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Nature of Deaf Mentoring Dyads: Role of Subjugated Knowledge

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Nature of Deaf Mentoring Dyads: Role of Subjugated Knowledge

Abstract
Research has indicated that the United States is lagging behind the rest of the world in producing science, technology, engineering, and math (STEM) majors and career professionals. The National Science Foundation has launched one particular initiative to address this need which is centered on underrepresented communities. Matching mentoring dyads based on similar social identities may provide necessary role models (Davidson & Foster-Johnson, 2001) and unlock subjugated knowledge (Collins 2000) about how to be both deaf and scientist. Among their underrepresented counterparts, deaf individuals are disproportionately underrepresented in STEM careers (NSF, 2011). The leakage in the STEM pipeline between undergraduate enrollment and the awarding of doctoral degrees to deaf students may be attributed, in part, to a lack of individuals in academic mentoring roles who are deaf; sharing the same social circumstances and characteristics as these students (Mertens & Hopson, 2006). Understanding the experience of deaf scholars and deaf students engaged in formally mentored undergraduate research efforts is helpful in determining the appropriate long term plans and strategies necessary to promote growth of deaf people entering STEM fields. This phenomenological study captured the experiences of three deaf mentoring dyads operating in undergraduate research laboratories. Informed by the subjugated knowledge framework (Collins, 2000), participants described the nature of their mentoring dyad and the nature and content of subjugated knowledge extended to deaf mentees. This process was identified as central to and helping deaf undergraduates to develop as both deaf individuals and ultimately deaf scientists. This study employed a triangulated data set, including semi-structured individual interviews with deaf mentors and deaf mentees, dyad interviews, and document collection. From data analysis, three themes emerged: (a) The “Psychology Of Deaf Space”, (b), How To Be A Deaf Scientist: Building Navigational Capital, and (c) Deaf Role Models: Transforming Experiences. The findings from this study inform undergraduate faculty and administrators in higher education on the importance of having deaf mentors as a part of the deaf undergraduate students’ success in the STEM arena. This study also offers to hearing mentors and administrators a series of recommendations for supporting deaf students with whom they may be working in isolation. These individuals have many opportunities to support the individual deaf student as the student works to successfully navigates predominantly hearing STEM communities.

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Nature of Deaf Mentoring Dyads: Role of Subjugated Knowledge

By

Jason D. Listman

Submitted in partial fulfillment
of the requirements for the degree
Ed.D. in Executive Leadership

Supervised by
Dr. Jeannine Dingus-Eason

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St. John Fisher College

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Dedication

This study is dedicated to my mentor, colleague, and friend, Dr. Peter C. Hauser. I would not be here today if it was not for him. I want to thank him for inspiring me to become a deaf scholar. To my partner, Jamal Abdunnasir, who has been my steadfast “rock” during my doctoral journey, thank you. The constant love, support, and encouragement are the reasons why I made it through. I love you.

I am privileged to also be able to share my gratitude with a number of additional individuals and groups who helped to make my journey a success:

To my interpreter, Courtney Williams, who sacrificed two years to work with me through the doctoral journey, thank you!

Thank to you, Dr. Karey Pine and Rupert Dubler for your dedication and time to proofreading my dissertation.

Thank you Kailea Colayori for your commitment to transcribing my data. I know it was a daunting task.

Thank you to all of my friends who sat and listened to me share my joys and frustrations with this process.

Thank you to my family for your constant support throughout my life.

Lastly, thank you to my dissertation chair, Dr. Jeannine Dingus-Eason, and my committee member Dr. Chinwe Ikpeze for your time and guidance as this bird spread his wings and flew smoothly from the nest.
Biographical Sketch

Jason Listman is currently a faculty in American Sign Language and Interpreting Education at National Technical Institute for the Deaf (NTID) housed at Rochester Institute of Technology (RIT). Mr. Listman attended NTID/RIT, graduating in 2007 with his Bachelor of Science in Psychology. He completed his Master of Science degree in Deaf Secondary Education at RIT as well in 2009. Mr. Listman began his doctoral studies in May 2011 with St. John Fisher College in Ed.D program in Executive Leadership. He pursued his research on the nature of deaf mentoring dyads: the role of subjugated knowledge under the direction of Dr. Jeannine Dingus-Eason and received his Ed.D degree in 2013.
Abstract

Research has indicated that the United States is lagging behind the rest of the world in producing science, technology, engineering, and math (STEM) majors and career professionals. The National Science Foundation has launched one particular initiative to address this need which is centered on underrepresented communities. Matching mentoring dyads based on similar social identities may provide necessary role models (Davidson & Foster-Johnson, 2001) and unlock subjugated knowledge (Collins 2000) about how to be both deaf and scientist.

Among their underrepresented counterparts, deaf individuals are disproportionately underrepresented in STEM careers (NSF, 2011). The leakage in the STEM pipeline between undergraduate enrollment and the awarding of doctoral degrees to deaf students may be attributed, in part, to a lack of individuals in academic mentoring roles who are deaf; sharing the same social circumstances and characteristics as these students (Mertens & Hopson, 2006). Understanding the experience of deaf scholars and deaf students engaged in formally mentored undergraduate research efforts is helpful in determining the appropriate long term plans and strategies necessary to promote growth of deaf people entering STEM fields.

This phenomenological study captured the experiences of three deaf mentoring dyads operating in undergraduate research laboratories. Informed by the subjugated knowledge framework (Collins, 2000), participants described the nature of their
mentoring dyad and the nature and content of subjugated knowledge extended to deaf mentees.

This process was identified as central to and helping deaf undergraduates to develop as both deaf individuals and ultimately deaf scientists.

This study employed a triangulated data set, including semi-structured individual interviews with deaf mentors and deaf mentees, dyad interviews, and document collection. From data analysis, three themes emerged: (a) The “Psychology Of Deaf Space”, (b), How To Be A Deaf Scientist: Building Navigational Capital, and (c) Deaf Role Models: Transforming Experiences. The findings from this study inform undergraduate faculty and administrators in higher education on the importance of having deaf mentors as a part of the deaf undergraduate students’ success in the STEM arena. This study also offers to hearing mentors and administrators a series of recommendations for supporting deaf students with whom they may be working in isolation. These individuals have many opportunities to support the individual deaf student as the student works to successfully navigates predominantly hearing STEM communities.
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Chapter 1: Introduction

How It All Began

Robert Frost believes that of the possible roads in life, choosing the road less travelled makes all the difference. The path to higher education for many college students was mapped out long before they entered college. Alas, the road was not quite as straightforward and obvious for me because it was not mapped out for a deaf person. The pivotal point in my life was when I met a deaf mentor who served as my role model and made all the difference in my life. Initially, he served as my academic advisor, then our mentoring relationship began when I was an undergraduate research assistant, in his laboratory focused on deaf studies. My mentor saw the potential in me to become a future scholar. Thus, he shared his knowledge, skills, and experience as a deaf person who successfully navigated through the obstacles in academia. None of those skills were taught in any of my undergraduate courses, primarily because my professors were not deaf themselves. This enriched research experience under the guidance of a motivated deaf mentor was not only appealing to me, but also to my deaf undergraduate peers in the laboratory as well. As result of this mentored undergraduate experience, my mentor contributed to the science, technology, engineering, and mathematics (STEM) pipeline leading to the production of future deaf scholars in the STEM fields. This personal narrative underscores this study of the nature of deaf mentor-mentee dyads.
**Introduction**

In the United States, there is a demand for more professionals within science, technology, engineering, and mathematics (STEM) fields. The number of individuals in these fields has grown at a faster rate in countries outside of the U.S. (Augustine, 2005). As a result of this lag of individuals studying within STEM fields in America, and the subsequent lag in entrance into STEM related careers, a national effort to strengthen STEM education and scholarship has emerged. With an end goal of preparing more students for STEM careers, and targeting women, underrepresented minorities, and persons with disabilities, the National Science Foundation (NSF) has set new priorities in their agency’s mission to broaden participation by these groups in the community of scientists and engineers (National Science Foundation, 1996).

The National Science Foundation has recognized changing ethnic and racial demographics in the U.S. population, an increase in the number of people with disabilities, a higher demand for STEM workers, and finally, the need to redress workforce inequities which exist for each of these groups (Meterns & Hopson, NSF, 2011). To promote an increase in these underrepresented groups entering science and research fields, NSF has allocated grant funds and established support programs including mentored Undergraduate Research Experiences (UREs). Although this seems to have sparked an increase in the number of mentored undergraduate research programs, growth has been gradual, and particularly so for programs targeting deaf students (Mertens & Hopson, 2006).

In response to the disproportionately low rate of students from underrepresented populations in STEM careers, many colleges and universities have invested resources
into developing their own undergraduate research programs and research related activities (Strayhorn, 2010). Such research programs, laboratories, and activities create experiential learning environments. In these cases, faculty members and/or lab directors become facilitators of students’ learning (Singer, Hilton, & Schweingruber, 2005).

Research laboratories, such as those sponsored by the NSF, have been recognized as a particularly effective strategy for increasing interest in STEM disciplines for a number of students, including those from minority communities (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2008; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998). Undergraduate involvement in research activities in the laboratory gives all students a hands-on learning experience. Students from underrepresented communities seem to gain greater benefits from the opportunity to learn through a process that is “situated” within a social and cultural context influenced by experience and practice (Lave & Wenger, 1991).

This situated learning is defined as a conceptual knowledge that cannot be separated from the situation in which it is learned and used. According to Lave (1995), this knowledge is considered as a series of “conceptual tools” which are best understood through hands-on activities. Thus, situational learning in a successful undergraduate research experience requires that faculty members provide hands-on activities for students in relevant academic fields. Additionally, faculty members must help students to think about the research activity in the same way as do the scholars in that field. When applied in the lab environment, students are first given the opportunity to observe and model research skills demonstrated by faculty guides, to then modify their research skills on the basis of feedback from faculty and peers, to receive further reinforcement for
successful task completion, and ultimately, to learn to behave as a scientist (Kardash, 2000).

Working closely with an experienced mentor while doing research in science, technology, engineering, and mathematics (STEM) can enhance a transformative experience for undergraduate students (Kardash, 2000). Mentored undergraduate research experiences are recognized as innovative, high-impact educational practices that increase student-faculty interactions, academic rigor, and the application of learning (Johnson, 2010; Kuh, 2008; Tsui, 2007). Unlike general undergraduate research experiences, in the formally mentored experience, a faculty-student mentoring dyad is established. In this dyad, the faculty member serves as a role model and assists the student in developing research-based knowledge and skills in preparation for admission into STEM graduate programs (Davidson & Foster-Johnson, 2001). The faculty member’s role is to facilitate and guide the student by integrating him or her into the culture of academia (Thiry & Laursen, 2011).

The mentors’ involvement helps students improve research skills such as inquiry, research writing, and collecting, analyzing, and reporting data. Students also learn how to engage in scholarly discussions (Hu, Scheuch, Schwartz, Gayles, & Li, 2008; Lopatto, 2003). Successful engagement in dialogues of this nature has been shown to positively impact students’ self-confidence (Campebl & Skoog, 2004; Phinney, Torres Campos, Kallemeyn, & Kim, 2011) and self-esteem (Jonides, von Hippel, Lerner, & Nagda, 1992). In turn, this helps students become more comfortable in the scholarly world, build their scientific identity, boost their career readiness, and increase their scholarly productivity.
Put simply, attaining research skills and tools can help students navigate through the STEM pipeline, and ultimately succeed in the STEM workforce.

In addition to its impact on students, the mentoring dyad benefits mentors as well. Faculty members who regularly mentor undergraduate students report increases in morale, self-esteem, and satisfaction with regard to their work, as a result of their close academic interactions with intelligent and stimulating students (Johnson, 2010; Wilson, 2000). They also become more successful in their teaching within the classroom, because of repeated contact with motivated mentees. Lectures become more current, and therefore more interesting to all students in the classroom (Hakim, 2000). It follows that mentors in undergraduate research laboratories are often characterized as enthusiastic faculty members with excellent interpersonal, organizational, and research skills (Joyce, 2003). It is apparent that the mentoring dyad experience is beneficial to both mentors and mentees.

Beyond the general benefits, underrepresented students who engage in undergraduate research find important advantages from the experience. Initially, the undergraduate research experience gives underrepresented students a deeper level of exposure to academia than the traditional classroom provides. This allows underrepresented students to more effectively understand, navigate, and overcome institutional and cultural challenges these communities routinely present (Tsui, 2007). This ability to successfully navigate academia is likely to result in a more positive attitude toward research activities (Frierson, Hargrove, & Lewis, 1994) and a heightened desire to pursue graduate studies (Gandara & Maxwell-Jolly, 1999).

There are a number of additional positive outcomes of involvement in research activities for underrepresented college students in STEM fields. These include increased
retention, persistence, academic progress, and successful career attainment (Boyle & Boice, 1998; Lopatto, 2003; Nagda, et al., 1998; Ragins, Cotton, & Miller, 2000). If the NSF is to strengthen the STEM pipeline while simultaneously diversifying the STEM community, it appears that the involvement of undergraduate students from underrepresented populations with research experiences can be a key tool for doing so (Girves, Zepda, & Gwathmey, 2005). The ultimate increase in the STEM workforce, and the novelty of perspectives previously excluded, but derived from the unique life experiences of these diverse communities, will serve research and its pursuit of new knowledge well (Collins, 2000).

As indicated, successful mentored undergraduate research experiences have documented benefits for general STEM students, mentors, and even for underrepresented students. However, the traditional mentorship model which assumes a one-size-fits-all formula for connection, often fails to consider the relevance of social identities such as race, class, gender (Darling-Hammond & Berry, 1999), and disability. The United States has a well-documented history and culture of discrimination and prejudice toward minorities in a variety of overt and subversive ways (Ferber, Jimenez, Herrera, & Samuels, 2009). This history provides an important contextual understanding for considering the relevance of similar social identities when establishing mentor/mentee relationships (Darling, Bogat, Cavell, Murphy, & Sanchez, 2006).

In higher education, faculty members are predominantly White, traditionally able-bodied, and hearing (Ward & Bensimon, 2002). This can present a challenge for underrepresented students. Steele (1997) found that a perceived threat of stereotyping and the resulting cultural mistrust can influence the evolution of a successful relationship
between people of two different social identities. Moses (1989) contended that mentors—
traditionally from mainstream majority communities—are typically unfamiliar with
minority students’ issues, and therefore may be unable to relate to the needs of students
from identities different than their own.

Matching mentoring dyads based on similar social identities has been one strategy
for mitigating this particular academic barrier experienced by underrepresented students.
There is some evidence in the mentoring literature that suggests mentorships can be more
successful when there are shared social identities within the mentoring dyad (Ensher &
Murphy, 1997; Koberg, Boss, & Goodman, 1998; Ragins, 2007). Mentees often develop
a greater connection to mentors with whom they share important demographic
characteristics such as gender, race, and/or disability. The mentees identify with mentors
from the same background and who seem to possess the values, attitudes, and
experiences that parallel their own (Whelley, Radtke, Burgstahler, & Christ, 2003).

Mentors of similar social identities also report feeling compelled—out of a moral
duty—to seek mentees with shared social characteristics in order to give back to their
own community (Dingus, 2008), and help this younger generation navigate through the
challenges the mentors have already overcome. The mentors can also provide the
mentees with the support they need to make sense of the rules and expectations of
academia. This can include both psychosocial support (Koberg, Boss, & Goodman, 1998)
and career development support (Ensher & Murphy, 1997). Although there are studies
that theorize that matching dyads benefit underrepresented students, there are relatively
few. There is a need for more research; especially research which captures the voice and
story of people from underrepresented communities, and their experience with matching mentoring dyads.

The challenge for mentees who identify themselves as individuals with disabilities is the relative shortage of similarly identified role models and mentors in STEM fields at the higher education level (NSF, 2011; Burgstahler, 1994). According to NSF, people with disabilities are underrepresented in STEM graduate disciplines, post-doctoral positions, and faculty positions (NSB, 2003; NSF, 2011). Students with disabilities represent 10% of the undergraduate student population. However, as recently as 2011, they only attained approximately 2% of the STEM doctorates awarded (NSF, 2011).

In spite of key legislative measures such as the Americans with Disabilities Act of 1990, and the Rehabilitation Act Section 504 which mandate educational institutions to provide equal access to education, students with disabilities still face multiple challenges. For instance, students with disabilities report that educators, employers, and colleagues typically have a poor understanding and recognition of their disabilities (Burgstahler, 1994). Often this means students with disabilities do not receive the accommodations needed to ensure an equal playing field within their classrooms and research settings (Lee, 2011). This challenge is particularly acute for deaf students for a number of reasons.

**Problem Statement**

This study focuses on the deaf and hard of hearing (henceforth, deaf) population who use American Sign Language (ASL) as their primary mode of communication. The deaf population is of particular interest because they represent a linguistic minority who
not only communicate using a different language, but using a different modality to do so. As a result, deaf students, faculty, and staff in a university setting often use the services of sign language interpreters to support their access to academic discourse and culture. Deaf people are unique among the communities of people with disabilities because their disability centers on their need to acquire information and express themselves visually.

Approximately 0.2% of all children are born deaf (Kitson & Fry, 1990; National Institute on Deafness and Other Communication Disorders, 2013) and an additional 0.1% of children become deaf before adulthood (Petit & Weil, 2001). Clearly, being a deaf child means having a low incidence disability, and that can translate to little information for hearing parents about what may be necessary to support their deaf child’s success at the K-12 level of education, and their appropriate preparation for college.

Of children who are born or become deaf before the age of three, only 23% will be supported with the use of ASL as their primary mode of communication at home (Gallaudet Research Institute, 2011). As result, deaf children are not likely to have full access to communication and language in the home. Deaf children are often raised and taught by adults that are unfamiliar with how to communicate effectively with deaf people (Hauser, O’Hearn, McKee, Steider, & Thew, 2010; Moores & Paul, 2010). This lack of access to and the lack of understanding about communication and language is a part of what hinders deaf children’s ability to learn at a pace and level matching their hearing peers (Hauser et al.; Moores & Paul).

Due in part to the challenges presented when access to language is limited, only 56% of all deaf students graduate from high school, as compared to their hearing peers, who graduate at a rate of 84% (Walter, 2010). Deaf students who do graduate and attend
college fail to complete their courses of study at rates as high as 75% (Stinson & Walter, 1992). Research identifies the reasons for this high failure rate to be deaf students’ underpreparedness for postsecondary education, difficulty in receiving appropriate access and accommodations, and the poor understanding and acceptance of deafness these students find with educators (Burgstahler, 1994).

The lack of representation of deaf faculty in STEM fields (NSF, 2010) means most mentors available to deaf students are likely to be hearing and non-signing, making the transmission of knowledge relatively inaccessible due to language barriers. Given that the primary availability of mentors for deaf students is with hearing non-signing mentors (NSF, 2010), mentoring programs are likely to be unprepared to accommodate deaf students who communicate primarily in ASL to the same level as these opportunities accommodate hearing students. Tinto (1993) notes that academic integration is essential for students’ success in higher education. Integration is not likely to happen without mentors who understand the needs of deaf students, and are in a position to effectively help them anticipate and prepare for navigating an academic environment which has not been designed with them in mind (Lane, 1992; Tinto, 1987). An impact on the pipeline for deaf students becoming scientists is inevitable.

Only 0.8% of deaf undergraduates are in STEM majors, and 0.13-0.19% of doctorates in STEM fields are awarded to deaf individuals (NSF, 2011). The importance of having undergraduate research experiences mentored by faculty researchers with similar cultural identities, combined with the relative scarcity of deaf faculty members in STEM fields, seems to help explain the constriction of the pipeline from deaf undergraduate enrollment to deaf doctoral degree acquisition. The suggested importance
of matching mentored research experiences for underrepresented groups, the lack of access to deaf mentors for STEM research experiences, and a national desire to expand the role of people who are minorities and/or have disabilities in STEM fields highlights an area for study and exploration.

**Deaf Students’ Educational Challenges**

**Parent and family interaction.** The root of this leakage in the STEM pipeline for deaf students dates back to the beginning of a deaf student’s life. More than 95% of deaf children are born to hearing parents (Mitchell & Karchmer, 2004) who are unfamiliar with how to raise a deaf child (Lane, 1992). Parents often have lower expectations of their deaf child, as they have not met successful deaf adults, and are unsure how independent or successful their child can be in the future (Hauser, et al., 2010; Listman, Rogers, & Hauser, 2011).

In addition to the lack of aspirational support a deaf child is likely to face, for deaf children who cannot hear the family discourse, there is also often a lack of access to those family conversations and the lessons that inform most children about incidental life experiences and navigation (Hopper, 2011; Lane, 1992; Hauser, et al., 2010). This is particularly true for deaf children who would most benefit from the use of ASL at home, because relatively few hearing parents sign fluently (Lane, 1992). The Gallaudet Research Institute (2011) reported that 23% of parents sign regularly at home which suggests that most deaf children do not have the same access to the knowledge or life capital that is routinely taught by hearing parents to their hearing children.

This life capital represents the body of knowledge and skills that is historically and culturally developed and shared through family interactions and conversations, and
enables any individual to translate skills from their own cultural experience to navigate within any other given culture (Moll, Amanti, Neff, & Gonzalez, 1992). The lessons and information necessary to expand life capital is not adequately accessible to deaf children, because they cannot decipher family information shared auditorally. This limited ability to build life capital can impact deaf students’ readiness in school and workforce.

Additionally, parents often lack information and consequently do not develop skills to effectively raise their deaf child to be an active--visual--learner (Singleton & Morgan, 2006; Corina & Singleton, 2009). Their deaf child is typically the first deaf person that hearing parents meet. As a result, hearing parents are unfamiliar with how to use visual strategies that are natural to deaf parents such as using eye gaze and other visually-centered language and information gathering techniques to help their deaf child to have as much access as possible to the hearing-centered world around them (Singleton & Morgan, 2006; Corina & Singleton, 2009).

As a result of the lack of the ability to acquire important life capital and environmental navigation skills, deaf children often begin their schooling less ready to learn. This lack of language and cultural understanding by parents also means deaf children receive less educational support from their families throughout their education (Hauser et al., 2010). Deaf children’s lack of academic preparation from families before school age, and the on-going lack of support at home throughout their schooling only begins a negative trajectory that is often reinforced in a multitude of ways once deaf children enter the school environment.

