sage.
- Mendoza, E. M., & Johnson, K. O. (2000). *Land of Plenty: Diversity as American's Competitive Edge in Science, Engineering, and Technology*. Taken October 6, 2009 from: <http://www.nsf.gov/od/cawmset/>
- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass.

Nasir, S., & Saxe, G. (2003). Ethnic and academic identities: A cultural practice perspective on emerging tensions and their management in the lives of minority students. *Educational Researcher*, 32, 14 – 18.

National Academic Advising Association. (2006). NACADA concept of academic advising. Retrieved April 27, 2012 from <http://www.nacada.ksu.edu/Clearinghouse/AdvisingIssues/Concept-Advising.htm>

National Academy of Engineering and National Research Council. (2005). *Enhancing the Community College Pathway to Engineering Careers*, The National Academies Press.

National Council for Research on Women. (2001). *Balancing the equation: Where are women and girls in science, engineering and technology?* New York: National Council for Research on Women.

National Science Foundation [NSF], Division of Science Resources Statistics. (2009). *Women, minorities, and persons with disabilities in science and engineering*. NSF 09-305. Retrieved 23 April 2012 from <http://www.nsf.gov/statistics/wmpd/pdf/nsf09305.pdf> .

NSF, Division of Science Resources Statistics. (2007). *Women, minorities, and persons with disabilities in science and engineering* (NSF 07 – 314). Washington, DC: National Science Foundation.

NSF, Division of Science Resources Statistics. (2004). *Women, minorities, and persons with disabilities in science and engineering* (NSF 04 – 317). Washington, DC: National Science Foundation.

Nora, A., and Cabrera, A. F. (1996). The Role of Perceptions of Prejudice and Discrimination on the Adjustment of Minority Students to College. *Journal of Higher Education*, 67(2), 119–148.

- Nora, A., & Cabrera, A. F. (1996). The role of perceptions of prejudice and discrimination on the adjustment of minority student to college. *Journal of Higher Education*, 67, 119-148.
- O'Connor, K., Amos, D., Bailey, T., Garrison, L., Lichtenstein, G., Loshbaugh, H., Jones, M., Seward, D., Perhamus, L., & Stevens, R. (2007). Sponsorship: Engineering's tacit gatekeeper. *American Society for Engineering Education Annual Conference*, Honolulu, Hawaii.
- Ong, M. (2002). *Against the current: Women of color succeeding in physics*. Unpublished doctoral dissertation. Retrieved 18 April 2012 from ProQuest Dissertations and Theses database.
- Ong, M., Wright, C., Espinosa, L. 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.
- Orbe, M. P. (2004). Negotiating multiple identities within multiple frames: An analysis of first-generation college students. *Communication Education*, 53(2), 131 – 149.
- Pascarella, E. T. (2006). How college affects students: ten directions for future research. *Journal of College Student Development*, 45(5), 508 – 520.
- Pascarella, E., & Terenzini, P. (2005). *How College affects students*. (2nd ed.). San Francisco, CA: Jossey-Bass.
- Pascarella, E. T., Wolniak, G. C., & Pierson, C. T. (2003). Influences on community college students' educational plans. *Research in Higher Education*, 44(3), 301 – 314.

- Pizzolato, J. E., Chaudhari, P., Murrell, E. D., Podobnik, S., Schaeffer, Z. (2008). Ethnic identity, epistemological development, and academic achievement in underrepresented students. *Journal of College Student Development*, 49(4), 301 – 318.
- Planty, M. Hussar, W., & Snyder, T. (2009). *The condition of education 2009*, Washington, DC: National Center for Education Statistics.
- Reyes, M.E. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. *Harvard Educational Review*, 81(2), 241-262.
- Robinson, J. G. & McIlwee, J. S. (1991). Men, Women, and the Culture of Engineering. *The Sociological Quarterly*, 32(3), 403 – 421.
- Robinson, T. N. III. (2003). Identity as a mediator of institutional integration variables in the predication of undergraduate persistence intentions. *Journal of Adolescent Research*, 18(1), 3 – 24.
- Rodriguez, J. L., Jones, E. B., Pand, V. O., & Park, C. D. (2004). Promoting academic achievement and identity development among diverse high school students. *High school Journal*, 87(3), 44 – 53.
- Russel, M. L., & Atwater, M. M. (2005). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominantly white institution. *Journal of Research in Science Teaching*, 42, 691 – 715.
- Saldana, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications.
- Sandoval-Lucero, E., Blasius, E., Klingsmith, L., & Waite, C. Student-Initiated Study Groups for STEM Classes in Community College Settings. *Higher Education Studies*, 2(2), 31-39.