The mainstream classroom. In the U.S. approximately 80% of deaf children are educated in mainstreamed academic environments (Gallaudet Research Institute, 2011).
The mainstream classroom is traditionally one that is predominantly hearing, taught by a hearing teacher, and which requires the use of a sign language interpreter for the deaf child using ASL to gain access to the information being exchanged (Lane, 1992). In spite of the interpreter’s presence, many of the same cultural and linguistic missteps which begin in the home of a deaf child are repeated and intensified in the classroom. Deaf children in mainstreamed classrooms who gain access to knowledge through educational sign language interpreters have less access to information when compared to their hearing classmates (Schick, Williams, & Kupermintz, 2005). Teachers in mainstream classrooms almost always lack any specialized training in educating deaf students (Kelly, Lang, & Pagliaro, 2003). Deaf students’ main – if not sole - accommodation is often the provision of a sign language interpreter in the classroom.

National efforts to rate the average quality of sign language interpreting in K-12 academic environment has identified that 63% of interpreters fall below acceptable skill levels (Jones, Clark, & Soltz, 1997). When faced with limited interpreting options, schools may feel they have no choice other than provide some level of interpreting coverage. The schools know the quality of the interpreting provided is less than desirable, but consider that some access would be better than a classroom without any interpreter (Schick, Williams, & Kupermintz, 2005).

Even when the most skilled educational sign language interpreters are provided, deaf K-12 students are still not able to participate in the full range of conversations, discussions, or lectures within the classroom (Schick, Williams, & Kupermintz, 2005). The pace of a predominantly hearing classroom means a great deal of information being transmitted simultaneously in the learning environment (Marchsark, Pelz, Convertino,
Sapere, Arndt, & Seewagen, 2005). When instructors are not trained to control the turn-taking and conversational pace, it is impossible for an interpreter to relay all of the simultaneous exchange to the deaf student (2005). The lack of classroom training exacerbates this challenge, because instruction practice grounded in an auditory model often requires the deaf student to take their eyes off the interpreter to look at whiteboards, computers, or attend to their own writing (Marcshark, et al., 2005; Proksch & Bavelier, 2002).

**Informal academic interaction.** Furthermore, the importance of informal learning with peers and through “hallway” and “lunchroom” conversations is often underestimated. Interpreting services are typically only provided during times of formal instruction. At school, deaf students generally do not have access to informal conversations within study groups, lab settings, or even in the hallways (Hopper, 2011). And the conversations they do have with their peers are rather infrequent and often superficial (Keating & Mirus, 2003; Mckee, 2008). The lack of informal interaction and meaningful conversation results in the deaf student missing information that is expected to be general knowledge in the mainstream society (Hopper). The assumption by teachers of a common level of this general knowledge translates to less explanation and clarification during classroom instruction, but often leaves deaf students unclear about what hearing individuals would label as “common sense.” (Foster 1989; Hopper).

**Schools for the deaf.** Nationally 20% of deaf students attend schools for the deaf and often have direct access to knowledge through Teachers of the Deaf (ToD) some of whom are fluent in ASL (Gallaudet Research Institute, 2011). While this may initially appear to help resolve many of the language and access issues above, there are challenges
in these settings as well. Many ToDs take a limited number of sign language classes before they begin teaching and often do not have the same level of fluency in ASL as their students. So, even in an environment with an expectation for direct language access instruction, there are resulting imperfections to the communication in the classroom.

**Instruction challenges in STEM content.** With regard to supporting an interest and aspiration in STEM related study there are a variety of instructional challenges. The first of these is that ASL signs for many STEM terms have not been sufficiently developed nor are they commonly identified and accepted (Bigham, Otero, DeWitt, Cavender, & Ladner, 2008). While limited signs exist, the evolution of sign language vocabulary in these fields is rather new. American Sign Language for the STEM fields does have some online resources that teachers can use, but these are recently established and not yet commonly used. There remains a need for a standardization of scientific terms in ASL (Lang, 2002).

In the mainstream classroom, this means that the most qualified of educational interpreters is in the position of fingerspelling most technical and scientific terms (Lang, 2002). Fingerspelling terms can be likened to the provision of having a running text of the words, similar to the circumstance of having C-print - a speech to text system - in the classroom. While this would seem to solve the challenges of knowing the actual vocabulary words as noted above, this presents an alternative challenge. Some deaf students’ indicate ASL, not English, is their first language (Bigham, et al., 2008; GRI, 2011). Using English captions (or fingerspelling) of the terms in the classroom lecture cannot adequately describe content beyond the vocabulary words (Bigham, et al., 2008).
Additionally, deaf students following the running text of C-print (or deciphering the complex fingerspellings of an interpreter) are likely to miss looking to the instructor, and therefore miss the intonation or facial expression of an instructor. American Sign Language relies on this visual check of facial expression to gain valuable cues and clues about what terms are key (Bigham, et al., 2008). For a variety of reasons, the challenge with STEM language is not isolated to either the vocabulary or to the content, but to the ability of a teacher to marry the two components of the classroom’s second language while keeping a rigorous classroom schedule (Foster, Long, & Snell, 1999; Saur, Layne, Hurley, & Opton, 1986; Spradbrow & Power, 2000). Finally all of this ultimately relies on the ability of interpreters to accurately interpret both the vocabulary and the explanations (Foster, Long, & Snell, 1999; Schick, Williams, & Kupermintz, 2005).

In the SoDs, many ToDs have specialized training and certifications only in the field of Deaf Education, and are not required to have adequate (or any) training in STEM course subjects (Kelly, Lang, & Pagliaro, 2003). This lack of STEM training impacts content, while the lack of appropriate signs for STEM terminology continues to impact vocabulary teaching. Whether ToDs have good signing skills or not, it remains nearly impossible to know accurate signs for STEM concepts.

**Accumulated disadvantage.** Gladwell (2008) defines *accumulated advantage* as the series of privileges extended to one group that build upon another to ultimately create the circumstance for success. In this case, hearing students are granted more privileges to excel academically because of their ability to acquire and use spoken language in schools and at homes, both of which are predominantly hearing. They have no trouble participating in everyday conversation and acquiring information incidentally. This is not
the case for deaf students because they do not have the same access to their environment as do hearing students.

As the result of a lack of understanding of the ways being deaf impacts informational acquisition and learning, it is as if deaf students of hearing parents and educated in the current schooling structures experience what can only be called an *accumulated disadvantage* throughout their K-12 years. The lag in information acquisition, and the lack of recognition of the resulting gaps in life capital and general knowledge seem to feed an ever growing distance between necessary knowledge known by the deaf and the hearing student; with the deaf student falling further behind at each milestone throughout the K-12 experience. An evaluation of deaf students upon their graduation illustrates the impact of this accumulated disadvantage. Deaf students graduate high school with limited math skills (Kelly, Lang, & Pagliaro, 2003; Traxler, 2000), and an average 4th grade reading level nationally (Allen, 1994; Traxler, 2000).

**Theoretical Framework: Subjugated Knowledge**

When present, Deaf parents, deaf teachers, and deaf role models are likely to have a better sense of the gaps found in deaf children’s life capital and general knowledge stores (Hauser, et al. 2010). These deaf adults also are likely to have more experience with what is necessary for filling those gaps (Hauser, et al., 2010). They have personally experienced the gaps, and therefore possess what is known as subjugated knowledge about the management of them.

Many underrepresented communities indigenously identify subjugated knowledge that is necessary to and unique within a shared cultural community group (Collins, 2000; Yosso, 2005). Understanding and accessing this knowledge allows minority individuals
to navigate and succeed as a minority individual in any number of majority environments (Collins, 2000; Yosso, 2005). In this instance, subjugated knowledge relates to how it is to be deaf in a predominantly hearing society and what is necessary to successfully navigate education, academia, and a career as a deaf individual (Hauser, et al., 2010).

For deaf individuals, the knowledge and skills that they acquire growing up in an auditory-focused society are markedly different from that of hearing individuals (Hauser, et. al, 2010). However unintentional, societal norms, expectations, and access create a discriminatory environment impacting deaf individuals and labeled as audism (Bauman, 2004; Humphries, 1975; Lane, 1992). Deaf adults can, and often do, function as role models to support the development of navigational skills in deaf children, increasing deaf children’s resilience against the adversities present in an audist society (Listman, Rogers, & Hauser, 2011; Wilkens & Hehir, 2008).

Collins’(2000) theoretical framework on Black Feminist Epistemology provides one useful theoretical lens for exploring mentoring relationships between deaf faculty members and deaf undergraduate students. Epistemology is the study of how “knowledge” is formed, while multiple epistemologies suggest that individuals learn in different ways and are shaped by life factors including education, family, and culture (Collins, 2000). Collins derived her theory from an understanding of the epistemology of Black women who had determined over time what was useful navigational knowledge, and then developed and transferred that knowledge to other women within their community.

According to Collins’ (2000) Black Feminist Theory, knowledge from oppressed groups is important because their experiences create new ways of looking at human rights
and social injustices. Elite White men who have their own set of knowledge and epistemologies, control most social institutions in America. In response, Black women were found to have developed subjugated knowledge allowing them to resist and overcome the inherent oppressions of the dominant community (Collins, 2000). Thus, Black women were found to possess traditions of “mothering the mind,” not only identifying their own subjugated knowledge, but also transmitting it across generations (p.121).

One application of Collins’ theory was found in a study of Black female teachers. Dingus (2008) noted that established Black female teachers mentored the development of younger generation of black female teachers. Using their own experiences as Black women, these teachers identified and honored a moral responsibility to share the subjugated knowledge which had brought them success (Dingus, 2008).

Though limited research exists on subjugated knowledge in the deaf community, there is some study focused on the ways deaf teachers successfully share navigational techniques and general knowledge with deaf children (Singleton & Morgan, 2006). This research is primarily centered in the context of preschool and elementary classrooms of deaf teachers with deaf children. Findings have included that deaf teachers understand and teach appropriate visual engagement techniques in the classroom, recognizing that deaf children depend on gathering information *visually* to acquire knowledge (Corina & Singleton, 2009). Specifically, deaf teachers were found to purposefully direct deaf children’s attention to learning events by using their eye gaze (Mather, 1989).

Deaf teachers were also found to intentionally share a broader array of ideas and concepts using visual language (Mather, 1989, Mayer, Akamatsu, & Stewart, 2002).
Deaf teachers demonstrated “everyday talk” in sign language with the intent of exposing deaf children to incidental knowledge that is not otherwise accessible to them in hearing homes and other environments (Morgan, 2004). Deaf teachers were more likely than hearing teachers to share narratives about what it is like being deaf, and to visually share and model for deaf children their instructors’ effective interactions with hearing people as bilingual and bicultural individuals (Morgan, 2004; Singleton & Morgan, 2004).

Deaf children obtain subjugated knowledge about being deaf by observing and learning from these deaf role models (Hauser, et al., 2010; Hill, 1993). Deaf children struggle to develop a healthy self-concept and a positive identity when they do not have access to deaf adults with whom they can readily identify and share experiences (Bat-Chava, 1994, 1993; Maxwell-McCaw, 2001). Deaf children – like all members of the deaf community - face oppression and discrimination in a hearing-centric society (Bauman, 2004; Hauser, et al., 2010; Humphries, 1975; Lane, 1992). And in 95% of the circumstances, their parents and hearing teachers never have had to identify or overcome the same. Because they are not deaf, these parents and teachers certainly cannot model how to be deaf. Because of their unfamiliarity with what it means to be deaf, they are also unlikely to know how to cope with challenges related to being deaf (Hauser, et al., 2010).

Like the black female teachers in Dingus’ (2008) study, deaf adults have recognized that a body of knowledge exists and is unavailable to deaf children in their predominantly hearing interactions. These deaf teachers have identified, developed, and shared a body of subjugated knowledge necessary for deaf student success in and beyond their classrooms. Collins’ theory is useful for considering deaf mentoring dyads and their
role in transmitting subjugated knowledge to support success of deaf students beyond the K-12 environment.

It is clear from the literature that deaf students are not receiving full access to the educational system and information, and that they typically lack access to deaf role models. They also experience discrimination in society in the forms of audism and ableism. As is the case with any discrimination, oppression hinders the acquisition of deaf students’ successful navigational skills— in general (Yosso, 2005), and therefore also in academia. Understanding the relationship between deaf mentor and mentee could be critical in determining the impact a shared social identity has in promoting deaf student success in STEM fields.

A study of these dyads could also help identify the ways subjugated knowledge is transmitted, and the nature of knowledge that is transmitted to help deaf students navigate in a predominatly hearing world. Not only is this valuable for mentors within the deaf community working to promote student success, but likely has importance for hearing individuals who may be working with one or few deaf students, and who are seeking ways to support those students in spite of their obvious differences in experiencing the world— academic and beyond. The subject of this study on the transmission of subjugated knowledge by deaf mentors working with deaf mentees in formally mentored research experiences therefore has the potential for broad impact supporting the success of the more than 30,000 deaf students who are reported to be enrolled in colleges and universities across the U.S. at present (Walter, 2010).
Research Questions

This phenomenological study considered the nature of the subjugated knowledge the deaf mentor and mentee share in the mentoring dyad. The study also addressed the formal and informal work structures these dyads used to share subjugated knowledge necessary for successfully navigating STEM academic and research experiences as deaf individuals. This exploration of the sharing of subjugated knowledge in the deaf mentoring dyads can be used to identify strategies which more broadly support deaf undergraduate students’ pursuits of STEM careers in both predominantly deaf and hearing environments.

To gain a better understanding of the experience which occurs for mentors and mentees in these dyads, this study was guided by one major question and three sub questions: How do deaf dyad mentoring relationships benefit faculty mentors and undergraduate mentees pursuing careers in the STEM field? Specifically, the study investigated the following questions: (a) How do deaf mentoring dyads evolve and interact in mentor-mentee relationships among deaf STEM undergraduates? (b) How do deaf mentees who have deaf mentors describe their undergraduate mentoring experience? (c) What is the nature of subjugated knowledge shared between deaf mentors and mentees?

Definitions of Terms

The following is a listing of key terms that are used throughout the study:

Audism: audism is the societal system and attitude, which perpetuates the belief that people who hear and speak, or have good English, are superior (Bauman, 2004; Humphries, 1975; Lane, 1992)
**Deaf Adults:** deaf adults who use ASL as their primary language and are culturally Deaf (Padden & Humphries, 2005).

**Deaf Culture:** a cultural, linguistic minority group, wherein deaf people share similar experiences, values, norms, traditions, and use American Sign Language (Padden & Humphries, 2005).

**Dyads:** a relationship between a mentor and a mentee. Can be developed informally or formally (Lyon, Farrington, & Westbrook, 2004).

**Hearing:** A term to describe people who are not deaf; hearing individuals who have no trouble hearing everyday conversation and sounds.

**Mainstream School:** a public school with some deaf students enrolled with accommodations (Padden & Humphries, 2005).

**Matching Mentors, Mentees, and/or Matching Dyads:** both mentors and mentees share same social background such as race, gender, disability, cultural identity, and sexual orientation.

**Mentoring:** a strategy to support student in academics with having a role model adult to support the student’s navigation in the academia (Jacobi, 1991).

**Predominantly hearing:** environments where a majority of hearing individuals are presented and indicidate that they have no trouble hearing everyday conversation and sounds.

**Subjugated Knowledge:** A term used by Collins (2000) to describe knowledge (and ways of knowing) on how to be a minority individual.

**STEM:** Science, Technology, Engineering, and Mathematics
**STEM pipeline**: a student’s journey to successfully attain degrees and be part of the STEM workforce.

**Undergraduate research experience**: is a research opportunity for undergraduate student to engage in research related activities with a faculty member. Typically, the student gain research skills from a mentor (Stocks, Ramey, & Lazarus, 2003)

**Underrepresented Students**: including persons with disabilities, women, and racial and ethnic members who are struggling in education due to cultural and institutional barriers (Tinto, 1988).

**Chapter Summary**

More research is needed to understand how to improve the STEM pipeline for students from underrepresented communities (Hurtado, et al., 2008). Underrepresented students face significant institutional and cultural barriers in STEM education. This is particularly true for deaf undergraduate students (NSF, 2011). Broadening the participation of deaf people in STEM careers is a challenge without strong mentoring programs tailored to the cultural and linguistic needs of this population.

An exploration of the experience for talented deaf students aspiring to be scientists, and for their deaf mentors who are guiding these students as they successfully become scientists could be helpful in providing general strategies to enhance the STEM pipeline. Because there are known deaf faculty members from STEM disciplines who are working with deaf undergraduate students in a laboratory environment, the opportunity for considering the impact of this experience is ripe for inquiry. The phenomenon of deaf mentoring dyads, the transmission of deaf subjugated knowledge in the STEM
environment, and the strategies identified to support student success through these relationships is the main focus of this study.

This chapter has reviewed the problem, purpose, research questions, and potential significance of a study seeking to understand the nature of deaf mentoring dyads and the role of subjugated knowledge. Chapter 2 provides a review of literature of the past studies on mentoring and matching based on similar social characteristics particularly with underrepresented groups. Chapter 3 describes the methodology of this study. Chapter 4 includes the findings of the study. Lastly, Chapter 5 discusses the implications for practice and limitations of the study.
Chapter 2: Review of the Literature

Introduction

Research has indicated that deaf individuals are underrepresented in STEM careers. The leakage in the pipeline between undergraduate enrollment and doctoral degrees awarded illustrates that significant barriers are preventing deaf individuals from advancing in STEM education. Mentored undergraduate research experience with a deaf mentor who possesses subjugated knowledge may help students overcome challenges, but this phenomenon has not yet been explored. This study will consider the deaf mentor and mentee experience, the mentoring dyad, and the process of sharing subjugated knowledge to navigate STEM fields successfully as a deaf individual. This phenomenological study proposes to explore how, and what types of subjugated knowledge are transmitted in the deaf mentoring dyads to support undergraduate student pursuits of STEM careers.

This chapter presents an overview of empirically researched studies that focus on mentoring, undergraduate research experiences, and matching mentoring dyads based on gender, race/ethnicity, and disability literature. The chapter is divided into three sections. In the first section, an overview of mentoring will be discussed. The second section will illustrate the empirical studies on undergraduate research experience. The third section will review studies on matching mentoring dyads based on same social characteristics. All studies will also highlight the experience of underrepresented students within mentoring relationships, undergraduate research experiences, and matching-mentoring dyads.
Overview on Mentoring

The term mentor was coined from Homer’s epic poem, *The Odyssey* in the 12th century B.C. (DuBois & Karcher, 2005). In *The Odyssey*, the character Odysseus had a friend, Mentor, to help him fight in the Trojan War. The character, Mentor, serves as a wise, responsible, and trusted advisor who contributed to Odysseus’s development (Miller, 2002). In the Middle Ages, apprenticeships with members of craft guilds were a form of mentoring. During the Renaissance period, mentoring was a common way to educate young people (Schwiebert, 2000). Throughout history, mentoring has been considered an instrument of social learning (DuBois & Karcher, 2005). Today the most common definition is a of a relationship that involves a senior experienced person who provides support and assistance to a junior person with less experience. However, in mentoring research, agreement on a common definition for *mentor* is a recurring problem. According to Crisp and Cruz, there are at least fifty definitions of mentoring (2009). Regardless of the numerous definitions of mentoring, common to most is the notion of a senior individual who is available to intervene, promote, and improve students’ academic success.

**Types of mentoring.** There are many types of mentoring. According to Philip and Hendry (2000), five types of mentoring include: classic mentoring (one-on-one relationship between experienced adult and a younger person, similar to an apprentice), individual-team (young group of people look to an individual or a few individuals for advice), friend-to-friend (provides a safety net, common among women friends), peer-group (among groups of friends, often when exploring an issue), and long-term relationships with “risk taking” individuals (similar to classic mentoring, but the person
being mentored has a history of rebellion).

Philip and Hendry (2000), noted that mentoring can be either formal or informal in nature. A formal mentoring relationship is described as a structured program that provides stated goals and targets specific groups. Communities, organizations, or academic programs often manage formal mentoring programs (Girves, Zepeda, & Gwathmey, 2005). In academia, the formal mentoring program often focuses on students from special populations and is established to improve academic outcomes.

In contrast to formal mentoring, informal mentoring relationships involve the mentor and mentee connecting in a more organic manner (2005). Informal mentoring is developed naturally over time. In academia, an example of informal mentoring would be a faculty and a student connecting to work on a research project out of a natural and common interest, and without any structured protocols to follow.

Mentoring relationships exist in all sorts of organizations including the corporate world, nonprofit agencies, and K-12 schools. Colleges and universities also value mentoring relationships (Crisp & Cruz, 2009). In all type of organizations, mentoring generally has one purpose, to foster an individual’s growth (Allen & Eby, 2008). Three common areas of focus are found in the mentoring literature, and include mentoring of youth, student-faculty mentoring relationships, and mentoring within the workplace. Each of these areas has limited consideration of each others’ processes and goals (Allen & Eby, 2008).

Regardless of the limitations in mentoring research, mentoring serves multiple purposes. Mentors can be described as advocates, coaches, teachers, counselors, supporters, and friends. In all cases, these individuals provide guidance, emotional
support, and interventions to improve mentees’ outcomes (Johnson, 2003).

Mentoring relationships matter, particularly for minority students often underrepresented in academia. The academic culture of the institution is not always immediately accessible for minority students and this problem can impact students’ academic success in a number of ways, including their retention and graduation rates. There continue to be growing numbers of minority students enrolled in undergraduate institutions. Yet, typically lower retention and graduation rates continue to challenge many institutions in their effective service and preparation of these students (Minorities in Higher Education, 2000).

Despite the challenges, some research has provided promising preliminary findings to indicate that mentoring is a key to supporting underrepresented students in improving their performance academically, and enhancing students’ aspirations and career development plans. With integration into the academic culture provided through a mentoring relationship, research suggests that minority students may feel more confident and remain in school. Unfortunately, there are surprisingly few empirical findings that document the impact of mentoring, and particularly its success. This is especially true for deaf students.

**Empirical Review on Mentored Undergraduate Research Experiences**

Mentoring is believed to be one of the most influential factors in U.S. efforts to encourage college students to seek careers in science, yet not much is known about the process of mentoring, especially in STEM fields. While recent research has documented the benefits to students from participating in undergraduate research, the literature is just beginning to describe the actual processes through which student researchers become
integrated into communities of practice and begin to develop their identities as scientists (Hunter, Laursen, & Seymour, 2007). Throughout these limited studies, it is clear that undergraduate students want research experience to enhance their learning, improve their chances of acceptance into graduate school, and increase their attractiveness to potential employers (Mashter, 1997). This section reviews studies on the mentoring process in the context of undergraduate research experiences.

**Undergraduate research experiences.** Undergraduate research experiences can be powerful because students are provided the opportunity to interact and work with faculty to conduct research while also collaborating with professional peers. One study, employed a multi-case narrative approach to understand students’ perceptions of their mentors’ roles and effectiveness in students’ development as scientists (Behar-Horenstein, Roberts, & Dix, 2010). Two groups including undergraduate science scholars (n=5) and mentoring professors (n=5) were interviewed twice at the beginning and the end of the first year of a funded research program.

The participants were recruited from a Howard Hughes Medical Institute undergraduate research program at a large research university in the southeast. Of the five students chosen to participate, three were females and two males. Three students were Caucasian, one was Vietnamese, and one was Middle Eastern. Their majors included Biology, Neuroscience, Chemistry, and undeclared (Behar-Horenstein, Roberts, & Dix, 2010).

Professors were recruited from the university’s undergraduate research program. Four male professors and one female professor participated. They represented a range of disciplines including Chemistry, Materials Science, Engineering, Medicine, and Zoology.
The participating students and professors were unmatched pairs due to difficulties associated with recruitment and the lack of diversity in the available pool of professors when compared to the students (Behar-Horenstein, Roberts, & Dix, 2010).

The study used a constructivist approach and grounded theory to design the study and guide the analysis of the data. Through the analysis several themes emerged. Students and professors described the benefits to students including increased technical expertise and communication skills. Mentors provided information, guidance, expertise, and advice. Students also reported gains in cognitive skill sets, the ability to interpret data on their own, the design and delivery of quality scientific presentations, the confidence to question existing protocols, and the familiarity with publishing processes (Behar-Horenstein, Roberts, & Dix, 2010).

The professors reported that students’ understanding of scientific community and scientific inquiry had increased as evidenced by their ability to explain and interpret results. Moreover, professors noted that students were able to communicate results at group meetings and at on-campus poster sessions. Professors also described challenges they experienced as mentors. These included difficulties in recruiting minorities, and in working with students for whom English is their second language (Behar-Horenstein, Roberts, & Dix, 2010).

Although students described enhanced skills, they did not allude to how specific areas of mentoring process influenced those changes. This is the same for mentors. Mentors did not identify how personal attributes, activities or practices influenced their roles as mentors (Behar-Horenstein, Roberts, & Dix, 2010).

A similar study explored the role of student-advisor interactions in
apprenticeships in undergraduate research, particularly in terms of acculturating students to the norms, values, and professional practice of science (Thiry & Laursen, 2011). The authors conducted a qualitative study to explore the role of student-advisor interactions. Seventy-three undergraduate research students were interviewed from two research-extensive institutions from the southern and southwestern regions of U.S.

The participant sample included students from four different undergraduate research programs within these two universities. Two of the programs were designed to enhance diversity in the sciences by serving a large number of underrepresented students in the sciences. Both programs aimed to recruit minority students into research early. Both programs also provided extensive academic and social support to students, including a journal club and laboratory techniques course on one campus, and a summer bridge program, academic tutoring and counseling, and career and educational guidance on the other campus. In addition to these supports, students in three of the programs were required to present at a poster session at the end of the research session. All four programs offered both academic year and summer research experiences (Thiry & Laursen, 2011).

The demographics of this study included gender and ethnic diversity. The sample was 48% women and 36% underrepresented minority students. Specifically, 23% were African American, 12% were Hispanic, and 1% identified as multi-racial. The remaining students were Caucasian (47%) and Asian or Asian-American (17%) (Thiry & Laursen, 2011).

The students represented a variety of disciplines. Fifty-four percent of students were from biological sciences or bioengineering majors, 19% were studying chemistry or
chemical engineering, 7% mechanical or civil engineering, 6% computer science, 5% physics, and 3% mathematics (Thiry & Laursen, 2011).

The authors divided students into two groups; novice and experienced. These designations were based on students’ prior undergraduate research experience. Fifty-four percent of interviewees were categorized as novice researchers, while 56% were considered to be experienced (Thiry & Laursen, 2011).

The authors developed their results using in-depth semi-structured interviews with participants. The interviews aimed to understand complex behaviors, interactions, and social processes that had not previously been investigated. The protocol of the interview was intended to elicit rich detailed information about students’ perceived gains from research; their lab interactions with their research advisors, principal investigators, and research group members; and the influence of the research experience on the development of their scientific temperament and identity. The students were only interviewed once and interviews lasted approximately 40 to 80 minutes (Thiry & Laursen, 2011).

As result of this study, the authors found a continuum of practices within three domains that research mentors employed to support undergraduate scientists-in-training. The three domains were professional socialization, intellectual support, and personal/emotional support. The study also found that novice students needed clear expectations, guidelines, and orientations to their research project. In contrast, experienced students needed broader socialization for adopting the traits, habits, and temperament of scientific researchers (Thiry & Laursen, 2011).

Another finding in this study was the specific importance of mentoring
interactions in meeting needs of students from underrepresented groups. These students reported a gain in confidence, and broadening of their future career and educational possibilities. Several reported the gain in confidence when their research mentors provided encouragement, modeled persistence, and were readily accessible to them. The underrepresented students also reported that their benefits came more from having a mentor in the academic field of study, not necessarily from having someone with a similar racial or gender background. Most important was that they felt their mentor was looking out for them (Thiry & Laursen, 2011).

The socialization process also played a role in undergraduate research experiences. Davis’ (2009) study on the ways mentoring programs influence students’ aspirations and pursuits of graduate studies examined socialization processes with the Committee on Institutional Cooperation Summer Research Opportunity Program’s (SROP) mentoring of underrepresented groups. The SROP program provides 8 to 10 weeks of mentoring and undergraduate research experiences for racial groups who are considered underrepresented in academia. The goal of the program is to enhance the number and completion rates of minority doctoral candidates pursuing academic careers.

Semi-structured group interviews were conducted with groups of only males, only females, and some mixed gender groups. These individuals included current students and former students with a range of racial/ethnic backgrounds. Eighteen undergraduates who were in active mentoring relationships with faculty members were included.

A thematic analysis of the data suggested that mentorship did influence the academic experiences of the participants. The respondents highlighted the importance of faculty-directed research in preparing racial minorities for graduate education. Some
findings showed that mentors challenged students with hard questions, guided them through new experiences, helped them think critically about research, influenced their academic aspirations, provided constructive feedback, assisted them in planning for graduate study, built autonomy to do research on their own, provided insider information on how to make themselves more competitive, encouraged them to become “experts,” and tailored their academic mentoring styles to suit the students’ needs at any given time. Overall, Davis (2009) concluded that mentorship served as an effective socialization tool for students before entering graduate study by exposing them to different opportunities.

Further evidence of the importance of mentors in the socialization process and engagement of students is the noted increase in mentees’ research skills (Kardash, 2000). Kardashian (2000) evaluated 14 research skills that undergraduate students improved as a result of their participation in undergraduate research experiences. The participants in this study were undergraduate science research interns and their faculty mentors in a specific research program at a Midwestern university with a Research I classification in the Carnegie classification system. The research program was funded to support undergraduate research in biology, biochemistry, chemistry and physics fields. The research program’s goal was to prepare students for careers in teaching and research.

The research interns in this program worked 12 hours a week in their mentors’ laboratories for a 32-week period. The research interns also participated in a summer component of the program. Fifty-seven interns participated in the study. Of these most were women (58%), and the interns represented four racial/ethnic groups; Caucasian (77%), African American (9%), Asian Pacific Islander (11%), and international (2%). The faculty mentors included 13 women (36%) and 23 men (64%) (Kardash, 2000).
Fifty-seven undergraduates self-rated their ability to perform the skills at the beginning and the end of their undergraduate research experience. The faculty mentors rated their interns’ research skills as well. The 14 skills were chosen from a review of the literature on undergraduate science (Kardash, 2000).

The mentors identified which of the 14 skills were most important. Each skill was rated on a 5-point scale ranging from 1 (not at all) to 5 (a great deal). A comparison of the results from faculty members and students found that the ratings between the two groups were similar. Both mentors and interns both gave their highest ratings to the same five skills; observing and collecting data, understanding the importance of controls, interpreting data, orally communicating the results of research projects, and thinking independently. Overall, the study suggested that undergraduate research experiences enhanced some skills better than others (Kardash, 2000).

Undergraduate research does not only improve students’ research skills, but also helped students pursue science careers and learning (Lopatto, 2004, 2007). These studies examined the reliability of students’ evaluations of summer undergraduate research experiences using the SURE (Survey of Undergraduate Research Experiences) and a follow-up survey disseminated 9 months later. The researcher hypothesized that having an undergraduate research experience would enhance the educational experience of science undergraduate students.

The participants in each study completed a survey online regarding their experience with research. The SURE is a tool used to assess the quality of undergraduate research experiences. The tool is grounded in three strategic questions based on the desired outcomes for the undergraduate research experience. The questions include: (a) Is
the educational experience of undergraduates being enhanced by a research experience?, (b) Are undergraduate research programs attracting and supporting talented students interested in career involving scientific research?, and (c) Are undergraduate research programs retaining minority students in the pathway to a scientific career? (Lopatto, 2004).

The studies’ survey consisted of 44 items, including demographic variables, learning gains, and evaluation of aspects of summer programs. A follow up survey was also administered, and consisted of 35 items, including some repeated items from the original survey. In addition to the survey, the participants were asked if they continued their research into the academic year, how they communicated the results of their research, and how their summer research experience affected their courses in college (Lopatto, 2004, 2007).

In Lopatto (2004), 1,135 undergraduate students had completed the SURE. The participants from that study represented 41 different universities. The data from that survey revealed that the students generally had a positive experience with undergraduate research, reporting enhanced technical and personal skills relevant to their field of study.

In the second study, Lopatto (2007) collected data from 2,021 undergraduates representing 66 institutions. The demographics included a majority of Caucasian students, and small number of underrepresented students including members of African American, Asian American, and other racial/ethnic groups. Approximately half of the participants were women. Both studies were used to identify the reliability of the instrument and determine if there had been increases to research skills for the participants in the studies.
Approximately 90% of the participants reported an increase in their interest for study and work in the sciences. Eight-four percent reported that the program experience was positive. As a result of the program, students also reported improvements to their research skills as documented by their responses on the SURE (Lopatto, 2004, 2007).

One of the biggest findings from these studies was that underrepresented students seemed to benefit more from the program than other groups. Further, as a result of the program in the summer, the students reportedly gained in their academic autonomy, intrinsic motivation to learn, and active participation when taking subsequent courses (Lopatto, 2007).

Undergraduate research experiences can help underrepresented students determine their own research goals. One study employed a phenomenological approach to examine and understand how underrepresented minority undergraduates develop scientific research career goals. (Hurtado, et al., 2008). The researchers analyzed the students’ experiences within structured research programs fostering a sense of science identity and scientific self-efficacy. The data was derived from focus groups at the following institutions: Massachusetts Institute of Technology (MIT), University of Texas, San Antonio (UTSA), University of New Mexico (UNM), and Xavier University of Louisiana. All programs were selected because of their relatively high number of underrepresented minority undergraduates in science.

The focus group participants were identified through purposeful sampling within a population identified through each campus’ science programs. The focus group sessions lasted approximately 45 to 90 minutes and ranged from 4 to 12 participants. A total of eight focus groups were conducted for this study. The sample represented a racially
diverse group: 60% Latina/o, 22% African American/Black, 5% Asian American, 8% multiracial, 3% American Indian, and 3% White. Within the sample there were 62% female, and the majority of students (72%) were biology, biochemistry, or chemistry majors (Hurtado, et al., 2008).

The researchers analyzed the focus group transcripts to identify emergent themes. Seven major themes were identified including student development of scientific interest and career aspirations, support received in pursuing this goal, and present or continuing obstacles and challenges faced by students. The researchers thematically coded the transcripts, and the veracity of the findings was ensured through inter-coder reliability checks (Hurtado, et al., 2008).

As result of this analysis, seven major themes were identified with the researchers choosing to present three of these themes for publication. These focused on: how to become scientists, how to navigate the culture of science, and the role of social stigma in the pursuit of a career as a scientist. Through the analysis, students reported that they were interested in science early in their lives. Many participants also reported a lack of awareness about scientific research careers as a long-term option before enrolling in college. The participants also reported that graduate school was a part of their future educational goals (Hurtado, et al., 2008).

Engaging in undergraduate research was reported to have helped these students to develop their independence and confidence as part of a scientific community. Some reportedly developed a stronger work ethic as a result of the experience. Additionally, participants reported improvements in the areas of patience and their ability to accept failure (Hurtado, et al., 2008).
In addition to these findings, the participants also expressed their experience with complex issues involving the role of race and social stigma in their ability to see themselves as scientists. Some students reported that they navigated differently because of social stigmas. Some were more vulnerable to stereotyping, entertaining thoughts that their involvement was an “unearned privilege” (Hurtado, et al., 2008, p.212). Others displayed high self-efficacy, and seemed to take on social stigmas without pause (Hurtado, et al., 2008). Overall this study showed that as result of being part of the science culture, students has developed science identities, become more efficient, and aspire to become scientists (Hurtado, et al., 2008).

**Empirical Review on the Effects of Matching Mentors**

There is some evidence in mentoring literature that mentorship can be more successful if there are shared social characteristics within the mentoring dyad. This research is traditionally affiliated with studies of mentoring with minority groups (Blake-Beard, Bayne, Crosby, & Muller, 2011; Ensher and Murphy, 1997; Lockwood, 2006). The findings are inconclusive at this point, with a number of studies also arguing that shared social characteristics within the mentoring dyad do not make any difference in student’s academic success (Hickson, 2002). More research is needed to understand the role of matching dyads in underrepresented student’s success in STEM fields (Ensher & Murphy, 1997).

**Matching mentoring based on race and gender.** Having mentors with the same race and gender of the mentees matters. A study found that science, technology, engineering, and math (STEM) students reported that having mentors of their own race and gender is important (Blake-Beard, Bayne, Crosby, & Muller, 2011). The researchers
surveyed 1,013 undergraduate, graduate, and postdoctoral students through MentorNet’s online community. The participants represented a variety of demographic backgrounds including race, gender and ethnicity. All participants completed a questionnaire that consisted of a series of thirty-eight questions, including their demographic information; amounts and sources of their mentoring support; desired mentoring experiences, actual mentoring experiences; and academic outcomes including participants’ grade point average, sense of confidence, and a sense of fit within their field.

The analysis of the survey results revealed that having a mentor of similar gender or race was felt to be important by many students. In addition, the results indicated that students who had a mentor of their own gender or race asked for and received more help. However, there was insufficient evidence to suggest that matching mentoring dyads impacted actual academic outcomes (Blake-Beard, Bayne, Crosby, & Muller, 2011). The researchers suggest that mentoring programs should be open to the possibility that mentoring support may come from a variety of individuals. Though every student may not, some students may benefit more from matching mentoring dyads.

A similar study conducted by Ensher and Murphy (1997) found that actual race pairing was related to mentees’ perceptions of the amount of career support they received, and also was related to mentors’ liking of mentees. The researchers collected data on 104 items about mentees and their volunteer staff mentors at the summer research program of a large West coast media organization. The mentees were randomly assigned to two groups; some with same and others with different race mentors. All participants were asked to measure items which included their liking of the mentor, satisfaction with the mentor, intended retention of the relationship, and degree of psychosocial and
instrumental functions experienced by the mentees. The result found that liking, satisfaction, and contacts with mentors were all higher when the mentees perceived themselves to be more similar to mentors. This study concluded that matching-race mentoring dyads were more beneficial than non-matching mentoring dyads. However, this study did not capture any information about why these matching mentoring dyads may be beneficial.

Matching mentoring based on social characteristics is predicted to result in positive educational outcomes. Santos’ and Reigadas’ study (2005) tested the Faculty Mentoring Program’s (FMP) conceptual model of ethnic homogeneity in student-mentor backgrounds, frequency of student-mentor contact and perceived mentor supportiveness, success of students’ attitudinal adjustment to college, success of students’ academic performance, and level of satisfaction with the program. The Faculty Mentoring Program, housed in a California university, was founded in 1987 to provide students who are “at-risk” (i.e., primarily ethnic minority students) with faculty mentors. The goal of this formal program is to encourage faculty-student interaction in support of students’ social and academic integration in college. The program is formal, structured and comprehensive with guidelines and protocols to follow.

To collect data, Santos and Reigadas (2005) mailed 200 students an evaluative survey, to measure the effectiveness of the FMP. The sample consisted of 65 subjects who completed the survey in its entirety. Of the participants, 49% were Latino, 30% were African American, 12% were European American, and 8% were from a mix of other racial/ethnic groups. The participants included 86% female students and 14% male. Approximately 70% of those completing the survey reported being first in their families
to attend college. Approximately 45% had been involved with the FMP for at least one year. Forty-five percent of the students were racially/ethically matched with their faculty mentor, while 55% were assigned mentors of different race or ethnicity. Eighty-six percent of the participants were matched to a faculty mentor of the same gender, and 89% of the students met with their mentor at least once per month.

The FMP survey included questions on ethnic homogeneity, social embeddedness, students’ attitudinal adjustment (college anxiety, college self-efficacy, college goal definition, and career expectations), perceived mentor support (modified version of Granger’s (1995) 20-item Faculty Mentor Perception Scale), program satisfaction, and academic performance (GPA). Overall, the results revealed a significant and direct connection between racial/ethnic matching and student-mentor contact. Students who had the same racial/ethnic background as their mentors met more frequently with their mentor than did students who were not background matched with their mentor. The more frequent contact was linked to a perception of stronger mentor support with regard to personal and career development. The conclusion to be drawn from this study is that frequent student contact with university faculty of the same ethnic background as the student seemed to predict positive educational outcomes for those who are at-risk (Santos & Reigadas, 2005).

**Mentee’s perspective.** One study focused on matching dyads based on social characteristics where both the mentor and the protégé developed as result of their relational connection. The study sought to identify the characteristics of quality mentoring from the protégé’s perspective (Beyene, Anglin, Sanchez, & Ballou, 2002). The research questions asked protégés to describe their mentoring experience, the ways
they (the protégés) support mentoring as a mutually relational process, and whether the protégés believed that similarities of race, ethnicity, gender between mentor and protégé were important parts of the mentoring relationship.

The data was collected using quantitative and qualitative approaches. The study showed several important findings. Approximately 90% of the participants agreed that mentoring involved mutually beneficial relationships. This data suggested that friendship and reciprocity were critical in developing strong mentoring relationships (Beyene, et al., 2002). In the sample, 82% of protégés reported feeling free to challenge their mentor’s ideas. Mentoring was perceived as important for success. Fifty-four percent of participants identified race/ethnicity or gender as important, but neither race nor gender were identified as critical influences on the mentoring process in a comprehensive analysis of the data (Beyene, et al., 2002). Some participants in this study reported that gender and racial/ethnic matching was important, but not all participants agreed. Like several others, this study was inconclusive about the value of matching mentor dyads.

Role models. The importance of having a role model with the same social characteristics in a mentoring relationship - including gender and disability matching - can result in positive experiences. Role models serve as persons of admiration, emulation, and respect (Whelley, et al., 2003). Lockwood (2006) considered the importance and impact of gender matching on career role modeling. The study was developed in response to literature indicating that women face negative stereotypes regarding their competence in the workplace, and the supposition that women may benefit from the example of outstanding women role models who can offer strategies for overcoming gender barriers to achieve success.
The impact of gender-matched career role models was assessed on the self-perceptions of female and male participants. Participants were asked to describe a career role model who had inspired them from their past. In total, 44 females and 33 males were asked to read articles on highly successful professionals, and describe their role models for the part of the study. After reading the articles, the participants were asked to complete a scale to assess the impact of their role models on self (Lockwood, 2006).

The findings indicated that gender matching was important for women. Females in the study with female role models possessed a better ability to map their career plans, and view the role model as an example for what was possible for their own future. In addition to the results, Lockwood (2006) noted that women were more likely to identify female than male role models. This study indicated that having role models of the same gender contributed to women’s aspirational planning and success.

Positive relationships with mentors and role models are crucial to enhance career, social, and emotional aspects in persons with disabilities as well (Whelley, et al., 2003). One program from Hawaii, known as DO-IT was developed to provide support for youths with disabilities helps these students consider and prepare for science, engineering and mathematics careers. The program helped support the participants in identifying and overcoming barriers.

A highlight of this program was its introduction of youths with disabilities to scientists and potential role models with disabilities, all of whom had achieved success in their field (DO-IT, 2003). Some evaluative data from the program has suggested that introducing the mentees to mentors with disabilities can help strengthen the STEM interests of youths with disabilities. One key quote illustrating the importance of having
persons with disabilities as role models was from one participant, “It feels so nice to know that there are adults with disabilities, or who know a lot about disabilities, because I think that people who are about to go college or start their adult life can learn a lot from mentors…” (Whelley, et al., 2003, p.48). Even with the success of the program, there are still many youths with disabilities that are not offered exposure to STEM professionals with disabilities.

Cultural space. Mentoring dyads with the same social characteristics can also provide safe cultural space for underrepresented communities. Safe cultural space is virtual or physical gathering space free of mainstream stereotypes and oppressions. For instance, Dingus (2008) interviewed African American K-12 and/or postsecondary educators about their experience with mentors of the same racial identity as the mentees. Dingus (2008) conducted both individual and group interviews ranging from 1 to 3 hours with three intergenerational families. From the interviews, she found three main themes emerged from the participant experiences. The themes included: Black women teachers’ standpoints, modeling for leadership, and racism within the teaching ranks. All three themes noted the importance of having same-race mentoring to support Black women’s career success, to engage in networking with Black women, learn how to become a Black leader, and to learn how to deal with institutional and individual acts of racism. Dingus concluded that mentoring models could benefit matching mentoring dyads from underrepresented communities by creating a space to validate and share knowledge with each other.

A similar finding was found in Johncilla’s (2006) dissertation study on Black women leaders. The study included an examination of the retention and continuity of
indigenous knowledge in transactional Black women’s leadership. She conducted semi-structured interviews with 15 participants from the African Canadian Diaspora.

The qualitative study revealed that participants described Black women’s leadership as the juncture of cultural resistance, transformation, and empowerment. Their collective agency set the stage for empowering themselves and others—as admired Black women and role models. The process of empowerment happened through the sharing of stories (oral traditions) which transferred cultural and indigenous knowledge about success and the ways Black women maintain their identity as leaders (Johncilla, 2006). The importance of having the same social characteristics to help empower mentees to become successful was a central finding of this study (Johncilla, 2006).