- Schultz, W. P., Hernandez, P. R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., & Serpe, R. T. (2011). Patching the Pipeline: Reducing Educational Disparities in the Sciences through Minority Training Programs. *Educational Evaluation And Policy Analysis, 33*(1), 95-114.
- Seidman, I.E. (1998). Establishing Access to, Making Contact With and Selecting Participants, Chapter 4 in *Interviewing as Qualitative Research*, Teachers College Press: New York.
- Seymour, E., & Hewitt, N. C. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.
- Smith, D. G. E., & Wolf-Wendel, L. E. E. (2005). The Challenge of Diversity: Involvement or Alienation in the Academy? ASHE Higher Education Report, Volume 31, Number 1. *Ashe Higher Education Report, 31, 1*, 1-100.
- Sólorzano, D. G., Ceja, M., & Yosso, T. (2000). Critical race theory, racial microaggressions, and campus racial climate: *The experiences of African American college students*. *Journal of Negro Education, 69*(1/2), 60–73.
- Spradley, H. (1979). *The ethnographic interview*. New York, NY: Holt, Rhinehart and Winston.
- Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613 – 629.
- Stevens, R., Amos, D., Jocuns, A., & Garrison, L. (2007). Engineering as lifestyle and a meritocracy of difficulty: Two pervasive beliefs among engineering students and their possible effects. *American Society for Engineering Education Annual Conference*, Honolulu, Hawaii.
- Tan, E. & Calabrese Barton A. (2007). Unpacking science for all through the lens of identities-in-practice. *Cultural Studies in Science Education, 3*, 43-71.

- Tate, E.D., & Linn, M.C. (2005). How does identity shape the experiences of women of color engineering students? *Journal of Science Education and Technology*, 14(5/6), 483 – 493).
- Tinto, V. (1999). Taking Retention Seriously: Rethinking the First Year of College. *NACADA Journal*, 19(2), 5-9.
- Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*. (2nd ed). Chicago: University of Chicago Press.
- Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago: University of Chicago Press.
- Tinto, V., & Russo P. (1994). Coordinated studies programs: Their effect on student involvement at community college. *Community College Review*, 22(2), 16 – 25.
- Tsapogas, J. (2004). *The role of community colleges in the education of recent science and engineering graduates*. Washington, DC: NSF.
- Tsai, L. (2003). Identity reconstruction of women in physics: Interventionist discourse matters. *Annual Meeting of the National Association for Research in Science Teaching*, Philadelphia, PA.
- Tonso, K. L. (2006). Student engineers and engineering identity: Campus engineer identities as figured world. *Cultural Studies of Science Education*, 1, 237 – 307.
- Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tuscon, AZ: Research Corporation.
- Valenzuela, Y. (2006). Mi fuerza/My strength: The academic and personal experiences of Chicana/Latina transfer students in math and science. Unpublished doctoral dissertation. Retrieved 18 April 2012 from Pro-Quest Dissertation and Theses database.

- Vaughan, G. B. (2006). *The Community College Story* (3rd ed.). Community College Press, Washington, DC.
- Vogt, K.E. (2005). Asian American women in science, engineering, and mathematics: background, contextual, and environment influences on self-efficacy and academic achievement. Unpublished dissertation. Retrieved 18 April, 2012 from <http://drum.lib.umd.edu/bitstream/1903/3197/1/umi-umd-3020.pdf>.
- Wasburn, M. H., & Miller, S. G. (2006): Still a chilly climate for women students in technology; a case study. In Fox, M. F., Johnson, D. G., & Rosser, S. V. (Eds.), *Women, Gender, & Technology* (pp. 60 – 79). Champaign, IL: University of Illinois Press.
- Yin, R. K. (2006). Case Study Methods. In Green, J. L., Camilli G., & Elmore, P. B. (Eds). *Handbook of Complementary Methods in Education Research* (p. 111 – 122). Mahwah, NJ: Lawrence Erlbaum Associates.