**Social capital.** Increased knowledge of and access to social capital was another outcome which occurred through matching mentorship. Social capital is the valuable relationship with other actors in a particular social network which results in increased access to information and resources (Coleman, 1988). The concept of social capital allows actors (e.g., students) to secure benefits by being part of the STEM/academic social network. One study showed that having a matching mentor could provide an increase in social capital, and greater access to inside information in the college environment (Palmer & Gasman). Insider information plays a huge role for Black students in Historically Black Colleges and Universities (HBCU). HBCUs provide rich educational opportunities for African American students. This study considered the experiences of eleven academically underprepared African American men at one HBCU, and focused on the ways social capital influenced their academic success.

From this interview-based study, the professors and administrators were identified
to be accessible, and successful in forming supportive relationships which encouraged persistence in students’ performance. The participants also indicated that faculty and administrators served as role models for them and encouraged their participation in student support services, campus organizations, internships, and scholarship programs. In total, HBCUs, and the environments with mentors on the campus played a huge role in providing social capital for African American men through mentoring relationships with African American faculty and administrators (2008).

Social capital for Black students can also be accessed at predominantly white institutions (PWIs), though matching mentorship and guidance still seem to play a role. One study highlighted the experiences of Black graduate students attending one research university between 1962 and 2003 (Johnson-Bailey, Valentine, Cervero, & Bowles, 2008). The results from a survey which included both closed and open-ended questions, found that black students’ primary sources of support were Black professors in PWIs. In addition to this result, qualitative findings showed that 95 black graduate students reported that having Black professors makes their lives better, because they get more support from Black professors than white professors. This study concluded that the perception of Black students was that they did not receive equal opportunities or support from white faculty, and that the presence of Black faculty was a benefit to their success (Johnson-Bailey, Valentine, Cervero, & Bowles, 2008).

Another study examined matching mentoring dyads in the academic mentoring process of college students, using Coleman’s social capital theory as a framework (Smith, 2007). Eight respondents (four mentors and four mentees) from a Midwestern Research University were central participants in this study. The mentees were undergraduate
students and the mentors were faculty and administrators who participated in one of two academic mentor programs. Some of the participants were matched based on race and ethnicity. Data was collected using individual interviews.

Mentors in the study reported teaching mentees how to navigate the culture of the university. The primary manner for this teaching was through mentors sharing their personal stories of their successes and accomplishments during their college years. Unfortunately, the study provides no context for the consideration of matching mentorship or the ways matching dyads might contribute to mentees’ knowledge, growth, and ability to navigate through obstacles in academia.

**Mentor’s responsibility.** The value of the mentoring relationship is not only identified by undergraduate students, but from mentors/professors too. Reddick (2006) studied the themes in African Americans faculty members’ descriptions of the mentoring relationship, using a modified grounded theory approach. Participants in the study included four African American professors who are mentors to African American undergraduates. Three of the four professors graduated from HBCUs, and this experience appeared to influence participant reflections. For instance, one professor recognized that the HBCU had taught him/her the value of mentoring and the skills to work effectively with Black undergraduate students experiencing challenges (e.g. lack of social support and racism) in academia and impacting the students’ social well-being. These reflections supported that the HBCU experience was helpful in preparing African American professors to teach and mentor Black undergraduate students at PWIs (Reddick, 2006).

**Criticism of matching mentorship.** Empirical research on matching mentoring has been limited (Bozeman & Feeney, 2008), and the findings contradictory. Some
scholarly work suggests it is important for mentees to seek similar social characteristics like gender, race/ethnicity, or disability, and it is in these relationships that mentees find positive support and outcomes from the mentoring relationship (Blake-Beard, Bayne, Crosby, & Muller, 2011). Other scholars claim that matching is not important, and in fact, being mentored by white men may have more advantages (Dreher & Cox, 1996). These scholars argue that because white men are routinely in positions of power, they are better positioned to open doors for underrepresented students to the structures and systems of power within their dominant culture.

One study supporting this notion found that African American students reported having a mentor with the same background was not important. One of the study’s goals was to investigate how many African American students felt it was necessary to have an African American professor as a mentor for their success and retention. Hickson (2002) developed a survey that was sent to African American students attending a HBCU in Texas. The participants’ sample included 134 freshmen, 30 sophomore students, 29 juniors, and 57 seniors. All students in the sample were full-time students and between the ages of 17 and 24. The survey items sought to understand students’ need to have a mentor, the need for a college professor to be a mentor, and the need for a college professor to be of the same race to be a mentor. The survey framed the questions for either yes or no responses.

As reported, 75% of students felt that it was more important for their professor to have an interest in them than for the professor to be of the same race. In addition, 75% also stated that one of the responsibilities of a professor should be to mentor students (Hickson, 2002). Generally, this study supported the scholars who do not believe mentors
must have the same social characteristics as their mentor. Black students in this study indicated it was more important to have a mentor who cares about their future and who is willing to invest into their education (Hickson, 2002).

Another study supporting that matching dyads based on same social characteristics does not matter examined whether - and how - participation with a faculty mentor plays a role in academic success (Campbell & Campbell, 1997). Using a mentoring program at a large metropolitan university on the West Coast which targets students from ethnic groups who are underrepresented in academics, students were matched with faculty based on their shared academic interests. The sample of 339 undergraduate students was statistically compared to a 339-member non-mentored control group, matched for gender, ethnicity, class level, and entering GPA. The participant demographics included 37% male students and 63% female. Racial and ethnic demographics for the participants were 69% Latino, 22% African American, 3% Native American, and the rest were from a variety of other racial or ethnic groups. The mentors group consisted of 126 faculty, administrators and staff who shared the academic interests of the mentored participants group.

The result compared academic performance and retention of mentor-mentees matched on gender and race/ethnicity versus those not matched for these characteristics. The report showed no difference in gender-match and racial/ethnic-match in the academic effectiveness of the mentoring relationships. However, students from racially/ethnically matched pairs remained enrolled for more semesters, than did pairs who were not matched by race/ethnicity. This did not describe the experiences of racially/ethnically matched pairs’ nor the ways this matching specifically supported
mentees’ abilities to stay in school (Campbell & Campbell, 1997).

**Deaf and mentoring.** There are two existing studies focused on mentoring deaf persons, yet both fail to discuss the role of sharing same social characteristics. Foster and MacLeod (2004) discussed the role of mentoring relationships and how they contributed to deaf career development (Foster & MacLeod, 2004) in their study. The study examined informal mentoring experiences among deaf supervisors. Fifteen deaf alumni of the Rochester Institute of Technology, who were supervisors at their workplaces at the time of the study were interviewed. The researchers used a semi-structured interview process to elicit the experiences of the participants.

From the interviews, it was clear that informal mentoring relationships influenced deaf respondents’ work persistence and career success. Six specific themes regarding the roles of informal mentors emerged from these interviews: (a) offer emotional support; (b) advise and teach; (c) be a role model; (d) set high goals; (e) advocate; and (f) communicate (Foster & MacLeod, 2004). According to the researchers, the first two were frequently cited in the interviews. Generally, the data revealed that parents, teachers, coworkers, supervisors, friends, and spouses played a role in deaf supervisors’ personal and professional development.

The role of communication also played a huge role in developing a strong mentoring relationship. Also, important individuals sharing emotional support and the belief that the deaf professional can succeed also helped deaf leaders to prepare for their careers. This study ultimately showed that there are many roles that contribute to deaf supervisors’ professional development. Absent in this study was any focus on the social characteristics or demographics of the mentors. There was also no identification of
hearing status in this study, though some of the narratives support the assumption that the mentors are primarily hearing (Foster & MacLeod, 2004).

An alternative study found that the support from mentors impacted deaf students’ career development and personal well-being, particularly when deaf students are experiencing critical events or obstacles in their lives. Framed in Chaos Theory, this study sought to understand the influence of life-altering experiences on deaf students’ lives, as well as the ways mentoring supports students through these challenges (Saur & Rasmussen, 2003). The researcher used a series of structured interview with five mentors of undergraduate students at a technical university in the northeastern United States.

The students who were involved in mentoring relationships were enrolled in bachelor’s level mainstream college programs in predominantly hearing classrooms. The interview included two parts. First, the mentors were asked to define mentoring and describe their roles in the mentoring process. Second, the participants were asked to reflect on a list of graduates—students who had attained baccalaureate degrees—and identify major events or incidents in these students’ college experiences that had impacted their lives and careers (Saur & Rasmussen, 2003).

It was found that mentors offered a safe, trusting environment where mentees were free to express themselves without fear of judgment. Mentors also indicated that they provided guidance and were there to listen. During the critical events, the mentors considered themselves to be interpreters of experiences, making sense of the events and clarifying options for the students’ response to these events. Second, the mentors identified themselves as change agents. Mentors helped students to work through an event and make positive changes. Third, the mentors identified their role as interveners,
taking action to provide resources to help students resolve critical issues. Ultimately, the study found that mentors played several roles to support deaf students in dealing with critical events while continuing their successful academic careers (Saur & Rasmussen, 2003).

This study did not reveal any information about the mentors or their demographic information. This did not explore the mentors’ reported experiences by also interviewing their mentees. The study was conducted only from the perspective of the mentors self-reflections. The question of the experience of a deaf mentoring dyad and its impact on identifying and sharing subjugated knowledge for the success of deaf students in STEM fields is under-studied, and yet its place on the national agenda of the NSF makes it remarkably important for consideration.

**Chapter Summary**

Research on mentoring and college students’ academic success is critical for college and universities. An understanding of the established goals and successful outcomes of the mentoring experience is important. A review of the literature reveals not only scarce consideration of this phenomena, but methodological problems within the research on mentoring in college students as well (Jacobi, 1991; Crisp & Cruz, 2009).

A need for more research on undergraduate mentoring is clear. With a multitude of definitions, it is apparent that no scholar has been successful in arriving at a definition which is universally acceptable to the larger community (Jacobi, 1991; Crisp & Cruz, 2009). There is also a lack of clarity on antecedents, outcomes, characteristics, and definitions of mentoring relationships (Jacobi, 1991; Crisp & Cruz, 2009). Finally there is a lack of theoretical and empirical research on the mentoring relationship and its support
of success in STEM undergraduate research. The study of undergraduate mentoring has not been popular, and a need exists for more research in this area (Jacobi, 1991; Crisp & Cruz, 2009).

Given the minimal literature and study, it is not surprising that in practice academic mentoring programs have not gone through rigorous evaluation processes to determine their effectiveness in promoting success. There are internal and external validity problems in mentoring studies (Jacobi, 1991). The findings on mentoring and the impact on academic success cannot be generalized to different student populations and types of college and universities due to poor external validity, small sample size, lack of diversity in student population, and lack of multiple research sites (Jacobi, 1991). Jacobi (1991) suggested five areas to improve the quality of this research. He indicates a need for descriptive information on the number of students accessing mentors, quasi-experimental research to understand the relationship between undergraduates and mentoring, evaluation of formal mentoring programs, qualitative and ethnographic studies to better understand the mentor-mentee relationship, and basic theoretical research to better understand the development of the mentoring relationship.

Literature on matching mentoring dyads is also limited. There is a need greater understanding of how matching mentors contribute to both mentors’ and mentees’ successes in undergraduate research activities. It is clear that role models can contribute to youths with disabilities’ aspirations to become future STEM professionals. The shared experiences with persons of the same social characteristics could help mentees to understand how to overcome challenges through the natural transmission of subjugated knowledge as noted in the studies by Dingus (2008) and Johncilla (2007). Literature on
matching mentoring dyads based on disability is nearly nonexistent. There are very few studies that discuss the importance of persons with disabilities serving as role models, and what does exist does not explore the ways mentors with disabilities can or do help to share subjugated knowledge to help with overcoming oppressions (Whelley, et al., 2003).

Chapter 2 outlined that mentored undergraduate research experiences seem to sometimes influence underrepresented students’ experience and their desire to pursue academic success. Additionally, there is evidence to suggest that undergraduate students also improve their research skills in preparation for futures in STEM-related fields. The literature also suggests that matching mentoring dyads may also play a role, but the understanding is limited. What is particularly under-studies is the nature of the deaf mentoring dyad and how deaf mentors and mentees share subjugated knowledge to overcome challenges in STEM fields.
Chapter 3: Methodology

Introduction

Research has indicated that deaf individuals are underrepresented in STEM careers (NSF, 2011). The leakage in the STEM pipeline between undergraduate enrollment and the number achieving doctoral degrees illustrates that a lack of quality mentorships is preventing deaf individuals from advancing in STEM education (Mertens & Hopson, 2006). Matching mentoring dyads based on similar social identities may serve as role models (Davidson & Foster-Johnson, 2001) and provide subjugated knowledge (Collins 2000) on how it is to be a deaf scientist. This phenomenological study captured how the participating deaf mentors and participating deaf mentees in undergraduate research laboratories described the nature of their mentoring dyad and the role of subjugated knowledge to help deaf mentees learn how to be deaf scientists.

This study was guided by one major question and three sub questions: How do deaf dyad mentoring relationships benefit faculty mentors and undergraduate mentees pursuing careers in the STEM field? Specifically, the study investigated the following questions: (a) How do deaf mentoring dyads evolve and interact in mentor-mentee relationship among deaf STEM undergraduates? (b) How do deaf mentees who have deaf mentors describe their undergraduate mentoring experience? (c) What is the nature of subjugated knowledge shared between mentors and mentees?

A phenomenological approach was an appropriate method of inquiry for this study because it allowed the researcher to capture the essence of a human experience
(Creswell, 2009). The topic is new, and has not been addressed with deaf people. Using the phenomenological approach allowed the researcher to search for meanings and use multiple approaches to capture the essence of deaf mentoring dyads and their role in sharing subjugated knowledge. While the participants were the experts in this study, the researcher’s personal experience, and place within the research environment was important to contextualize the final interpretations of the phenomenon. According to Berg (2001), personal biases can influence the trustworthiness of qualitative studies. The researcher had to put his own experience, biases, and past knowledge aside to understand the phenomena at a deeper level (Berg, 1993) using a bracketing process (Colaizzi, 1978). This is also known as “epoche” (Creswell, 2009). As result the researcher was able to explore the lived experience with a sense of “newness” to identify the common themes derived from the data.

The researcher is deaf and has worked in a deaf-mentored undergraduate research laboratory during his undergraduate and graduate years. He is also currently working as a research collaborator at one laboratory. The laboratory has recruited many deaf undergraduate and graduate students to work there. The students are provided the opportunity to have hands-on learning experiences with research and become better prepared for graduate or doctoral programs. The researcher’s experience will be suspended during the data analysis process as explained in the data analysis and study credibility sections.

**Study Context**

This study took place at two universities in the northeast region of the United States with a critical mass of deaf college students and deaf faculty members.
Pseudonyms will be employed for the participating institutions and the participants to protect the identity and reputation of all involved. Thoreau College, one of the nine colleges at Emerson University, is the world’s first and largest technological college for students who are deaf and hard of hearing. Emerson University serves over 16,200 non-deaf students studying at associate, baccalaureate, masters, and doctoral levels. Thoreau College serves over 1,500 students, 1,323 are deaf students, 29% are minority students and 2.7% are international students from 20 countries. Thoreau College has a strong deaf community where students and faculty are identified as part of Deaf culture, a linguistic and cultural minority. The majority of students use ASL as their primary language. Also, approximately 20% of the faculty are deaf and use ASL (Thoreau University Annual Report, 2011).

Thoreau College conducts a wide variety of science, technology, engineering, and mathematics activities, including academic majors for undergraduates and graduate students offered within Thoreau College, majors and courses of study supported by Thoreau College in other colleges of Emerson University, and a number of programs targeting pre-college student outreach and research (Thoreau College Annual Report, 2011). Students enrolled at Thoreau College can earn associate degrees, bachelor and graduate degrees. Qualified deaf students also can earn bachelor or master degrees in more than 200 programs offered by Emerson University including science, technology, engineering, and mathematics. There are approximately 35% of deaf students enrolled in STEM programs at Emerson University (Thoreau College Annual Report, 2011).

Thoreau College also has multiple research-based laboratories in the fields of psychology, technology, and biology. Some of the research activities are directed by deaf
faculty members while others include deaf faculty members as collaborators in the leadership of the projects. The laboratories include undergraduate and graduate students in a variety of research support roles. Those activities include projects focused on the psychological foundations of mathematics performance by deaf and hard of hearing students, Deaf and Hard of Hearing (DHH) Cyber-Community supporting deaf and hard of hearing students in STEM, and a NSF grant-funded study on the Science of Visual Language and Visual Learning.

The second institution is Hawthorne University, a liberal arts institution, which serves 1,100 deaf students studying at associate, baccalaureate, masters, and doctoral levels. More than 25% of Hawthorne’s students are minorities, Hawthorne University has a strong deaf community where students and faculty are identified part of Deaf culture. Majority of students use ASL as their primary language. Also approximately 44% of the faculty are deaf and use ASL (Hawthorne University Annual Report, 2011).

Hawthorne has averaged an enrollment of 51 deaf STEM majors (not including psychology and sociology majors) over the past five years. These represent 4.7% of all Hawthorne majors. Hawthorne has multiple research-based laboratories in fields of linguistics, education, psychology, and biology. Some of the research activities are directed by deaf faculty members while others include deaf faculty members as collaborators in the leadership of the projects. The laboratories include undergraduate, graduate, and doctoral students in a variety of research support roles (Hawthorne Annual Report, 2011).

**Study Participants**

To locate the participating mentees and mentors, the researcher has employed
purposeful sampling criterion. Purposeful sampling has allowed the researcher the opportunity to develop a criterion, and recruit participants who have experienced the phenomenon (Creswell, 2010; Miles & Huberman, 1994). The study’s focus on the converging experience of Deaf people, STEM majors, and being a cultural and linguistic minority drove the criteria for participants.

To participate as a mentee in this study, a number of requirements were identified. As a result of the focus of the study, one aspect of eligibility criteria required the participating mentees to be current deaf undergraduate students or graduated students attaining baccalaureate degrees in science, technology, engineering, or mathematics (STEM). Because this study focused on those students experiencing increased challenges in the academic pipeline due to a lack of access to information, the mentees were also required to be fluent in ASL as their primary language for communication.

Another requirement was that participating mentees experienced an undergraduate research relationship with a mentor for at least one year. Students in their second year to fifth year were therefore qualified to participate in this study because they had the potential for sufficient mentoring experiences. Because the consistency of the mentoring relationship would likely provide for the greater opportunity for mentees to be able to describe their mentoring experience in rich detail, it was ideal if the mentee had at least five face-to-face meetings with their mentor within a one-year period. All of these criteria were shared with individuals when seeking participating mentees.

As for mentors, the eligibility criteria required them to be deaf and have participated in research laboratories for at least one year because the mentor would be more familiar with the academic network and culture of the academic field. At least one
undergraduate research assistant must have been employed during the same time frame as the mentor, because the study focuses on the relational aspect of the mentoring dyad. The mentor would be more aware and comfortable adopting the role of a mentor. Mentors must use American Sign Language as a primary language for communication, to provide an accessible mentoring experience for the undergraduate deaf students. Additionally, the mentors must have already received a masters or doctoral degree in their discipline and be a current employee at the university with at least one year of experience there, because they would be more familiar and comfortable with the university.

Upon developing the participant criteria, the researcher utilized his professional networks to contact prospective mentees and mentors participants for the study. The researcher emailed prospective mentees (see Appendix A). In the email, the researcher asked prospective mentees to identify their current or former mentor to be part of the study. Once a mentor was named, the potential mentors were contacted via email (see Appendix B). The email described the purpose of the study, and explained that the study was voluntary. Scheduling for interviews was arranged once the participating mentors and mentees consented to participate in the study. As a result of this recruitment process, three participating mentees, and their corresponding mentors were identified for this study. Two of the mentoring dyads were from Thoreau University and one mentoring dyad was from Hawthorne University.

The first mentoring dyad was John and Ashley. John is a deaf faculty member at Thoreau University and has worked there for more than five years. He has his own funded research laboratory with a small number of deaf undergraduate and graduate students as research assistants. John hired Ashley as one of his research assistants when
she was an undergraduate student majoring in Psychology. Ashley had recently graduated and decided to pursue graduate studies at Thoreau University. Because this study focused on undergraduate students’ experiences, Ashley was asked to reflect on her experiences as an undergraduate student mentored by John. The risk did however exist that some of Ashley’s reflections were influenced by her graduate mentoring experience. According to Ashley’s C.V. she has presented research findings from John’s research projects at a conference. The undergraduate mentoring relationship between John and Ashley was in place for over two years. See Table 3.1. for more information on John and Ashley.

Table 3.1

Profiles of Study Dyad #1

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity/Race</th>
<th>Deaf Identity</th>
<th>Degrees</th>
<th>Research Experiences</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>43</td>
<td>Male</td>
<td>Caucasian</td>
<td>Deaf</td>
<td>Ph.D.</td>
<td>Published a numerous of articles, presented at conferences and mentoring deaf undergraduate and graduate students</td>
</tr>
<tr>
<td>Ashley</td>
<td>28</td>
<td>Female</td>
<td>AALANA</td>
<td>Deaf</td>
<td>B.S. in Psychology</td>
<td>Presented at a conference, collected data, supervised other students in the lab, and participated in grant funded research projects</td>
</tr>
</tbody>
</table>

The second participating mentoring dyad was Walter and Joey. Walter is a faculty member at Thoreau University and is a director of his research center. He has conducted a number of projects and presented at conferences. His research center includes both deaf
and hearing undergraduate, graduate and doctoral students. Joey initially sought an internship opportunity at Walter’s research center, and then was hired for one summer in that capacity. After completing his internship, Joey was asked to return and work as a research assistant for Walter. Joey’s C.V. and interviews revealed that he presented a research project at Thoreau University as a result of his work in Walter’s lab. More information about Walter and Joey can be found in Table 3.2.

Table 3.2

*Profiles of Study Dyad #2*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity/Race</th>
<th>Deaf Identity</th>
<th>Degrees</th>
<th>Research Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walter</td>
<td>57</td>
<td>Male</td>
<td>Caucasian</td>
<td>Deaf</td>
<td>M.S.</td>
<td>Director of his own research center, created his own patents, mentor deaf and hearing undergraduate, graduate, and doctoral students</td>
</tr>
<tr>
<td>Joey</td>
<td>22</td>
<td>Male</td>
<td>Caucasian</td>
<td>Deaf</td>
<td>B.S. in Computer Science</td>
<td>Research intern, worked with number of projects, and presented at his college about his team’s research project.</td>
</tr>
</tbody>
</table>

Michael and Melissa were the third mentoring dyad, and they were from Hawthorne University. Michael is a deaf faculty member that has his own research laboratory with undergraduate students working on research projects. Michael hired Melissa to become his undergraduate research assistant and mentored her for more than two years. As result of being mentored by Michael, Melissa’s CV indicates a presentation
of their research findings at a national conference. More information about Michael and Melissa is provided in Table 3.3.

Table 3.3

Profiles of Study Dyad #3

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity/Race</th>
<th>Deaf Identity</th>
<th>Degrees</th>
<th>Research Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael</td>
<td>40</td>
<td>Male</td>
<td>Caucasian</td>
<td>Deaf</td>
<td>Ph.D.</td>
<td>Run his own laboratory, mentor deaf undergraduate students, presented at conferences, and published a numerous articles</td>
</tr>
<tr>
<td>Melissa</td>
<td>21</td>
<td>Female</td>
<td>Caucasian</td>
<td>Deaf</td>
<td>B.S. in Biology</td>
<td>Worked as a research assistant, collected data, mentor younger undergraduate students, and presented at a conference.</td>
</tr>
</tbody>
</table>

Data Collection

In this study, the data collection process included: (a) informed consent form (see Appendix C); (b) demographic forms for both mentors and mentees (see Appendix D and E); 2) individual interviews for both mentors and mentees (see Appendix F and G); (c) dyad interviews (see Appendix H); (d) field notes; and (e) document collections (curriculum vitae). A triangulated review of the interviews and artifacts was used to assemble a picture of the phenomena, and create a rich data set.

Demographic form. A demographic form was a crucial part of the triangulation method because the participants’ backgrounds were not captured during the interviews.
The background information gave a better sense of who the participants were and how their background experiences shaped their mentoring experiences. In this study, two different demographic forms were used: one for mentors (see Appendix D) and the other for mentees (see Appendix E). Both demographic forms asked the respondents’ race/ethnicity, gender identity, hearing status, cultural identities, socio-economic status, and educational degrees. That information gave an overview of who the participants were and how their previous background influenced the mentoring experiences. All of the participants completed the demographic forms prior to the one-on-one interviews.

Compensation of a gift card of $40.00 was given to the participants after they completed the dyad interviews. The researcher also provided his email address for the participants to use with further questions or clarifications.

**Individual interview.** Individual interviews captured mentors’ and mentees’ voices about their mentoring experiences and gave them the opportunity to provide rich details about the experience and meaning of this mentoring phenomena. Prior to commencing the one-on-one interview with both mentors and mentees, the participants were informed of the purpose of the interview in both written English and American Sign Language (see Appendix C). The researcher emphasized that this study was voluntary. The participants were able to withdraw from this study at any time. For the individual interviews, the researcher started with the three participating mentees first and then interviewed the mentors. All the interviews took place at the researcher’s workplace. There are several rooms equipped for video-recording activities. The researcher had access to use those rooms for the interviews. The rooms had adjustable control dual cameras and computer equipment that allowed the researcher to capture his participants
as well as himself. Interviews were recorded using these multiple video cameras and captured both researcher and participant language subtleties and cultural cues (Kvale & Brinkmann, 2009; Mertens & Ginsberg, 2009). These were used to develop transcriptions from ASL to English. The videotape also helped the researcher to do field notes, since the researcher was deaf and not able to engage with the participants in ASL and write the field notes simultaneously.

During the individual interviews with the mentees, the researcher asked a list of open-ended questions to capture their mentoring experiences (Creswell, 2009) (see Appendix F). The questions included requests for describing the mentee’s experience with a deaf role model, and the ways that may have helped to prepare the mentee to navigate in academia. The questions were then modified and tailored for mentors (see Appendix G). During the individual interviews with the mentors, the researcher asked them to describe their experiences in guiding their undergraduate mentees into academia, STEM fields, and as a deaf scientist.

**Dyad interviews.** The researcher had the opportunity to ask for clarification on previous individual interviews during the dyad interviews. The dyad interviews asked both participating members of the dyad to be interviewed together. During the dyad interviews, the researcher elicited more information, including follow-up questions developed and based on the information from the individual interviews with both participating mentees and mentors (e.g., *describe the transformation in your mentoring relationship*?). The dyad interviews were videotaped as well. The researcher reserved a room at his workplace that allowed more space, and had a video camera with a tripod to capture everyone in the interview. For the participants at a distant university,
Fuzemeeting and FaceTime platforms were used to capture the dyad interview. Each dyad interview took approximately 60 minutes.

**Field notes.** The researcher documented the field notes promptly after tall interviews. Notes on video observations were recorded in the researcher’s journal as field notes. The researcher used the field notes to document his observation, as well as actions and non-verbal cues from the participants in the video (Morgan, 1997). Notes were not recorded during the interview because the researcher is deaf and not able to engage with the participants in ASL and write simultaneously.

**Document collection.** Request for documents was also part of this study. Participating mentors shared their curriculum vitae and other additional information about their laboratories including brochures, joint-publications, and job descriptions for research assistants. The participating mentees also shared their resume or curriculum vitae, and any joint publications with which they had been involved. These documents were used to reinforce the nature and extent of the opportunities participating mentees received through their experience with mentors, and to note the accomplishments of all participants in their academic fields.

**Data Analysis**

This study followed the Miles and Huberman (1994) analysis model, which consists of three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. These concurrent flows of activity helped the researcher to paint a more complete picture of the experiences for deaf mentoring dyads (Seidel, 1998). Data analysis is a cycle; it allows the researcher to move through noticing, collecting, and thinking interchangeably (Siedel, 1998). All the interviews were recorded and transcribed.
through the methodical process of selecting, focusing, simplifying, abstracting, and transforming as part of data reduction by the researcher and an expert in ASL-English translation.

**Coding.** Coding is essential part of the data analysis (Miles & Huberman, 1994). The process of coding allowed the researcher to combine data for themes, ideas, and categories, and then mark similar passage of text with a code label. This approach was employed so that the codes could be easily be retrieved at a later stage for further comparison and analysis. Coding can be based on themes, topics, ideas, concepts, terms, and keywords found in data. For this study, three types of coding were conducted, including a priori codes, open coding and axial coding. Codes were identified in all types of data in this study including transcripts and field notes.

At the first level of coding, the researcher coded with themes identified from a priori ideas such, including previous research and Collins’ Black Feminist Theory, research questions, and the researcher’s intuitive feeling about the data. Examples of a priori codes included *subjugated knowledge*, *role of the mentor*, and *the laboratory*. The researcher searched in the data for any text or meanings that could be relate to the a priori codes. Through the process of reviewing the transcripts, the researcher had the opportunity to create new codes in a process of open coding (Strauss & Corbin, 1990). Open coding allowed new codes to emerge after reviewing the data without the constraints of preconceived categories. The researcher refined and merged the codes through the process of analyzing each aspect of the data.

To further data reduction and visualization of these codes, the researcher assembled the data in a new way by making connections between categories. This is
known as axial coding (Miles & Huberman, 1994). For example, the researcher made the connection between two codes and merged them into one theme. Cross-case analysis was utilized to compare responses received independently from mentees, mentors, and then collectively when interviewing both mentees and mentors.

**Trustworthiness.** Trustworthiness is an essential component of data analysis because it ensures the veracity of the study (Glesne, 1999). The researcher examined trustworthiness by triangulating the data, bracketing, reviewing the data and findings with a critical friend, and engaging in member checks. First, the researcher used bracketing, a method used in phenomenological study to mitigate effects of the researcher’s preconceptions that may taint the research process such as researcher’s interests, personal experience, cultural factors, and hunches (Moustakas, 1994). Prior to the analysis, the researcher has described his researcher bias using bracketing. The bracketing approach allowed the researcher to step aside and see data from a fresh perspective (Moustakas, 1994).

Additionally, to increasing the trustworthiness of data, the researcher reviewed a priori codes, open-end codes, axial coding, and final cluster of themes with a critical friend. The critical friends included researchers in qualitative fields, and they were asked to review the preliminary study findings. Having critical friends review the data helped support the credibility of the findings.

After reviewing with a critical friend, the researcher conducted member checks. The researcher carefully picked phrases, excerpts, and words that the participant used in the data and verified the accuracy of the translations with the participant. The researcher sent an email to the participant sharing the exact phrase, texts, or paragraph to confirm
that meanings were translated and understood correctly (Glense, 1999). Bracketing, reviewing with critical friends, and conducting a member check solidified the virtue of the data analysis.

**Data Management**

Rigorous data management was crucial to organize and protect the data. The field notes were structured with the name of the researcher, the pseudonyms, and the date. The data was documented on loose-leaf paper, and then typed into a Word document. It was saved in a locked folder on the researcher’s computer. The notes were sorted into a structure of file types to identify the participant, events, or topics relevant to the study. A cross-referencing system was developed to allow only the researcher to locate the data. Indexing was employed to set clear categories and organize them into a codebook. The researcher compiled an abstract of the field notes as well. To locate the specific data in the field notes, a system of numbers/letters was developed and used.

As for the interview videos, the researcher securely protected the confidentiality of the participants by not using their names. The researcher created unique letters that were assigned to each participant, on their demographic information sheet, document collections, field notes, video files, and other related materials for the selected participants. Since the participants come from a small deaf STEM community, their confidentiality was carefully protected. To secure their confidentiality, the researcher ensured that no direct quotes or excerpts in the result section revealed the identity of the participant. Texts were carefully reviewed. Confidential information relating to the participants was secured in a memory stick stored in a locked drawer. Only the researcher had access to the file. In case the videos become corrupted, the researcher backed up the
videos to his external hard drive. The drive was locked in an independent file cabinet in a secure office location.

**Chapter Summary**

In summary, this chapter explained the complete data collection process for this phenomenological study. The objective of this study was to obtain rich descriptive and triangulated data including: background information; one-on-one interviews with the participating mentors and mentees individually; dyad interviews; field notes; and documentations. This section offered a detailed description of why and how data was captured to describe the nature of deaf mentoring dyads and the role of subjugated knowledge in supporting the success of deaf undergraduates.
Chapter 4: Study Findings

Introduction

Chapter 4 reports study findings generated from a cross-data analysis. This study is guided by one major question and three sub questions: How do deaf dyad mentoring relationships benefit faculty mentors and undergraduate mentees pursuing careers in the STEM field? Specifically, the study investigated the following questions: (a) How do deaf mentoring dyads evolve and interact in mentor-mentee relationships among deaf STEM undergraduates? (b) How do deaf mentees who have deaf mentors describe their undergraduate mentoring experiences? (c) What is the nature of subjugated knowledge shared between mentors and mentees?

The questions were posed in consideration of Black Feminist Theory (Collins, 2000) on subjugated knowledge as well as other research findings with regard to same-background mentoring. The study was centered on how this previous research context might frame the lived experience of deaf mentors and mentees navigating a predominantly hearing academic community. The research questions focused on the ways deaf mentors and deaf mentees described the nature of their mentoring relationship, and what role the sharing of subjugated knowledge had for deaf mentors and scholars successfully navigating mentoring relationships with their mentees. Data included individual interviews with participating mentors and mentees, mentoring dyad interviews, videos of the interviews, artifacts including curriculum vitae and laboratory information from brochures and websites, and participant demographic information. Three themes
emerged from the data collected and the analysis conducted. Each theme is related to the study’s research questions, which specifically seek to understand the ways deaf mentors impact the experiences of deaf undergraduate students’ education.

The first theme, titled the *Psychology of Deaf Space*, centers on descriptions from the participants identifying the laboratory as a place where cultural and linguistic understanding is readily available and accepted by deaf mentors and for deaf mentees. Mentors model and communicate what it means to be *deaf* and *scholar* in a space established to mutually value both identities. Sharing the ways they are empowered by this integrated cultural and scholarly experience, mentees are awakened to new understandings of academic subject matter and new possibilities for their future role as a researcher, scientist, and scholar.

The second theme is *How to Be a Deaf Scientist: Building Navigational Capital*. This theme references the manner by which mentors share and mentees gain information about the academy. This exchange allows mentees to gain insights and information about succeeding in the university—within and beyond the laboratory.

*Deaf Role Models: Transforming Experiences* is the third and final theme. This theme identified how mentors seem to possess a consistent and almost instinctual desire to invest in the pipeline of the next generation of deaf scholars by serving as role models. This was apparent to deaf students, and demonstrated by their gratitude and appreciation for the mentors who had believed and invested in them. Mentees now can aspire to careers as deaf scientists in the future. After reporting on each theme, the chapter concludes with a summary of the results in preparation for the chapter five discussions of the findings.
Theme 1: The Psychology of Deaf Space

Participants in this study recognized that access to the academic culture and discourse present in hearing undergraduate research laboratories is challenging for deaf students who identify themselves as culturally Deaf and use American Sign Language as their primary language. Most traditional research laboratories have been designed, operated, and populated by a predominantly hearing academic community. Design decisions in labs typically pay little or no attention to the establishment of a visually open and accessible space which would promote the deaf researcher’s involvement. Appendix I offers photographs and architectural designs from leading laboratory design firms. Each reflects both the solitary and auditory environment described below.

Expectations that individuals gather from and contribute to the activities of the lab while talking through cubicles, “around” office walls, or in research spaces where work stations have researchers positioned with their backs to one another are the norm. People share information while passing by one another, with their heads down, and across the laboratory with little thought about whether there is a need to actually look at one another. These norms are not culturally and linguistically supportive of deaf students, and limit their educational opportunities to either learn from or contribute to the research activities in these hearing spaces. From society’s perspective, these labs emphasize the solitary nature of a successful scholar’s work, but are still deceptively permissive of the exchange of information - just dependent on auditory cues and conditions. From a deaf student’s perspective, they are the environment of a hearing scholar, and the prevailing message is that deaf people do not belong.

As described by the mentors, *Deaf space* considers a physical location where
most of the people are Deaf, the environment is supportive of visual connections and information sharing, and ASL is the dominant language. These laboratory environments promote the inclusion of deaf people by providing an open and accessible environment—both physically and linguistically. This model provides deaf students a culturally attentive space, which welcomes them and continues to reinforce the message that they can and should find a home in the academic setting, because what they have to learn and what they have to contribute matters. Through the design of the physical space, the deaf mentors intentionally offer a model for what it means to embrace both deaf and academic cultures.

According to John, a deaf scholar at Thoreau University, he is one of few deaf faculty members nationally who have their own laboratories. John’s experience is that deaf students are eager to be involved hands on in research, but do not have a culturally mindful space where they can be at ease with their identity as well as involved in STEM research. Specifically, John has secured financial and physical resources which have allowed him to establish and operate a lab that affords deaf professionals and students with this opportunity. His lab is a deaf-centric space, providing for direct-access interactions and a safe place for deaf scholars and scholars-to-be to create an academic community.

John reflected during the dyad interview on inheriting a hearing designed laboratory space, and its lack of consideration of the physical needs of deaf people to visually see each other and engage in academic discourse using a visual language:

I struggled with… our meeting area. I really had to fight for that [design]. We have cubicles in the [office areas of the] lab so we can’t see anything around us.
With hearing people, they can hear who is around. Deaf people can’t do that.

[When we inherited this lab] our meeting area had cubicles in there as well, and I really fought to get them removed to have an open area for us.

John’s decisions were deliberate in enhancing the culturally sensitive laboratory environment, and fostering the exchange of information and knowledge in a place where the act of communicating was centrally visual.

John’s mentee, Ashley recognized the importance of the visually open meeting area John had created in promoting the discourse and collegiality necessary for successful lab environments. Ashley stated in the same interview: “Last summer we just took over the entire area and left our cubicles. They (the cubicles) weren't designed with [deaf people] in mind. We brought our… laptops…to the table…we were able to work in the same space together.”

John had intentionally recognized the linguist and physical norms of a lab which would encourage deaf people to participate and engage in discussions. Ashley realized the effectiveness of those decisions in contributing to the dynamic lab environment. John ultimately offered in the dyad interview:

Hearing people think they know what is best for Deaf people but it isn't always a perfect match. I can pick what is natural and what is best for myself…that is the “psychology” of Deaf space. I have yet to see a purely Deaf space, because there are still hearing people involved in [defining norms and designing the places deaf people interact and work.

Regarding the importance of deaf-centric labs in creating opportunities for deaf students, John contrasted the experience of hearing and deaf students in the pursuit of
research experience in his individual interview:

There are an extremely limited amount of opportunities for Deaf students.

Hearing students can join other labs, on and off campus so there are plenty of opportunities for them; but there are none for Deaf students. [The deaf-centric lab] provides them with opportunities [similarly inclusive to those of their hearing peers] that they can take complete advantage of.

John reflected that deaf run laboratories provide deaf students with deaf adult mentors, who are more likely to know how to best work with and provide learning experiences for deaf students in a culturally and linguistically relevant manner. He went on and stated in his interview, that, at its core, “a [lab’s] purpose is to give students hands on experiences.” The deaf-centric lab gives deaf students the freedom to access this opportunity to the fullest extent, as there are no cultural or language barriers.

The anticipated linguistic and cultural barriers or burdens limiting participation by deaf students in traditional hearing labs were described by Melissa, an undergraduate student majoring in a physical science at Hawthorne University in her individual interview:

As a Deaf person, I have to make sure I am on the same page and caught up with everyone else and that I understand everything going on [in a hearing lab]. In a Deaf environment I can relax more, and I know that someone will come to talk to me or I can to talk to them and have a smooth conversation. In a hearing environment, I have to make sure I don’t miss anything.

Melissa recognized that in a hearing laboratory, she would feel differently about her inclusion in scholarly discussions. It was additional work on her part to understand the
dynamics and even to know who was talking at any given time in the lab environment, distracting her from the work central to that of a scholar-in-training.

Mentors and mentees agreed that the deaf-centric laboratory is a place where confidence is built within and comfort is felt by deaf students and faculty members. Having a deaf-centric laboratory allowed mentees to feel at ease with their Deaf identity, which seemed to open them to more possibilities, including the consideration of themselves as scholars. John made this point when commenting on his mentee, Ashley. He stated in the individual interview: “[Ashley] sees things differently and is inspired [by having a deaf-centric laboratory]. Because of that [deaf-centric laboratory] I know that giving her an [inclusive and accepting environment], also gives her a space to learn rich and useful information for herself in [John’s laboratory].”

Given John’s observation, the lab provided a space where his mentee’s abilities could be evaluated for their scholarly merit. As detailed by Ashley, presently a graduate student at Hawthorne University, who worked with her mentor John during her undergraduate years, social acceptance in the lab provided a place for her to maintain her cultural identity and engage in research. She stated in her interview, “I felt connected, understood, they knew about [Deaf] culture.” Ashley described the ways that a deaf-centric lab allowed her to focus beyond her identity as a deaf person and consider gathering the knowledge and experience necessary to the business of becoming a scholar. She expanded in her dyad interview:

I don’t have to worry about being Deaf there. I get support and learn what I need to be a Deaf person. When I go into John's lab, I learn all the things that I am missing when I am in a hearing environment. [My experience in] John's lab fills
gaps [that are present in hearing spaces].

John also reported that even as a mentor he feels differently in his laboratory than he feels in many other places at the university. Of his laboratory, he commented in the dyad interview:

My home. It is my sanctuary, the lab and Thoreau University. My everyday life can be all over the place and I can go to the lab and just be. I can work, do school work, anything. It’s a place I want to be. It is a place I feel comfortable, safe, understood. Often the people who don’t understand [my experiences] aren't there in the lab. It is my sanctuary.

John’s desire to create a “home” for his students had also allowed him to create one for himself. The establishment of a space, which was physically separate and culturally distinct from the hearing world, seemed to have curiously been credited as empowering deaf individuals to contribute and connect to the broader hearing academic community.

Mentors also noted that they were deliberate in attending to communication in the establishment of lab culture as a place where deaf students could build confidence as future deaf scholars. Joey, a mentee who is majoring in computer science at Thoreau University, described the advantage of being in a deaf-centric laboratory because of his full access to conversations and discourse. Joey had previously worked in a hearing lab, and discussed those challenges as well in his individual interview.

I really enjoy it in [my mentor’s] lab. I feel like I have full access to everything because everything is in ASL. In the other [hearing] lab, I didn’t understand what was being talked about, the inside jokes, or what everyone was doing, because I couldn’t hear them. In [my mentor’s] lab, I really enjoy being able to work there
and talk to [my mentor] or other people who come into the lab.

Melissa also shared her appreciation for a lab environment where she was able to understand everything in the individual interview:

I love it there [in the lab] because everyone is Deaf. In a hearing environment, I always feel a little tense and unsure. I really need to make sure I understand what’s going on. I don’t want to miss anything. I think the Deaf environment is more peaceful and we can do anything and everyone can communicate with each other because we are all the same. And they are all friendly so that helps.

These inclusive environments helped Joey and Melissa to be involved with and capture the subtleties of conversations in the lab. Such conversations served as incidental learning moments, in which, mentees could gain additional information and confidence to help prepare them for careers in the sciences. Ashley reinforced the importance of having access to the sources of information and sharing in the laboratory in her individual interview:

I have more access to everything. I can learn. There is a wealth of information, and there is incidental learning happening there. I can [oversee] something really interesting and be able to learn from that. I can pick up things from all over the lab. Hearing people always have access to that and I never have that [in hearing environments]. In [my academic] program, I am always the last person to find things out. They [hearing students] could have just talked about something while I am working at the computer and I’ve missed out on that.

A lab with deaf leadership, and where ASL was the dominant language was clearly reported to provide participants with connections and confidence. Experiences of
more intimate and informative sharing between mentors and mentees, and greater understanding, appreciation, and acceptance for deaf students were repeatedly revealed. Sensitivity to the visual nature of the language and lab was another aspect important to the incidental gathering of information that seemed to previously elude deaf students in hearing labs.

Increasing a general understanding of academic subject matter was also likely to bring clarity to lab related duties and to the development of scholar worthy research projects. The use of American Sign Language in deaf-centric labs also provided a mechanism for clarifying academic concepts raised in classrooms, and relevant to the pursuit of useful research. As Joey observed in the dyad interview:

I think ASL was a more effective language [than English] because we were discussing so much [academic content]. I’m trying to think of how we would have discussed these things if we were both hearing and using English. I don’t think I could communicate as well without ASL. I think having a visual language was really a benefit to us.

As informed by Joey’s experience, ASL was effective in elevating the intellectual content of his discussions with his mentor.

Melissa further expanded on the importance of ASL to promote a well-informed scholarly environment in the individual interview.

It [ASL] really helps me visualize how to understand things in biology, like concepts and processes. [My mentor] also uses drawings, which helps me understand things so well. Hearing professors have a hard time explaining concepts but with ASL I can see it clearly, and I understand it better.
She added in her dyad interview: “Mostly [my mentor] gives me information so I can do my own research. He explains genetics concepts to me in sign which really helps me understand them better.” John added to the ways that using ASL exclusively allows the mentees to participate and ask for clarification during his individual interview: “Another cool thing about my lab is that there is an opportunity for [students] to see something and understand it, or question it.”