Dear Student:

Rachel Wade, a PhD student in the College of Education at the University of Washington is inviting you to participate in this research study.

The title of this study is: *Becoming Scientists, STEM identity development in Community College Students.*

The purpose of this study is to understand the benefits and challenges that students experience in community college science, engineering, and mathematics degree programs and how these experiences impacts students' educational goals.

If you choose to participate, your participation in this study will involve three 90 minute interviews and a half day of observations on campus.

The results of this study may be published in scientific research journals or presented at professional conferences. However, your name and identity will not be revealed and your record will remain confidential.

You can choose not to participate. If you decide not to participate, there will not be a penalty to you or impact to your grades or student standing. You may withdraw from the study at any time.

Becoming Scientists– Fall 2010, Participant

Observation Protocol

Title/description of Observation: _____

Date(s) of observation: _____ Date of observation: _____

Participant initials: _____ Observer: _____

Context Notes (contextual influences on observation- i.e. location, class topic, other people):

Participant observations

1. make notes of participant schedule, and use of time on campus, including how much time spent at school—in class, out of class—time spent working, studying, with friends, etc, and where participant spends time on campus, when not in class.
2. make notes of participant body language and evidence of engagement when in and out of classes (in class: note taking, asking and answering questions, referencing texts, participation in group discussion, etc; outside of class: greeting and interacting with other students, staff, and faculty members)
3. highlight questions the teacher asked & questions the participant asked during class.

Time	Script	Notes
	<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	

CCSTEM Student Semi-structured Interview Protocol Interview #1

I. Introduction

I really appreciate your taking the time to meet me today. To start things off, I would like to give you a little bit of background about my project, what I am working on, what your participation will involve.

1. Researcher briefly introduces herself and the project.

The purpose of our study is to find out how community college students view science, math, and engineering as majors or as a career interests, and what experiences they have in community college science, math, and engineering. During these interviews I will ask you about your background, your interest in Science, Math, Engineering & Technology (STEM), the circumstances that brought you to CCX, and your experiences in STEM and at CCX. If you would rather not respond to a particular question, simply say “I pass.”

2. Researcher explains participation and the informed consent document

I anticipate that each interview will take no more than 90 minutes. Unless you have any objections, I would like to record the interviews. Only I will have access to the audio-recorded interviews and at no time will your name or any identifying information be disclosed. Before we begin, do you have any questions for me?

II. Interview

The questions listed below will direct the interview conversations. This protocol is semi-structured, therefore the questions may or may not be posed according to the conversation between the interviewer and the interviewee. Similarly, questions may be posed out of order and the interviewer may pose emerging questions (not listed below) as appropriate according to the interview conversation. Each interview is anticipated to last not more than 90 minutes. It is recommended for the interviewer to keep to the designated time limits, skipping the remaining questions in each part if the designated time limit is exceeded.

Part I- Getting to know participant and exploring background. (Limited to 20 minutes)

1. Tell me a little about your background.
 - a. Where did you grow up?
 - b. What is your work experience? Are you currently working?
 - c. Where did you go to school before CCX? (High School and previous college)
 - d. Tell me about your family
 - i. Parents/siblings—education and occupation

- ii. Spouse—education and occupation
 - iii. Children—number and ages, childcare
2. How long have you been at CCX?
 3. Are you a full-time or part-time student?
 4. When do you plan to finish your degree?