And, while an interpreter is often provided in academic settings to help facilitate communication between hearing non-signers and deaf people, Melissa also discussed the unacceptable nature of this arrangement in an academic laboratory. She stated in her interview: “For me I can understand biology better because the explanation is provided in images when it’s signed [directly]. If it was coming to me through an interpreter it would be harder for me to understand.”

The challenge of working through interpreters was also mentioned by John during his interview.

They [mentees] won’t get full access [to the conversations in the lab]. Even with the best interpreter they still will not get full access. With my hearing mentors and an interpreter, I know I am always missing something. Direct communication does have benefits.

Joey agreed with the importance of having direct access, and discussed it in the context of receiving feedback on his lab work in his interview: “That constant feedback was so helpful, it was direct, not through email or interpreters. Communication with each other was easy.”

John shared in the dyad interview the importance of considering the primary
language when aiming to include deaf students and colleagues. He explained the isolation of his experience in meetings designed and dominated by hearing people and conducted in spoken English.

In a hearing meeting there are certain dynamics. If a Deaf person joins that meeting with an interpreter, he or she is left out and it’s hard to participate in that meeting. If it’s a mixed meeting with hearing a Deaf people, hearing people take over because of it being voiced… I’m often left out because I’m alone in these meetings with all hearing people.

It was important to establish American Sign Language as the primary language in a deaf-centric lab for a variety of reasons. Learning about the work of the lab and the application of classroom teaching to experimental projects was one. Another was the opportunity language access provided deaf students to better understand the daily work of a deaf scholar.

Another priority for the deaf-centric lab mentioned by the mentors, was its importance in highlighting the culture of academia and research for their mentees. Michael, a deaf faculty member at Hawthorne University, who also runs his own laboratory, described this as follows in the dyad interview:

I think in the lab we have to model the life of a scientist. That involves problem solving, knowledge of science in the given discipline, and [the development/use] of general decision making skills. Students also get to see the grant process, our frustrations, our successes, and the many issues that we face.

His mentee, Melissa reinforced the success of Michael’s vision in their dyad interview:

Inside the lab I have learned what is involved in the basic work of a wet lab, and
have been able to build on that knowledge. I gained a lot of in-depth knowledge on computer programs and how to use them with DNA information and genetics as it applies to what we were doing in the lab.

Deaf centric labs seem to “normalize” the scholarly experience for deaf students in a laboratory. They offer safe haven, warm welcome, visual environments, application of complex academic concepts and theories, and role models who are approachable and wise. The environments established by deaf mentors allowed deaf students to not only accept their identity as a deaf person, but ultimately explore and pursue their identity as a scholar. Once the experience of and exposure to life as a scholar is revealed to students, it awakens possibilities for their own future. The next theme will discuss how mentors help mentees with navigating into academia and learning how to be deaf in their discipline.

**Theme 2: How to Be a Deaf Scientist: Building Navigational Capital**

Participants in the study encountered barriers when they attempted to access and understand the formal and informal norms of the academy. These norms were grounded and operated within a culture and language different than their own. Equipped with the knowledge and tools acquired through their own successful academic experience, deaf mentors were both called upon and compelled to serve as guides for deaf mentees wishing to enter and understand this new frontier. Navigational capital from mentors in the forms of shared knowledge and networks became essential to informing the academic trajectory of the mentees, allowing them to chart their own successful course forward. Navigational capital was described by participants in multiple ways, but often included the following aspects for how to be a deaf scientist: (a) inviting mentees into a broader community of scholars, (b) story sharing, (c) transferring self-advocacy skills for access
and accommodation needs, and (d) introducing students to a broader STEM network. The benefit and impact of the mentors’ guidance and these intentional strategies was evident during the interviews, and is highlighted below.

Participating mentors acknowledged that one aspect of their mentorship was to introduce and enlighten the mentees’ about an academic culture whose norms and language have been traditionally dominated by hearing leaders. As John stated in the individual interview, “There is a struggle being Deaf in a hearing academic setting. Science and STEM fields are generally dominated by hearing people and [the rules and expectations] are less transparent to Deaf people.” Given that norms are unclear and the informal system obscure, John felt compelled to support his mentee’s understanding and success in this environment, “My job as a mentor is to navigate [mentees] through that darkness, like a flashlight guiding the way, and eventually to give them the ability to see a path for their own success.”

Invitations to a broader community of scholarship. One way to help mentees navigate and conquer uncertain academic terrain was to purposefully invite deaf mentees to join mentors at conferences, business meetings, or other types of research related activities. During those various activities, mentees were given the opportunity to witness their mentors as they successfully managed and interacted in situations that mentees had not previously seen their mentors encounter. This provided mentees environmental learning opportunities, and allowed them to bear witness to the real world for a deaf scientist. For a member of the visually-centered deaf community, this “witnessing” is a like a visual “eavesdropping,” and allowed mentees to gain the incidental information necessary for their later success as a deaf scholar. John stated in the individual interview
“[mentees] tagging along is important. . . Many people, hearing and deaf, see work within STEM sciences as just big dark clouds and they are blindly trying to find their way. [Mentees] can’t see their way clearly, and that’s why I like bringing students to meetings, conferences, and NSF meetings. [Mentees] see that it isn’t just about big branches and corporations. There are people [at these meetings and conferences] and [mentees] get to see the operations of these meetings.

John was committed to showing mentees what it was like being a deaf scholar in a predominantly hearing academic community. He offered mentees an opportunity to become prepared and comfortable with the culture of STEM. For instance, he explained in the individual interview:

Students see me working on manuscripts or on an abstract draft for a conference. They can see some are accepted and some are rejected. [Mentees] start to see the life of a scientist…it isn’t this big black space they have to navigate blindly. [Mentees] start to become less scared and start to be able to expect what is to come. They know… hurdles they will experience…have learned what to expect through the exposure and insight my work and communication… is able to provide.

Walter and Joey also described the importance of the experiential nature of these invitations during their dyad interview. They both reflected on their trip to one company when Walter was looking for a piece of equipment for their lab. Joey was able to witness the ways Walter successfully interacted with hearing people:
Experience [at the business meeting] helped me see how you [Walter] deal and interact with the hearing world. [Walter] had the experience, knowledge and resources. Even when [Walter] couldn’t get an interpreter [he] tried [his] best to interact with a representative from the company.

Joey continued by recalling what he saw and learned during the visit:

We had to engage in conversation with hearing representatives. That was a challenge, but we made it through with our team. And then, we went to a room where the company representatives gave us a presentation and that made me see what it is like to be in a business meeting where they try to sell us their product.

In their dyad interview, Walter added to Joey’s comments about the advantage of witnessing a business meeting and how he communicated with hearing representatives:

It was nice opportunity for [Joey] to see my real life experience. It is not as easy for me to tell him, or describe to him how to navigate. It is better to see it live. He can see and learn from this opportunity, and why it is important [for him in the future].

Walter helped Joey to experience what it means to navigate broader hearing environments as a deaf scientist by inviting him into an environment where Joey was able to gain incidental information visually. As Walter noted, it would not be easy to simply describe this kind of experience. Walter believed that the best approach was to provide Joey a window into the interaction between himself and other people in the STEM community.

John and Walter both recognized the importance of their role in guiding mentees over uncertain academic terrain by providing access to broader research-related
environments so that mentees could observe and learn in real time. Offering an invitation to mentees while mentors participated in routine, but essential academic and business environments beyond the lab was a deliberate strategy employed by deaf mentors. Incidental learning was provided visually, and gave deaf mentees valuable information to assist with coping and managing their own career and work environments into the future. The power of learning through these live situations contributed to mentees’ navigational capital.

**Unearthing subjugated knowledge through storytelling.** Another strategy in building mentee’s navigational capital involved mentors sharing their own stories to illustrate the ways they navigated as a linguistic and cultural minority through a world dominated by hearing cultural norms and spoken/written English. The importance of learning not only how to be a scientist, but rather how to be a deaf scientist was again noted, and taught - in this case through storytelling and experience sharing. Mentees recognized that those stories and experiences were valuable for the ways they would help them to cope when presented with similar experiences. Joey offered the lessons and benefit he received from his mentor’s story sharing in his individual interview:

> Being a role model, as I said before [we] shared an experience in life. As for specific knowledge, [his anecdotes highlighted] how to communicate with hearing people and the outside world, how to convince people that even though you’re Deaf you can be successful, how to cope with being lonely in a STEM field, and how to cope with being a minority.

Joey expanded further during his individual interview. On the importance of having a deaf mentor share his stories and its impact on Joey’s ability to see a path for his
own future he commented:

It’s important that I have a Deaf mentor who has already gone through that experience in the real world and can encourage me in a way that helps me to see what those experiences are like. He can tell me about jobs and what it will be like in this world for me. From that I can develop a vision for my future. I might have been uncertain as to whether a future in computer science is for me, but he has been really encouraging and shares a lot of information and his experiences with me.

Joey also discussed how his mentor, Walter described his real world experiences through storytelling during the individual interview:

I learned a lot about his background and that like me he went to Thoreau college. He also shared his journey with me about working at his former workplace and how he became project manager there. He gave me an idea of what the future might look like for a Deaf person in a STEM field…he talked about his experiences working with hearing people in STEM fields, and being the only Deaf person there. He really talked about how to get through it all.

In sharing stories of his struggles and successes, Joey’s mentor Walter offered a different kind of reassurance to Joey that he would not be as isolated on his journey during their dyad interview:

I told him that he’s not alone, I went through it too. The frustrations of having a hearing loss, and communication troubles are normal and others just like you face them too. What’s important is how you cope with them.

Walter’s reassurance and storytelling clearly were central to supporting Joey as he
envisioned his own future in a similar field.

During their dyad interview Michael and Melissa pointed out the benefit of sharing experiences and academic knowledge through storytelling in their relationship. Michael expanded during his individual interview when describing that he hosted lunch meetings to give the students the opportunity to ask questions and discuss anything that may be on their mind.

We try our best to go for a lab lunch every Thursday or Friday. [Students] don’t have to come but Melissa generally comes to it all the time so there are usually three of us, Melissa, my assistant, and myself. We have lunch and just talk about anything. . . Sometimes I talk about growing up in a Deaf program at school, but a lot of my stories are about graduate school and science.

Melissa pointed out during her individual interview that the informal conversations with Michael and other colleagues benefited her. She had the opportunity to listen to other people’s stories while participating fully in the dialogue.

Once a week we have lunches together with the other lab assistants and sometimes other professors. During that time we talk about pretty much anything…There is some overall life advice, generally not relationship advice but there is career advice during those talks. Sometimes we talk about graduate school, and I’ll share some of my stories. Other times we just discuss everyday things . . .

The interaction at informal mentoring events seemed to provide Melissa another opportunity to gather the advice of her mentor and other deaf professionals. Story sharing from these adults, and her ability to share her stories in this environment of individuals
with similar backgrounds and cultures was a comfort.

John also raised the importance of sharing stories. In his individual interview he shared: “I try and talk about my personal life, how I cope, my frustrations, and I think a big part of their education is me giving them that information.” John explained his approach and the sometimes redundant nature evident in this aspect of the mentoring relationship as follows: “So that’s what I consider the more informal mentoring. I repeatedly talk about my life, academia, my experiences, and each time I discuss it, it seems to digest and settle a bit deeper into the thinking of my mentees.”

John also discussed the opportunity for mentees to witness other faculty members’ stories and experiences during research related meetings in and beyond the lab. John shared in his interview: “I also introduce my mentees to many different Deaf scientists and researchers so they see that the [stories] experiences are not just mine but they are shared between all of us.” He also invited mentees to participate in grant-centered meetings with other faculty members or principal investigators.

Every Friday there is a grant-centered meeting where other PhD students and PIs share their [stories] about becoming a scientist, researcher, and scholar. The mentees can see there is a commonality there. [Mentees] realize what they are going through is similar to what others have experienced – and survived. They learn that the challenges are part of the journey.

As a result, Ashley seemed to recognize the ways exchanging stories and experiences helped her to navigate her own challenges during their dyad interview.

I can take the information [stories and experiences] and apply it to my own issues at school. I am able to think about my approach using the ways John or the [deaf]
scholars] have approached things. Knowing their stories and experiences has allowed me to consider what is worth fighting for and what I can let go.

All mentors were in agreement on the importance of sharing stories and experiences. These moments were integral in sharing wisdom and knowledge, which supported mentee’s navigation across the academic frontier. Mentees were empowered by these stories, knowing that they could survive and thrive on their journey into the STEM community as a deaf individual.

**Inclusion and access: promoting and fostering self-advocacy skills.** For individuals confronting the reality of a career filled with predominantly hearing environments, access and accommodation was also an understandably central topic of conversation during these interviews. Mentees recognized the importance of learning how to advocate for themselves in appropriate ways as part of building their navigational capital. Therefore, in addition to inviting mentees in to witness broader experiences and sharing stories relevant to the life of a successful deaf scientist, mentors also discussed the importance and ways of building self-advocacy skills when securing appropriate accommodations. These access services were recognized as essential to the navigation and support of academic and career progress for deaf people.

When discussing how to access and receive appropriate accommodations, John and Michael focused on the importance of self-advocacy. John discussed this as follows in his individual interview: “I tell [mentees], you do what you need to do to make it work; every Deaf person has different needs. [Mentees] need to be able to explain what they need in order to get it and fight for their accommodations.” John emphasized the importance of showing mentees how to advocate for their rights to receive appropriate
access to information. For instance, during the same interview he described his experience dealing with requests for good interpreters:

Interpreter issues come up. Even I have interpreter issues. Sometimes I don’t get a good interpreter and they [mentees] see how I cope with that situation. Sometimes I request an interpreter and I am told no, so they learn how I handle that situation as well. I share it all with [mentees] because it could happen to them some day.

In his individual interview Michael also pointed out how gaps in access services systems sometimes escalated his need to be more assertive when advocating for his needs.

The interpreting office… sometimes I tell the students the best thing to do is go complain to them. And other times it’s better to go another route. In theory we fill out a form and get an interpreter and all is well. In practice we sometimes have to fight for something or argue or be more resistant. It really depends on the situation.

Michael continued by describing what he hoped his mentees would learn from him when considering their needs for interpreting and access: “I hope they get the information from watching me, and use it to their advantage as these issues appear in their lives. This way they will know what to do.”

Melissa stated in her individual interview that she learned from Michael, how to decide to keep fighting for accommodations or let some things go:

One thing I was told [by Michael] that I thought was important was “if those people are not willing to provide you interpreter or access services or other accommodations, you don’t want to work for them anyways because they don’t
really want you.” Sometimes it is hard to deal with and can be a blow to your ego, but do you want to work with them if that is how they are going to treat you?

Teaching ways to advocate for their access and accommodation needs was another tool when building mentees’ capital in navigating their futures as deaf scholars. Mentees were given the opportunity to learn from their mentors’ successes and frustrations when managing access and accommodation support. Mentees ultimately would be able to apply these strategies to support their own scholarly journeys.

Identifying the unwritten rules of the workplace. Codes for behavior in the workplace can be largely unwritten, and for hearing people are often learned incidentally through dinner table, church group, and other family and friend conversations. Since most deaf students are born to and interact in predominantly hearing environments, these students have often lack access to these unwritten rules and norms. The participants recognized another aspect of building navigational capital as the filling in of these gaps. By providing mentees information about professionalism and the ways to behave in the scholarly workplace, mentors provided additional preparation and knowledge essential for deaf students’ future success.

John stated in the dyad interview: “There are many levels of feedback. There’s feedback related to teamwork, professionalism, how to write...” John suggested that deaf students missed the opportunities to learn about more abstract concepts associated with professionalism because the incidental information necessary for this kind of learning is routinely inaccessible to deaf students in the typically hearing homes and schools from which they come. His strategy to fill in the gaps of this incidental learning was to be clear and honest when discussing professionalism with his mentees, and to set high
expectations for his laboratory as a workplace.

I see [the gaps in managing situations like these] as a huge weakness with [deaf] students. Their soft skills aren’t developed…probably inaccessible through incidental or cultural learning. I do push my students …I have high expectations for my workplace, and that includes basic things like showing up on time. These are expectations of academia…so I try to make those expectations and the informal teaching of these expectations transparent and explicit...

Walter also discussed this topic in his interview. To improve deaf student’s professionalism, he wanted:

…to teach them how to communicate appropriately and ask questions correctly. There is a code of standards in our field of engineering. I focus on that aspect of professionalism. It is not just the technical knowledge but the whole picture.

During the dyad interview Michael reiterated that because deaf students are mostly from hearing families communication is not readily accessible. This prevents deaf students from benefiting from informal learning opportunities in areas that are routinely taught to hearing students through modeling and incidental conversation. Michael stated: “some students do have gaps in their knowledge of appropriate workplace behavior [professionalism]. They did not seem to get it from their parents or someone else.”

Michael’s mentee, Melissa explained how he had prepared her for future work situations. She noted in her individual interview: “He [Michael] helped me most with professional techniques. If I got my first job and had not had a mentor, I would surely fail. He taught me a lot about how to interact with your boss.”

To navigate successfully in academic communities mentors believed it was a
priority for participants to know and understand the undocumented “codes” that regulate workplace behavior. These codes often eluded deaf students during informal conversations in predominantly hearing environments. Mentors helped build mentees’ skills in this area by filling in gaps about what is unwritten, but expected. This type of navigational capital will help mentees to avoid costly missteps during their evolution from student to scholar.

**Networking with a broader community of scholars.** Part of becoming a successful and relevant scholar is the development of a network of scholars to promote research collaborations and the exchange of discourse and ideas. An advantage of acquiring this aspect of navigational capital under a mentors’ guidance was the broad access mentees were often offered to a STEM network and colleagues. Mentees were given the opportunity to meet other researchers, scholars, and STEM professionals, as well as hearing allies who could be important advocates for deaf needs in some circumstances.

For instance, in his interview John identified a key to his mentoring role as “showing [mentees] who the players are. That’s why I introduce my students to people… some deaf… some hearing…some that sign. That allows [mentees] to build their network, and to be familiar with the players.” He indicated that networking with other deaf colleagues in the STEM community was important, but that one challenge was the residential distance of deaf professionals from one another:

The network of deaf colleagues is located all over. For a hearing student at a college it is easy to be satisfied with a collegial network within their program or college or school. For Deaf, they aren’t going to be able to identify a diverse
network of people with different information and who sign fluently or who will take the time to connect with a Deaf colleague within one single university. So, Deaf students must think beyond an institutional network to a national network and even an international network.

During the same session, John also pointed out that in addition to the opportunity networking gives his students to gain access to the culture and the community of scholars, it also helps the scholarly community come to know his students – a next generation of scholars, “… networking… it is not only good for my students to see the players, but for those at the conference to be able to see my students as well. The conference leads to many opportunities [for continued research and growth].”

Michael also mentioned the significance of networking and finding the right players in the STEM community. Not only was he focused on Deaf colleagues, but also on the development of hearing allies. He hoped to teach Melissa: “how to identify the Deaf friendly people as opposed to those who are not Deaf friendly. I have the ability to help her to effectively evaluate individuals in our field.” He explained the way he helped his mentee to find hearing allies in her field during their dyad interview:

Also [I teach my mentee about] who we pick as friends. What I mean by “friends” are [hearing] allies…[Mentees] have to learn how to identify hearing people who have negative perspectives about Deaf scholars. Those are the people to ignore, but there are others that are deaf friendly…If I can identify them, they are the ones that generally become my allies. They are the people that if I need a favor I can ask them, not the other [hearing] people who are unfriendly to deaf colleagues.
Having access to a network and identifying hearing allies were reiterated as two important aspects of building navigational capital. Mentors viewed networking as an opportunity for their mentees to reach out and become known to a larger community. This larger community was an important one when seeking to expand current and future opportunities for research and learning.

Building navigational capital is essential for mentees to shape and foster their scholarly progress and identity in the STEM communities. The systems, structures, and expectations necessary for success as a scholar require access to that which is often learned by identifying cues and nuances of communication and behavior in the environment. These remain distant and inaccessible to deaf students when raised in predominantly hearing environments. To prepare mentees for their pursuits in graduate school and the STEM workforce, mentors - equipped with knowledge and tools acquired through their experience - seemed compelled to share their strategies by inviting mentees along, sharing stories, instilling the important link between self-advocacy and the request of access services, fostering professionalism, and connecting mentees to a broader scholarly network.

**Theme 3: Deaf Role Models: Transforming Experiences**

Central in each interview was the discussion of mentors’ inherent responsibility to be role models for the next generation of deaf scholars. Citing concerns about deaf students who are traditionally underrepresented in predominantly hearing STEM fields, mentors were acutely aware of the natural limitations deaf students may place on their aspirations when there are few deaf role models in STEM fields. Thus, mentors described a sense of responsibility for offering their mentees guidance and “light,” not only to
support individual students, but as a mechanism for preserving a community of deaf scholars for generations to come. In turn, mentees developed confidence, underwent personal and professional transformation, and ultimately began to imagine their lives as deaf scholars.

**Deaf mentors: transforming individuals and communities.** Mentors described a variety of reasons for engaging in the activities and business of inspiring and supporting the deaf scholar-to-be. Deaf mentors revealed an unmitigated determination and drive to act when a deaf undergraduate expressed interest and/or proficiency in STEM-related fields and research. Not only did mentoring help to enlighten an undergraduate’s career plan and path, but the success of a mentee also gave promise to the possibility for expansion of a community of deaf scholars in the STEM fields.

Walter acknowledged his concern for the individual and the scarcity of deaf students in STEM fields as one reason he was compelled to mentor during his interview. He recognized that his lab is a unique place for providing deaf students the opportunity to experience the real world, “This [lab environment] gives Deaf students a chance to plan for the real world”. He also mentioned:

I know what it’s like to work in the hearing world and to progress in your field. I know it’s hard for Deaf people to move up in their field. I have a soft spot for Deaf engineering students. I want to give them all the opportunities. Not only to advance in work, but socially as well.

In the same interview, Walter became more specific when he identified the transformation in his mentee, Joey during their time working together: “He [Joey] also seemed to find his identity and become comfortable with himself. This is also important
to me.” Walter’s expectations for students and their education were not only centered in their technical areas, but in their management of social aspects of their lives as well. He was deliberate and strategic beginning with staffing of the lab and his work environments. “We need Deaf students. It is my number one priority to hire Deaf students.” Walter’s passion for providing deaf students opportunities to learn and prepare for the real world was apparent from point of hire to the on-going mentoring responsibilities he identified and embraced.

John shared another reason for embracing the responsibility to mentor his deaf students in his individual interview.

[Mentoring of deaf students] gives me the opportunity to pass the tools necessary for success. [Mentees] will marry the tools I supply with others they have gathered to determine their own unique path. Some might be studying reading comprehension, some might study memory, others could study education, but ultimately, to me, they are all deaf scholars.

According to Michael, he mentors deaf students to honor the community from which he has come. In the dyad interview with Melissa, he revealed the intensity and care with which he approaches his work when commenting specifically about his mentee, Melissa’s future as a deaf scientist: “She is an incredible student. Just really great. She is also a nice person and fun to talk to. She is also great in the lab, she will have a great future.” Michael articulated this point as well in his individual interview.

Deaf people are my people. Hearing people have many opportunities and I can’t communicate with them easily. [Hearing people] are still people but it is a different world for them. Deaf people are my people; they are my family, friends,
and children. I want them to succeed.

The additional opportunity to expand a deaf scholarly community within STEM-related fields was mentioned as another motivation for mentors. As John described it in his individual interview:

STEM are lonely fields. There are not many [deaf scholars] in the science fields. The number of deaf people in these fields needs to grow. I feel like I can help. My [experience mentoring deaf students] has helped [deaf students] succeed in multiple cases. And seeing this makes me want to do more.

Heightening his resolve was an articulation that as deaf mentors grew older it became increasingly critical to tap into what seemed mentors’ instinctual need to fortify and establish the next generation of deaf scholars.

It is common and I think [deaf mentors] all react with a sense of urgency that we need to expose [deaf] students now and challenge them now. If we see someone with potential we have to invest in them right then, and expose them to as much as possible because we will get older and younger students need to come [and continue the work].

Michael shared that having deaf role models for deaf students can inspire and increase involvement with research in his individual interview. Doing so can also help to create a community of deaf scholars; broadening his own and his colleague’s opportunity for networking and academic discourse: “I want to see more Deaf students in graduate school, getting their PhDs, and doing research.” Michael’s dream would be “to go to that conference which has around 3-4 thousand people, and find 20 Deaf people there. We all could talk, and mingle with everyone…discuss things, go out to dinner, collaborate. I
really want that to happen.”

In addition to supporting emerging scholars and broadening scholarly communities, another desire is that the mentoring of deaf students by deaf faculty will initiate a cycle of reiterative mentoring; mentors teaching mentees, who become mentors themselves to teach others. While passing on subjugated knowledge, this reiterative cycle is still another way for current mentors to contribute to deaf scholars and scholarship beyond the present generation. John touched on this point in his individual interview:

[My wish]…for [mentees] to become mentors themselves. I mentored them, and now hope they can turn around and mentor someone else. Having the cycle continue means [the growth of] more Deaf people in different disciplines. That realizes one of my biggest goals.

Whether a mentor’s goals were intended to address individual or community needs, Michael articulated one motivation at the core of all the work in support of future deaf scholars in his individual interview:

You need someone to inspire you. When I was young in school I had so many people telling me I can’t do things and it made me angry. [These comments] had a huge impact on me. [The experiences] almost caused me to give up. I think what happened to me was wrong. I don’t want that to happen with my [deaf students]. Instead, I tell them they can succeed and that they should go for it.

*after long silence*

To expand the number of deaf scholars in the STEM fields, Michael and his peers in this study recognized the importance of building confidence in the next generation of deaf scholars. Michael recognized that societal and institutional oppression towards deaf
people exists, and that he has both a duty and an opportunity to counteract that. Each deaf mentor held this same duty as an almost sacred pact, often seemingly made with their younger selves, and in response to their own academic journeys which had been routinely navigated in the absence of deaf mentors and scholars.

**Deaf mentees: learning and lives transformed.** These investments by mentors also created transformational experiences for mentees. According to mentees, they reported an increased sense of confidence as current students and an ability to see possibilities for themselves in the STEM community.

Joey noted the ways that having a deaf role model made a significant impact on his life today and how he believed it would continue to do so into the future in his dyad interview with Walter:

I think that [mentoring] is the most important part of my life. I was able to think about my future. In high school I did compete against hearing students and worked hard to go on, but I was unsure of myself. I had low self-confidence, and I think really the most important part of my life was working with Walter. [Upon meeting him my confidence grew] and my future became clear. He continued to focus on the impact a deaf role model has had on his own aspirations and plans:

The benefits of having a Deaf mentor...I can identify with that person. I can see myself becoming like [my mentor] in the future. If my co-op [research internship] was with a hearing professor it would not be as easy to see myself in their shoes in the future. Instead, I want someone [a deaf mentor] who has gone through the same experiences I have and will go through. It is easier to look up to that kind of
[deaf mentor], especially in STEM.

While Walter had commented on Joey’s growth during the individual interview, at the dyad interview, Joey recognized the ways Walter’s belief in him had made him feel while traversing the STEM community. With a smile on his face, he signed to Walter: “Walter [you] pushed me to be ready to show my work, to be confident with [my work], and to show it to the real world.”

The impact her mentor had on Ashley was also shared during her individual interview. “I have the potential, and I know I do. I have always known that, but if it wasn’t for John I wouldn’t have been able to pursue this field.” She added that she did not have many deaf role models growing up. Meeting her role model, John inspired her to learn from him and build upon his knowledge.

John is the kind of role model I didn’t have growing up. I look to my mentor as a role model. He is what I want to be. He said to me once, that when he retires I will be smarter than he is. I found this notion impossible. Then he continued and explained to me that with research everything is new, and when he retires the research information he has will become outdated. I will already have that knowledge, and I should build up on that, making me smarter than him.

Melissa also reflected about her mentor, Michael, and the transformative opportunity presented by both shared journeys and shared collegiality with him in her individual interview.

I look up to Michael. He is Deaf like me. We have something in common which makes us understand each other better. With hearing mentors, they may see me as beneath them, but with Michael he makes me feel as though I am an equal, even
though I am a student.

The similarity and comfort Michael created allowed for Melissa to benefit from his
guidance in a number of ways:

…he can give me advice on how to succeed in the hearing world, because he has
already done it. With a hearing mentor I would only learn about science, not how
to deal with being Deaf in a hearing science environment. A Deaf mentor really
helps with that.

Deaf mentors seemed to possess a consistent and almost instinctual desire to
sustain and expand a deaf community of scholars by becoming role models. Whether
their motivation was to awaken potential within individuals who seemed like mirrors of
their own past, or to create a community of colleagues with a common language and
cultural understanding in their present, the notion of “paying it forward” was held as an
hallowed duty among those who had already made their place at the table of the STEM
academic community. This was apparent to deaf mentees, and their gratitude and
appreciation for those who had believed and invested in them was reflected in the
aspirations they had and the opportunities they saw and were pursuing for their futures.
Clearly these relationships had a profound and lasting impact on both mentor and mentee
– each gaining a new sense of purpose and promise from their journeys.

**Summary of Results**

In summary, the three major themes emerged from the data. The initial theme was
an *in-vivo quote*. The “Psychology of Deaf Space” which discussed how mentors
provided an open and accessible environment; physically, culturally, and linguistically a
model for what it means to embrace both *deaf* and *academic* cultures. This model
provides deaf students a culturally attentive space which welcomes them and continues to reinforce the message that they can and should find a home in the academic setting. This theme also addressed how deaf space has contributed to mentees’ confidence when engaging in research with the guidance of deaf mentors.

The second theme detailed that deaf mentors were deliberate in building deaf mentees’ navigational capital in order to teach them how to be a deaf scientist. To prepare mentees for their pursuits in graduate school and the STEM workforce, mentors were equipped with knowledge and tools acquired through their experience. Mentors were compelled to share their strategies by inviting mentees along, sharing stories, instilling the important link between self-advocacy and the request of access services, fostering professionalism, and connecting mentees to a broader scholarly network.

The final theme was, Deaf Role Models: Transformative Experiences. This theme discussed how the presence of deaf role models inspired deaf mentees to become scientists themselves. Deaf mentors seemed to possess a consistent and almost instinctual desire to sustain and expand a deaf community of scholars by becoming role models. As result of that, deaf mentees, inspired by those who believed and invested in them, built aspirations to pursue graduate school and other STEM professions.

The final chapter of this study synthesizes the data within a discussion of literature relevant to the research questions. Furthermore, implications and recommendations for practice and future research are identified. A discussion of the study’s limitation is also provided to suggest future study opportunities.
Chapter 5: Discussion

Introduction

This phenomenological study examined how and what types of subjugated knowledge were transmitted in deaf mentoring dyads to support undergraduate students’ successful pursuit of STEM careers. The study was guided by the following research questions: How do deaf mentoring dyads benefit faculty mentors and undergraduate mentees pursuing careers in the STEM field? How do deaf mentees who have deaf mentors describe their undergraduate mentoring experience? Finally, the study considered what was the nature of subjugated knowledge shared between deaf mentors and mentees?

The purpose of this chapter is to discuss the emergent findings from this study of three deaf mentoring dyads. Participants described the nature of mentorship and the role of subjugated knowledge in the context of undergraduate research laboratories. Implications of the study based on the literature review and theoretical framework will be drawn, and recommendations for practice and future research will be suggested. Additionally, limitations of the study will be considered and presented. Finally, a summary inclusive of conclusions from chapter five and from the entirety of the dissertation will be shared.

Study Implications

Three themes framed the study participants’ experiences in deaf mentoring dyads, and highlighted the previously subjugated navigational knowledge necessary for
supporting mentees’ success in STEM fields. These themes were: The Psychology of Deaf Space; How to Be a Deaf Scientist: Building Navigational Capital; and Deaf Role Models: Transformative Experiences. The responses from the participants revealed the importance of deaf mentors and the deaf spaces they create. It was reportedly in these described experiences and environments that participants gained access to subjugated knowledge relevant to their navigation of academic and scholarly environments as deaf scientists in the predominantly hearing STEM community. Consistent through all themes was a shared expression of the importance of participants’ same cultural and linguistic backgrounds in achieving this access. These findings are consistent in several ways with literature reviewed on mentoring in undergraduate research experiences, and its contribution to undergraduate students’ success and the impact of same background mentoring.

**Mentored undergraduate research experiences.** Findings from this study of deaf mentoring dyads in STEM fields revealed consistencies with previous studies outlining the general importance of mentoring in STEM-focused undergraduate research experiences. According to the literature, mentored undergraduate research experiences in STEM fields are recognized as an innovative, high impact educational practice, which increase student-faculty interaction, academic rigor, and the application of learning (Johnson, 2010; Kuh, 2008; Tsui, 2007). This type of hands-on experience in research has allowed students to become prepared for STEM fields. For instance, undergraduate research experiences have helped undergraduate students to improve their research skills, engage in scholarly discussions (Hu, Scheuch, Schwartz, Gayles, & Li, 2008; Lopatto, 2003), become confident in themselves as scholars (Campbell & Skoog, 2004; Phinney,
Torres Campos, Kalleeveyn, & Kim, 2011), and increase their self-esteem (Jonides, von Hippel, Lerner, & Nagada, 1992).

Mentored undergraduate research experiences, where the process is “situated” within a social and cultural context that is influenced by a faculty member’s introduction to experience and practice (Lave & Wagner, 1991) is particularly beneficial to underrepresented students’ success in STEM disciplines (Nagda, et al., 1998; NSF, 2011 Hurtado, et al., 2008). Through the process of enculturation into the research community, mentees are given the opportunity to observe and model research skills demonstrated by mentors (Kardash, 2000). A faculty member’s facilitation and guidance was identified as important for underrepresented students’ integration into the culture of academia (Thiry & Laursen, 2011).

In general, mentored undergraduate research experiences give students the opportunity to observe and model research skills demonstrated by faculty mentors, improve their research skills based on feedback from mentors, receive reinforcement for successful task completion, and learn to behave as scientists (Kardash, 2000). These opportunities to become comfortable in lab environments, and to situate themselves as scientists and researchers are especially important for underrepresented students who have traditionally had less exposure and are likely to be both unfamiliar and intimidated by these environments (Nagda, et al., 1998; NSF, 2011 Hurtado, et al., 2008). While the benefits of mentoring in undergraduate research experiences identified in the above studies were consistent for the deaf mentoring pairs, deaf individuals in this study identified gaps in their ability to achieve these mentoring experiences when placed in traditional (e.g. predominantly hearing) research settings.
According to the participants in this study, their ability to benefit from a mentor and work in a research laboratory seemed closely connected with their ability to gain visual access to language, information, and collegial interactions. Several participants in this study noted that working in a hearing laboratory is a significant challenge. There was little time for them to focus on learning what it meant to be a scientist, because they were constantly trying to just keep up with what was happening, what information was being exchanged, and even when spoken information was being shared. Hearing lab operations included ongoing dialogue and the exchange of both academic and collegial information, while researchers continued to look down, conduct experiments, pass in hallways, or write notes.

Because a hearing lab environment provides for no requisite visual cuing when conversation is occurring, deaf participants in this study struggled to know when academic or collegial exchanges happened. Therefore, it became impossible for participants to gain access to the incidental information and learning necessary to provide them safe introduction or integration into STEM work in hearing lab environments. Successful undergraduate research experiences for deaf students in this study seemed to emphasize the special significance of the ways same background and language mentors were better able to create lab environments cognizant of the visual language and learning that is central to the deaf student’s academic growth.

While the benefits for deaf students of having mentors with similar social and cultural identities paralleled many of the benefits identified in other studies of matching mentor dyads, those benefits that were unique to deaf people may offer some insights for all STEM fields. Ninety-five percent of deaf people are born to hearing parents, and the
lack of immediate connection to deaf adults means language and cultural understanding as a deaf person are routinely delayed. From the study findings, it appears that the role of STEM mentor in a deaf matching dyad pair carries responsibilities beyond the traditional academic and laboratory environments.

Beyond learning about the culture of academia, and perhaps even before that learning could take place, there was the described learning about oneself as deaf. To note that a mentor permitted – or even invited – a relationship with a mentee that would include the routine sharing of personal narratives and everyday stories about experiences and life in *and beyond* the academic world would seem to initially counter traditional views about the production of quality research. In conventional views of the research laboratory objectivity, boundaries, and neutrality are valued and vigorously preserved (Porter, 1996).

Objectivity is reported to be necessary—in part—to prevent the risk of personal connections influencing the questions being asked of studies, and then ultimately influencing the results of those studies (Porter, 1996). From the diversity and renown of the grant funding sources, the amounts of grant funding secured, and the accomplishments and recognition of the research produced by each of the research laboratories in this study of matching dyads, the personal relationships appeared of no hindrance to the quality of the lab environment or the research produced. Perhaps general notions of the neutrality of relationships between scientists in the lab are overly valued, and in fact, developing that personal connection would result in more students identifying interest and commitment to the study of STEM fields without diminishing the nature or quality of academic study.
Matching mentoring dyads based on social and cultural backgrounds. The gaps and challenges for deaf academics seeking mentorship and learning in traditional research labs underscored previous findings about the importance of matching mentors. These dyads repeatedly highlighted the value of the exchange of subjugated knowledge associated with successful navigation as a minority scientist. A number of findings in this study paralleled those of previously published studies about matching mentor dyads.

Though there were some contradictions, much of the mentoring literature indicated that mentorship can be especially successful for minority mentees when shared social characteristics such as race and gender within the mentoring dyad are present (Ensher & Murphy, 1997; Koberg, Boss, Goodman, 1998; Noe, 1988; Ragins, 2007). Mentors serve as role models for minority individuals, providing inspirational and aspirational capital supporting minority student success (Whelley, et al., 2003; Lockwood, 2006). Mentors with shared social characteristics helped mentees from minority communities navigate through challenges they – as mentors - have already overcome (Blake-Beard, Bayne, Crosby, & Muller, 2011). The arena for these navigational strategies included both psychosocial support (Koberg, Boss, Goodman, 1998) and career development support (Ensher & Murphy, 1997). Research on matching also found that mentors from minority communities are compelled by a moral duty to seek mentees with shared social characteristics in order to give back to their minority group (Dingus, 2008).

As result of shared social identities, there was a reported ability for mentors to connect with students on several meaningful levels. Same background mentoring provided mentees with the subjugated knowledge necessary to overcome oppression.
experienced as minority individuals (Dingus, 2008; Ragins, 2007). This type of mentoring also provided necessary role models and story sharers important to the mentees’ development of the psychosocial and academic savvy necessary for success. Finally, this type of mentoring was driven by a different sense of urgency among established scholars, given their inherent recognition of the responsibility to reach back and give others their hand.

Consistent with the literature, the importance of matching dyads for deaf academics focused on the establishment of culturally safe environments. This safety allowed for the sharing and identification of subjugated knowledge, role models, and the acceptance of an accountability for future generations of deaf students entering STEM fields. While safety within the space of the mentoring relationship was important, the physical spaces in which these dyads studied were also universally central to establishing a sense of safety and entry into the non-deaf STEM community.

Deaf mentoring dyads emphasized the importance of space as a mechanism for creating safety and for exchanging previously subjugated knowledge in a linguistically inclusive and culturally sensitive manner. This was consistent with Dingus’ (2008) study noting that Black women in mentoring dyads used cultural gathering space to unearth subjugated knowledge for Black women without being faced with the threat of stereotypes and oppression. In this study of deaf mentoring dyads, the research laboratory was often noted first for its design as a cultural gathering space.

Narratives and discussions of matching mentors’ labs frequently referenced their linguistic access, visual nature, and opportunities for collective dialogues. There was a freedom for deaf people in these lab spaces notably absent of hearing-dominant designs
and norms. And as Dingus’ study of Black women would suggest, when oppressive elements were eliminated, the exchange of subjugated knowledge unique and critical for success was unearthed and freely shared.

While the benefits of matching mentoring identified in the above studies were also reflected among the deaf mentoring pairs, the findings of this study suggest an expansion of “matching” characteristics beyond gender and race. This study highlights the importance of sharing a same cultural and linguistic background. Based on the findings of this study, matching deaf mentors’ and mentees’ common cultural and linguistic backgrounds seemed central to providing subjugated knowledge relevant to successful navigational strategies in the hearing STEM community. This offered a sense of understanding and possibility for deaf students considering the pursuit of STEM research careers.

Some participants in this study noted that having a hearing mentor who did not share or understand their cultural and linguistic background was a block to their success in the lab. Hearing mentors were frequently described as “unfamiliar” with ways for supporting deaf mentees’ transition to deaf scientists. These mentors seemed naïve to the barriers which existed and limited access to the academic and lab cultures for deaf students. In the case of the three matching deaf dyads in this study, each reported that those cultural and linguistic barriers had been resolved as a result of the matching social and linguistic characteristics they shared.

Hauser and his colleagues (2010) account for this finding when contending that Deaf role models often have a better sense of what types of gaps exist with deaf children’s stores of navigational knowledge. Deaf adults have more experience with those
gaps, as they have personally navigated them, and have gained knowledge and capital during their own navigation. Successful deaf mentoring dyads showcased the importance of this shared background beyond the child/adult relationship, and well into adulthood.

**Subjugated knowledge and the Black Feminist Framework.** Just as it frames the work of Dingus (2008), Collins’ (2000) Black Feminist theory provides theoretical support and foundation for considering the findings from this study. The value of establishing cultural gathering space to create the environment for an exchange of subjugated knowledge among deaf scientists and students is reinforced by Collins’ Black Feminist theory. Recall that Collins’ theory defines subjugated knowledge as knowledge that is alternative or in addition to conventional information surrounding a circumstance or phenomena, and that is knowledge produced from, and validated within the minority community’s cultural group (Collins, 2000; Dingus, 2008). Collins theorized that subjugated knowledge from Black women was shared within their gathering space to empower Black female colleagues and the next generation, as each prepared to navigate through societal and institutional challenge—as Black women. Moreover, Collins concluded that understanding this knowledge from oppressed groups is important because their experience creates new ways of looking at the circumstances being navigated, and at the conditions necessary to support and evolve human rights and social justice.

Collins’ theory with regard to cultural space for Black women provided an applicable framework for the reflections of deaf participants in this study. Participants described the physical and psychosocial benefits of deaf space in much the same way as Collins discusses space for Black women. Put simply, deaf mentees navigated academia successfully because of the previously subjugated information they gained in labs.
operated by deaf mentors.

**Recommendations**

Findings from this study highlight unique experiences of deaf undergraduates when navigating STEM research environments. The relationship fostered by culturally and linguistically similar mentors, and the characteristics of the spaces these mentors created, can drive recommendations for a number of constituencies who may be working with deaf undergraduates and emerging scientists across the U.S. The constituencies discussed here include hearing and deaf faculty mentors, higher education administrators in both predominantly hearing and deaf institutions, and STEM mentors seeking to promote and encourage future generations of deaf and hearing scientists.

**Recommendations for undergraduate faculty mentors.** The results of this study suggest that achieving access to academic culture and discourse present in hearing academic environments for hearing students is a challenge for students who identify themselves as deaf and use American Sign Language as their primary language. The importance of this access is made clear by the participants in this study. The undergraduate faculty mentor can play a key role in maximizing any student’s access to research related activities, their coursework, and other academic related activities through the guidance and direction they offer. Most deaf students in the U.S. are navigating college campuses that are largely hearing, and therefore may not have immediate access to a deaf mentor (Walter, 2010). Recommendations for both hearing and deaf mentors of deaf students are included in the next two sections.

**Hearing mentors of deaf students.** For those hearing mentors of deaf students, it is recommended that they provide appropriate and quality access services to support deaf
students’ learning experiences in undergraduate research laboratories. For instance, hearing mentors should communicate with the disability office to ensure that deaf students are receiving appropriate accommodations such as having an ASL interpreter to mitigate the cultural and language differences in the lab. For those hearing mentors who are familiar with ASL, it is recommended that they seek resources on how to sign STEM concepts using conceptually accurate ASL. There are resources online that offer different examples of STEM ASL vocabulary (see Appendix J). Hearing mentors could also seek opportunities for ASL-STEM workshops where possible.

Finally, with regard to access services, hearing mentors may want to schedule regular opportunities to gather feedback and ideas from their deaf undergraduates regarding the students’ satisfaction with and ideas about accommodations. Establishing an environment that is welcoming of on-going dialogue and continuous improvement with and for the deaf student is essential for connection and inclusion in these predominantly hearing academic settings. Hearing mentors can and should be not only effective mentors, but also effective allies and advocates in partnership with deaf undergraduates.