Part II- Exploring motivation and academic goals. (Limited to 30 minutes)

5. What is your major and what motivated you to pursue science as a major?
 - a. Did you ever think about changing majors? What made you stay in your current major?
6. What do you plan to do when you finish your degree at CCX?
 - a. To what programs, schools, scholarships, or internships are you applying (or plan to apply to)?
 - b. What are the major external and internal factors that spurred you to apply to these schools/programs?
7. What do you see yourself doing after you graduate with your STEM degree?
 - a. Have you ever considered pursuing a research scientist career? Why or why not?
 - b. How has your college experience at CCX helping you to achieve your career goals?
8. What kind of STEM classes have you taken? What classes do you still have to take?
9. Tell me a little about your favorite class ever (K-12 or college).
 - a. What factors contribute to making it your favorite class?
 - i. Teacher
 - ii. Students
 - iii. Class activities
 - iv. Subject
 - b. In what way did your experience in this class impact your decision to pursue your degree?

Part III- Exploring experiences at CCX and in STEM (Limited to 30 minutes)

10. What types of activities or programs have you participated in while at CCX? What role has your participation in a program (name programs) played in supporting you?
 - a. What about the program was most important to you (e.g. financial support, academic support, peer group, advising, etc.)?
 - b. Do you have any needs/concerns that might be addressed in the program? (Probe for any details on what the programs really do and how students experience them).
11. What skills do you think are important to becoming a scientist, and how are these skills being developed in your college classes or lab settings?
 - a. What has an instructor done to help you best understand scientific concepts?

- b. Have you experienced competition in classes or do you tend to work together with other students in your science classes and/or labs? Is this facilitated by instructors, peers, or program activities?
12. Tell me about your best undergraduate learning experience at CCX
 - a. What factors contribute to making it the best experience?
 - b. How did this experience impact your decision to pursue STEM?
 13. Tell me about your worst learning experience at CCX
 - a. What factors contribute to making it the worst experience?
 - b. How did this experience impact your decision to pursue STEM?
 14. Tell me about positive and negative experiences you've had with small group discussion, group project, laboratory projects, and whole class discussion
 15. Do you have any concerns/worries about classes in the future? What are they?

Part V- Ending the interview. (unlimited)

My questions end here; do you have anything else you would like to add about your background, your interest in STEM, or your experiences at CCX? Or is there anything related that I didn't to ask about, but you would like to share?

Interviewer will thank participant for her/his time and interest in participating the study. The recording will be stopped and the interview will end.

CCX STEM Student Semi-structured Interview Protocol Interview #2

III. Introduction

I really appreciate your taking the time to meet with me again. Last time we met I asked you questions about your background, your interest in STEM, and some of your experiences at CCX. Today I hope to learn more about your experiences as a student at CCX. Again, I anticipate that this interview will take about 90 minutes. Unless you have any objections, I would like to record the interview. I will remind you that only I will have access to the audio-recorded interviews and at no time will your name or any identifying information be disclosed to anyone. Before we begin, do you have any questions for me?

IV. Interview

This is an ethnographic interview, and is even less structured than the first. The interview will begin with the question listed below, and follow-on questions will be posed according to the conversation between the interviewer and the interviewee. The interview begins with a “grand tour” descriptive question (Spradley, 1979), asking the participant to describe a typical day as a CCX student. This will be followed up by “mini-tour” questions that ask the participant to describe some smaller unit of an event or activity mentioned during the conversation. Next, the interviewer will ask some structural questions to find out how the participant organizes his/her knowledge, such as the different types of activities s/he participates in during the day. The goal of this interview is to understand community college STEM students from the student’s point of view.

Each interview is anticipated to last not more than 90 minutes. It is recommended for the interviewer to skip the remaining questions in each part if the designated time limit is exceeded.

Part I- Getting to know CCX student daily experience. (Limited to 80 minutes)

1. Giving ethnographic explanation: *Today I would like to ask you some different kinds of questions. Though I’ve spent time on community college campuses, I have never been a community college student and don’t know what a typical day is like for community college students. For example, where I went to college, I lived on campus (as did most students at my college) which creates a different environment than CCX where all students commute to campus. I suspect that there are many other differences that I don’t know about.*
2. Grand Tour question: *I want to understand how CCX students talk about what they do, how they see their work, their classmates, their teachers, themselves. I would like to find out what it is like to be a STEM student at CCX, from your point of view. Could you start*

at the beginning of a typical school day, and describe to me what you do? Like, when do you wake up? Where do you start your day? How do you get to school? When do you usually arrive on campus? What are some of the things you would have to do on a typical day, and go through the day right up until you go to bed?

3. Follow-on questions, based on participant responses. These questions may also incorporate responses to questions from the first interview.

Part II- Ending the interview. (unlimited)

My questions end here; do you have anything else you would like to add about your background, your interest in STEM, or your experiences at CCX? Or is there anything related that I didn't to ask about, but you would like to share?

Interviewer will thank participant for her/his time and interest in participating the study. The recording will be stopped and the interview will end.

Par II- Questions about challenges and obstacles faced by participants and where they find support. (Limited to 60 minutes)

1. What were/are the biggest challenges or obstacles that you deal with as a STEM major?
 - a. Did you feel prepared to take scientific coursework in college? Why or why not?
 - b. Do you feel like these challenges are common for STEM students, or unique to you? Why or why not?
2. Are there moments when you feel discouraged? Can you provide an example?
 - a. Has your confidence in your ability to do well in the major/field increased or decreased? Why?
3. Have you ever thought about switching majors? If so, why?
 - a. What other majors have you considered?
 - b. Do you feel like you are major are a good fit?
 - c. Are you happy with your decision?
 - d. Would you make the same decision if you knew earlier what you know now?
4. What are your sources of academic support that have helped you succeed in your major?
 - a. Is there anyone who has especially encouraged you to in terms of school and your major choice?
 - b. Do you have a mentor guiding you in your major? If so, how has your mentor helped you?
 - c. How have your family, friends, and/or co-workers responded to your choice of major?
5. What is your best experience with a faculty member?
 - a. Worst?
 - b. How often do you interact with faculty?
 - c. Who are the people who are important to you (role models)/who do you identify with?
6. How often do you interact with other students (in your major and other)? When/where? What kinds of interactions to you have with fellow _____majors?
 - a. What kinds of things do you do or talk about?
 - b. How have these interactions changed over time?
 - c. Who are the people who are important to you (role models)/who do you identify with?
7. What advice would you give to new students in your major?
 - a. Is your advice different for women than for men?
 - b. Is your advice different for students of color?
8. Do you have any ideas of why so few women and people of color are in your field at large?
 - a. Ideas on what would have to be different to attract/excite more women?
 - b. To attract more people of color?

- c. What "works" at CCX?
9. Does race or gender factor into your experiences at CCX? In your major? If so how?
 - a. Have you ever faced/experienced difficulties at CCX/in your department you feel/felt were related to race or gender?
 - b. Do you feel/have you ever felt isolated?
 - c. Have you witnessed the impact of race in the experiences of other students of color at CCX? (Please give specific examples/no names necessary)
 10. How would you characterize the climate of inclusion (campus climate) at CCX?
 - a. Would you say the same for your department?
 - b. In what ways have you witnessed changes in the climate of inclusion at CCX?
 - c. Are there unique challenges in the CCX culture that shape the climate of inclusion (campus climate)? If so what are they?
 - d. How can the climate of inclusion (campus climate) be improved at CCX?
 - e. Have you ever attended a college other than CCX? If so, how is the campus climate (climate of inclusion) similar/different from that other institution?

Part III- Ending the interview. (unlimited)

My questions end here; do you have anything else you would like to add about your background, your interest in STEM, or your experiences at CCX? Or is there anything related that I didn't to ask about, but you would like to share?

Interviewer will thank participant for her/his time and interest in participating the study. The recording will be stopped and the interview will end.

UNIVERSITY OF WASHINGTON
COLLEGE OF EDUCATION

Title of Study: Becoming Scientists, STEM identity development in Community College Students

STUDENT-PARTICIPANT CONSENT FORM

Investigator:

Rachel Wade, PhD Candidate, College of Education, (206) 718-8891, rwade@u.washington.edu

INVESTIGATOR'S STATEMENT

I am asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called "informed consent." We will give you a copy of this form for your records.

PURPOSE OF THE STUDY

The purpose of this study is to understand the benefits and challenges that students experience in community college STEM degree programs and how these experiences impact students' educational goals. I hope to find out what role, if any, community colleges play in the decisions of URM students to enter, continue in, or leave their STEM majors as well as discovering what factors have bearing for college persistence. I hope to learn how students experience community college as STEM majors, how they describe their classes, how they are, or are not, involved on campus, and how they think that their ethnic, racial, gender, or other identities might influence their experiences on campus and in their major. This seems particularly important as the STEM fields are still not very diverse.

PROCEDURES

You will participate in three interviews and a half-day of observation over a period of about 3 months. The first interview is designed to get to know you, your background, your educational goals, and your interest in STEM. The second interview will focus on your experiences in college and your major. These interviews will take place on your campus and be scheduled for times that are convenient for you. Following the second interview we will arrange a time for me to observe you on campus and in class. This will involve me shadowing you for a few hours while at school, seeing where you attend class, where you study, where you hang-out, and so forth. During this time, I will take notes on your environment, your interactions with peers and teachers, and your daily schedule. You do not have to do any special preparation; rather I hope to see what typically occurs during a day at school. The final interview will take place after the observations and give me a chance to better understand what I observed during that time. During this final interview I will also ask you some questions specifically related to your experiences as a minority in your major area. The interviews will each last 90 minutes. During the interviews, I might ask you questions like: What skills do you think are important to become a scientist? Have you ever experienced competition in classes? What has been your best learning experience at this college? Have you ever thought about switching majors? Does race or gender factor into your experiences at this college? I would like to audiotape the interview. Only I will have access to the audiotapes. I will transcribe the tapes and assign a code to the transcripts. I will only use pseudonyms in the reporting of my analyses. You are welcome to review the audiotapes or the transcripts at any time and make changes or delete any of your comments. Also, I will not provide any information that might identify your class schedule or

instructors. I will destroy the tapes by within two months of the interviews, at the completion of the transcription.

RISK, STRESS, OR DISCOMFORT

Sometimes people feel awkward when a stranger is asking them questions. Usually this awkwardness goes away in a short while, once they become comfortable with the interviewer. In addition, it can take time for people to feel comfortable being audio taped. The audio taping equipment will be made as unobtrusive as possible. If, however, you feel uncomfortable at any time, you may choose not to respond to a question, ask to stop audio-recording, or withdraw from the study. You may contact me if you have any questions or concerns about the study.

BENEFITS OF THE STUDY

We hope the results of this study will help colleges to better create and support diversity in STEM. You may not directly benefit from this study.

OTHER INFORMATION

All information from this study will be confidential. Your participation is voluntary. Only the researcher will have access to your name and only for purposes of contacting you to arrange for interviews and observations. The links between transcripts and observational notes and your name will be destroyed in no later than June 2011. Only descriptive information about you (major, year in school, sex, enrollment status (part-time or full-time), etc.) will be retained with the records. At any time, you can decide not to participate in the study. Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

Rachel Wade

Name of Investigator

Signature of Investigator

Date

Subject's statement

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later on about the research I can ask one of the investigators listed above. I give my permission to be video and audio taped as described above. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098. I will receive a copy of this consent form.

I give you permission to audiotape my interviews.

I DO NOT give you permission to audiotape my interviews.

I give you permission to observe me working while at school and in class.

I DO NOT give you permission to observe me while at school and in class.

Name of subject

Signature of subject

Date

Copies to:
Participant
Investigator

VITA

Rachel Wade was raised on Bainbridge Island, Washington. At Whitman College she earned a Bachelor of Arts degree in Physics. After graduation she served on active duty with the United States Navy, teaching physics and engineering at the Navy Nuclear Power Training Command. After separating from active duty, she entered graduate school at the University of Washington, earning a Master of Science in Oceanography (2004) followed by a Master of Education in Science Education (2006). She began teaching physics and physics science at Edmonds Community College in 2005, and continues to serve as a Meteorology and Oceanography officer in the United States Navy Reserve. In 2012 she earned a Doctor of Philosophy at the University of Washington in Education.