Participants in this study recognized that access to the academic culture and discourse present in hearing undergraduate research laboratories, is challenging for deaf students who identify themselves as deaf and use American Sign Language as their primary language. Most traditional research laboratories have been designed, operated, and populated by a predominantly hearing academic community. Design decisions in labs typically pay little or no attention to the establishment of a visually open and accessible space which would promote the deaf researcher’s involvement (Appendix I).
Hearing mentors should consider the “psychology of Deaf space” and make modifications to their lab—where possible—which attend to the visual needs of deaf students. For instance, the hearing mentors could evaluate the design of the lab and make alterations to support increased visual sight lines where possible. Lab stations and work tables could be arranged to allow workers to face one another. Cubicle walls could be either shortened or removed.

In addition, hearing mentors should consider creating or structuring regular pauses in the work flow, holding mini team meetings at different points in a lab process or during a work day in the lab. This creates an opportunity for everyone to have access to information by coming together, visibly seeing one another, reviewing the progress they are making, discussing findings, and brainstorming solutions to challenges they may have. By providing an open and accessible environment—both physically and linguistically—the mentors can offer a model for what it means to embrace both deaf and academic cultures. This model provides deaf students a culturally attentive space which welcomes them and continues to reinforce the message that they can and should find a home in the academic setting.

Additionally, hearing mentors should connect deaf students with deaf academics in a virtual environment, using the deaf academics listserv, as an example. Hearing mentors could also join these listservs. This would provide mentors with a network for assistance and guidance, and help them to remain cognizant of conferences where deaf scholars in their field may be scheduled to present.

Lastly, hearing mentors could identify a deaf scholar in the field and invite that person to campus to share their research with all students and faculty. The hearing faculty
mentor might arrange some time for the deaf scholar to meet with the deaf student one on one, and additionally may want to schedule his/her own one on one time with the scholar. These meetings would give both the deaf student and the hearing mentor an opportunity to discuss additional strategies for their success as student/mentee and mentor.

Participants in this study reported barriers to success in predominantly hearing labs. Hearing mentors in predominantly hearing environments can consider the visual nature of the environment, the access to language and appropriate vocabulary, the feedback of deaf students, and the opportunities which are available to connect deaf students with deaf scholars. Improving the environment for deaf students would help to mitigate the impact of these barriers, and allow for deaf students to benefit from undergraduate research experiences in a hearing environment in a manner more consistent with their hearing peers.

**Deaf mentors of deaf students.** Based on the findings of this study, it is likely that deaf faculty mentors are models for the various strategies outlined above, even though the recommendations are proposed for predominantly hearing environments. It is a reality that deaf individuals often inherit an environment fraught with cultural norms and physical spaces designed by hearing people. Therefore, it is important that deaf mentors review and ensure they are including the recommendations above as they make decisions about the experience and environment they wish to create for their deaf mentees.

Additional recommendations for deaf mentors working with deaf students in a one on one setting are intended to recognize the significance of their role in shaping deaf students’ identities, and ultimately in teaching them *how* to be deaf scientists. From the study narratives, one strategy which supports this process includes inviting mentees into
the broader STEM community. Mentors can do this through allowing mentees to be present for grant meetings or presentations, supporting mentees’ attendance at conferences, and fostering mentees’ interaction with additional deaf scholars through formal and informal opportunities.

Another important finding emphasized the importance of deaf mentors sharing stories of the ways they have navigated the STEM and academic environments as deaf scholars. Finally, the maintenance of high personal expectations for access and high accountability to professional and business norms by mentors each serves to support the adoption of important life skills and lessons for deaf mentees. Providing these foundational structures and networks to deaf mentees is key to supporting the success of these students in STEM fields.

Consistent with the literature on mentoring within minority communities, deaf mentors in this study also identified a responsibility for expanding the next generation of scholars. Most deaf students will not have the opportunity to work directly with a deaf faculty member on their own campus. This next series of recommendations suggests that established deaf scholars focus on generating a national presence to assist deaf mentees, whether on their own campuses or studying in remote locations.

Deaf scholars should consider creating a national coalition. Deaf scholars could create a central online presence for the purpose of creating and sharing resources, developing and informing readers about mentoring strategies and models, educating all faculty about cultural mentoring practices, and helping to standardize and legitimize ASL STEM signs by sharing them virtually. Examples of the kinds of resources to be shared could include informative videos, an interactive series of vlogs, and links to useful
websites.

One component of this online presence could be tailored to serve “mentors of deaf undergraduates” and another to serve “deaf undergraduates” with the focus of the resources in each area appropriately designed to support each constituency. Deaf mentees could be recruited to share successful strategies and experiences which demonstrate the ways hearing and deaf mentors are tailoring their mentoring practices to support their success.

The primary goal of this coalition would be to engage and inspire deaf undergraduates in STEM fields, ultimately growing and fostering an expanding and sustainable deaf scholarly community. A secondary goal would be to contribute to the stores of shared knowledge about mentors’ and mentees’ experiences and strategies. The information could be analyzed and disseminated by this coalition to improve the work of all mentors of deaf students. A coalition of this nature gives mentors the opportunity to create partnerships with one another, which could ultimately lead to the development of new mentoring models better suited for deaf students. This evolving mentoring model for deaf students could continuously be implemented, practiced, and evaluated to ensure that mentors are increasingly successful in preparing deaf students to pursue careers in STEM fields.

The findings from this study suggest a number of strategies and opportunities for deaf mentors and scholars to enhance and expand their impact on deaf undergraduates. Strengthening deaf mentors’ work in individual settings is certainly important to the success of deaf undergraduates on a local level. Expanding the presence and network of resources to mentors and mentees nationally will be essential in generating the deaf
scholarly community described as the dream for many current deaf mentors and scholars in this study.

**Recommendations for higher education administrators.** This study suggests that several opportunities for system change exist for colleges and universities wishing to improve the climate for deaf students. Again, most deaf students in America are studying on predominantly hearing college campuses. The findings from this study can assist with informing adjustments to campus operations at these institutions to support success for both the deaf student and the campus.

Predominantly deaf universities hold a unique opportunity to influence success. This study can help administrators on these campuses attend to their own continuous improvement. Because these institutions are also charged by the Federal government to be national research centers and clearinghouses for best practice, there are additional activities they may adopt to influence change beyond the parameters of their own campuses. Recommendations for both administrators at traditional hearing institutions and administrators in predominantly deaf institutions are included in the next two sections.

**Administrators at traditional hearing institutions.** There are deaf students attending predominantly hearing colleges and universities with few or no deaf peers or deaf faculty members. The findings from this study suggest a series of actions for administrative leaders which could improve the quality of life and success for deaf students on these campuses. Higher education administrators with deaf students attending their university should consider and determine which of the strategies outlined will allow for the most integrated academic experience for the deaf student(s) on their campuses,
and will best support the faculty who are in positions to mentor and serve these students.

Initially, administrators could connect with one or more of the predominantly deaf universities to collect resources and strategies supporting deaf student success at the college level. Leaders may also want to consider modifying the plans of work for faculty supporting deaf students. Modifications could include support for training in the areas of deaf culture, sensitivity, and appropriate use of interpreters and access services, as well as scheduling additional time for the faculty member to engage in the conversations necessary to adequately know and understand the deaf student.

Administrators could identify relevant faculty through the deaf academics listserv to connect with their own faculty, perhaps supporting either live or virtual seminars with relevant department faculty. Seminars could discuss classroom management for inclusion, and department support strategies for success. Additional topics for faculty development could be recommended by the deaf student or deaf scholars from the listserv.

In addition, leaders could require workshops for their disability services staff members on how to hire and effectively work with sign language interpreters. They should also determine if additional access needs will be met for activities outside of the classroom, and then develop and share the system which would allow the deaf student to request and arrange those services. Leaders should also establish mechanisms for receiving reports to maintain an awareness of the effectiveness of their access services in supporting the deaf student.

Leaders in higher education would do well to consider developing and/or reevaluating operational policies and practices on their campuses to increase the chance
for academic success of deaf students. The participants in this study repeatedly emphasized the importance of access to information and a cultural space where they felt at ease with their identity. These environments were especially scarce in predominantly hearing academic communities. To provide better communication access and more sensitive space, administrators should ensure deaf students have ready access to the appropriate services of qualified sign language interpreters. Leaders should also understand and identify a comprehensive plan which supports the perpetual development of deaf cultural competencies by hearing faculty mentors working with deaf students (Appendix J).

To expand the number of deaf faculty members in higher education, administrators need to be strategic in searching for opportunities for deaf faculty to work at their institutions. Based on the annual reports of the two predominantly deaf institutions in this study, there are few deaf faculty members in STEM fields (Thoreau Annual Report 2012, Hawthorne Annual Report, 2011). Administrators should proactively seek to be present in circumstances where appropriate prospects can be found. Leaders could insure university presence at deaf related conferences, or conferences where a number of deaf scholars are in attendance. These would be ideal environments for higher education leaders and faculty member to identify prospective deaf faculty members.

Another approach is to actively identify deaf doctoral and post-doctoral students and build meaningful relationships with them in hopes of recruiting them in the future. Leaders could support post-doctoral fellowships to draw these students to their campuses, and expose them to additional mentoring and support. Expanding a diverse group of deaf
faculty members will continue to awaken the possibilities for deaf undergraduates to consider becoming tomorrow’s deaf scientists.

Most importantly, the leaders must consider how culture influences every deaf student’s experience in higher education. They must understand the ways their campus environments can proximate the physical and emotional deaf space as outlined in the prior recommendations of this section. They must understand that these modifications may require additional resources in the form of time and money, and identify ways to be supportive of finding both. A deaf student enrolling in a hearing institution for college only has a 75% chance of graduating (Stinson & Walter, 1992). If there is to be improvement in student success and in building a national network of deaf scholars, leaders on hearing campuses have a great deal of opportunity, influence, and responsibility.

Administrators at predominantly deaf institutions. In addition to making the improvements which benefit deaf students in college listed above, predominantly deaf institutions have an additional role to play. The study identified a need to improve the pipeline of deaf students graduating from high school and entering college. The national space and prominence deaf universities claim gives them a unique opportunity to support improvement in this area.

Based on the findings in this study, there are several key recommendations which higher education administrators in predominantly deaf environments should take into consideration for improving the pipeline of deaf students to STEM fields. To increase representation of deaf students in higher education, leaders could develop partnerships and agreements with secondary schools to identify deaf students who are interested in
STEM fields. Once identified, deaf institutions could host special weekend open houses focused on STEM departments on their campus. These weekends could include sessions for coaching students and families through the college application process, guiding families with regard to the application of access laws at the college level, and could provide financial aid information and resources.

To expand the pool of prospective deaf students able to consider college, administrators could capitalize on their name recognition and network in the deaf community to establish or expand summer camp programs. Programs exposing deaf youth to STEM fields, and which also include a component for parent workshops about admission to, access in, and the financing of college would serve to strengthen partnerships between secondary schools, students, parents, and colleges. Implementation of these programs or camps could provide hands on experiences in STEM related activities to students, and a necessary primer for parents who may be concerned or confused about any differences in the college admission process because their child is deaf.

The findings of this study indicate deaf faculty members are important and significant figures when deaf students are seeking validation about what they can achieve in the academic arena. Deaf faculty members seem to be able to connect with deaf students in deep and meaningful ways because of their shared social identities and experiences. In addition to the strategies for recruiting and hiring deaf faculty mentioned in the previous section, administrators on predominantly deaf campuses could again capitalize on their unique network, visibility, and draw for deaf scholars looking for a community of deaf scholars and a culturally sensitive environment. Leaders on these
camperus should strategically review their current diversity initiatives on recruiting and hiring underrepresented faculty, to ensure goals remain ambitious with regard to hiring of deaf faculty. Using their national prominence and networks, leaders at predominantly deaf institutions can impact both pipeline initiatives and the expansion of deaf faculty on their campuses, and ultimately, nationally. Both of these are essential to success of deaf undergraduates according to the research and findings identified in this study.

**Recommendations for formal mentors of undergraduate research in STEM laboratories.** This study suggests that laboratory relationships and experiences, which are traditionally expected to be more boundaried in nature to support the production of quality research might benefit from the adoption of a new paradigm. Perhaps a reconsideration of this paradigm to include a more personally and socially connected research, lab, and mentoring experience would be beneficial to all undergraduates. Through these relationships, the laboratory could foster personal and identity development for the emerging scientists in and beyond their research environment. Creating these kinds of mentoring experiences could not only provide a more connected experience for those already interested in STEM fields. These kinds of relationships and this approach could serve to inspire a whole new group of students to seek majors and careers in STEM disciplines. The objective nature of STEM fields can be something that either serves to intimidate or distance some students who possess the intellectual ability to succeed, but desire a more humanistic experience to better connect with and understand their work environment.

To exclude or boundary personal experiences denies these undergraduates an exposure to mentors and successful navigation strategies which, if present, could be the
draw which prompts longer term interest. While it is true a hearing student is likely to have had better access to life capital information, it is unlikely that all hearing undergraduates in the STEM arena would have had valuable navigational and personal information about STEM success available to them prior their experience in research with their mentor. Based on this study finding, it is recommended that mentors never underestimate the need for, and the value of sharing time and personal narrative in generating a successful mentoring relationship. According to the findings of this study, mentors’ attention and support for a mentee’s identity development and navigation as an emerging scientist would promote both interest and success in STEM fields.

Limitations of the Study

There are limitations in this study that are important to recognize. For instance, the study had a small number of participants, and was conducted at two higher education institutions which are not representative of most colleges and universities and undergraduate research laboratories where deaf students are enrolled. Another limitation is the lack of ethnic and racial diversity among participants.

The study was designed with the intention of including at least one African American, Latino American, and Native American (AALANA) mentee and mentor. The presumption was that the more diverse the participant group, the more readily the study would lead to a greater understanding of the ways the intersectionality of race, gender and disability contribute to the nature of the mentoring relationship. Among mentees only one participating mentee was identified as a member of the AALANA community. All mentors in this study self reported as male and Caucasian. The lack of diversity prevented the identification of any findings or recommendations regarding the intended
intersectionality.

Finally, there are theoretical limitations. Collins’ (2000) Black Feminist theory only focuses on the experience of Black women in generating a cultural space to exchange subjugated knowledge as well as to empower each other in the context of oppression. This theory explains the process of identifying and exchanging subjugated knowledge for a community who are largely born in to families with individuals sharing their race and gender. Because the majority of deaf individuals come from hearing families, a different theoretical framework which considers the ways a lack of shared family background and characteristics influences the significance of same background adults and role models could be useful for framing similar future studies.

**Recommendations for Future Research**

In response to the limitations, there are several recommendations for future research which emerged from the study. A future study could provide more robust data by including more participants. The composition of the participants could be defined to intentionally include women and more AALANA individuals, to generate a greater understanding of the intersectionality and influence of race, gender, and ethnicity. In addition, future study could capture mentoring dyads with hearing mentors and deaf mentees to understand how hearing mentors support deaf students’ success in STEM fields at predominantly hearing institutions.

A study using focus groups to gather information about the experiences of deaf mentoring dyads could be built using information and themes from this study. In addition to capitalizing on what has been learned here, creating focus groups for deaf participants may allow more dialogue and interaction, with participants adding to each others’
insights, and resulting in a richer narrative. Deaf community members are recognized as a collectivistic group valuing cohesion and the open exchange of information with each other (Padden & Humphries, 2005), making focus groups an interesting methodological strategy for this community.

Theoretical frameworks like social identity theory and deaf epistemology could be considered for use in future studies. These theories offer alternative lenses in consideration of the differences between deaf individuals and the Black women at the center of Collins’ (2000) theory. In spite of the limitations, this study remains valuable for informing higher education regarding the importance of matching mentoring dyads and the growth of individuals entering STEM fields.

**Conclusions**

In the United States, fostering growth and success in the study of STEM fields is a national priority. Mentored undergraduate research experiences for deaf and other underrepresented students seem to provide an environment with the potential for increasing retention, persistence, academic progress, and degree attainment in STEM fields (Boyle & Boice, 1998; Lopatto, 2003; Nagda, et al., 1998). Studies also have shown that matching mentorships based on same social characteristics are likely to enhance the contributions to students’ preparation for successful navigation of the STEM academic environment (Blake-Beard, Bayne, Crosby, & Muller, 2011; Dingus, 2008; Ragins, 2007; Whelley, et al., 2003).

However, the understanding of these matching mentorship experiences is limited for all underrepresented groups. This is particularly challenging when seeking to understand how cultural and linguistic similarities influence deaf students’ aspirations.
and interest in pursuing in STEM careers. To address the gap in this area, the present study used a qualitative phenomenological research approach to explore the nature of deaf mentoring dyads and the role of subjugated knowledge in the success of deaf students pursuing majors, research, and careers centered in STEM study. This study was considered through the lens of Black Feminist theory (Collins, 2000), and supported the theoretical supposition that cultural space is critical for minority students to exchange subjugated knowledge on how to be a minority individual and successfully navigate in a majority circumstance.

Guided by research questions including: How did deaf mentoring dyads benefit faculty mentors and undergraduate mentees pursuing careers in the STEM field? How did deaf mentees who have deaf mentors describe their undergraduate mentoring experience? And, finally, the study considered the nature of subjugated knowledge shared between deaf mentors and mentees? Data that was collected included interviews with deaf participating mentors and mentees, videos of the interviews, documents, and demographic information revealed the emergent themes: The Psychology of Deaf Space; How to Be a Deaf Scientist: Building Navigational Capital; and Deaf Role Models: Transformative Experiences.

The first theme, the Psychology of Deaf Space, revealed that deaf space provides the most comfortable and accessible environment for deaf students to engage and succeed as STEM researchers. The second theme, How to Be a Deaf Scientist: Building Navigational Capital, described the intentional strategies mentors employ in building deaf students’ navigational stores for success in STEM communities that are not likely to be designed to naturally support them either culturally or linguistically The final theme;
Deaf Role Models: Transformative Experiences, reported that mentors a consistent and almost instinctual desire to invest in the pipeline of the next generation of deaf scholars by accepting a duty to serve as a role model.

The findings of this study offer a response to the national call to increase STEM study and success. Using the series of key instructions and implications, scholar-mentors can develop an enhanced or alternative model of support. While the findings are fundamentally pertinent to undergraduate faculty members and higher education administrators serving and seeking to increase the number of deaf students in STEM careers on their campuses, there are broader application possibilities. As important as their support of deaf students, the findings suggest that an environment which promotes comfort with cultural identity, language, and inclusion offers a unique and alternative model for the general scientific community seeking to increase and support STEM undergraduates. For deaf and hearing scholars mentoring deaf students, and for all STEM scientists working with the broad community of emerging scholars, there is much to be learned from the success of deaf dyads, and much to be gained for a national agenda seeking growth in STEM success.
References


Hickson, M. G. (2002). What role does the race of professors have on the retention of students attending historically black colleges and universities? *Education, 123*, 186-190.


Seidel, J. V. (1998) Qualitative Data Analysis. Qualis Research, Qualis@qualisresearch.com


Appendix A

St. John Fisher College/Rochester Institute of Technology/Gallaudet University

INFORMED CONSENT FORM

Title of the Study: Nature of Deaf Mentoring Dyad: Role of Subjugated Knowledge

Name of the researcher: Jason Listman, a doctoral candidate at St. John Fisher, Executive Leadership Program.

Faculty Supervisor: Dr. Jeannine Dingus-Eason. Phone for further information: 585-385-8002.

Purpose of the Study
The purpose of this study is to explore the nature of deaf mentoring dyads and the role of indigenous knowledge. The researcher will conduct two interviews. The first interview will be with you only for approximately 60 minutes. The second interview will include both mentor and mentee for approximately 60 minutes. During the first interview, I will be asking you about your experiences in a mentoring dyad such as how do you both support each other in research, how do you navigate in academia as a deaf person, and how you share set of knowledge within a dyadic relationship. During the second interview, I will be interviewing both the mentor and the mentee to follow-up and ask more questions about the mentoring relationship.

Approval of study: This study has been reviewed and approved by the St. John Fisher College and Rochester Institute of Technology Institutional Review Boards (IRBs).

Place of study: Rochester Institute of Technology and Gallaudet University

Videotape Consent
The interviews will be video recorded so I will have a record to help me remember what participants said. I will also write down things that were said at the meetings. Personal information, such as names, will not be identified in these records. Your videos may be reviewed by my selected research assistant to transcribe the data. In regard to providing consent to access to videotaped record, you may change your mind at any time by contacting the researcher listed above. By signing this form, you acknowledge and give us permission to include your interview in the video recording session for our study.

Confidentiality
I will keep your personal information confidential. The participants will be granted pseudo names to protect you. If results of this research are published or presented in a talk, information that identifies you will not be used. The transcription of the information from the recording of the interview meeting will be stored on a secure computer. Your name and other information that could identify you will not be part of the computer record made from the video. The video will be destroyed after the termination of this project. The computer record of the interview meeting will
be retained for up to 2 years after completion of the project and then be destroyed. All other personal information collected for research purposes will be kept in locked cabinets in the research office until the project is finished, including this consent form.

**Risks and Benefits**
I don’t anticipate any risks, however since this study requires a small sample, I can’t guarantee that you will not be identified. Problems involving the identification of participants, recruitment efforts or data collection are not expected.

**Voluntary Participation**
Participation in this study is your choice and entirely voluntary. You are free to decline your participation for any reason. If you do participate and then decide you want to stop during the study, your decision will be respected. If you withdraw from the research study, all of your personal information and links to personal information will be destroyed. If this happens, no one will be able to identify you by looking at the research data. Your academic record or employment will not be impact by non-participation in this study.

**Compensation**
You will be paid with a gift certification for your participation in this study.

**Contact Person**
If you want more information about this study, please email Mr. Listman at jdlnss@rit.edu. If you have any further questions regarding this study, please contact the dissertation chairperson, listed above. If you have any questions regarding human subject’s rights, please contact Heather Foti, Associate Director of Human Subject Research at RIT, hmsrs@rit.edu, and Eileen Merges, Director of Human Subjects Research at St. John Fisher College, emerges@sjfc.edu.

**Consent**
I have read this permission form and have had the opportunity to ask questions. I have been given answers to my questions. I understand that the person listed above will answer any questions I have about the study or about participants’ rights. I have received a signed copy of this consent form.

Participant’s signature: ____________________________ Date: ____________________________

Participant’s print name: ____________________________ Date: ____________________________

Investigator’s signature: ____________________________ Date: ____________________________
Appendix B

Recruitment Email Template for the Mentee

Dear Name,

Hello, I would like to invite you to consider participating in a study being conducted by Jason Listman, a doctoral candidate at St. John Fisher College. Study seeks to explore the experiences of being in a mentoring relationship, specifically between deaf faculty members and deaf undergraduate students in Science, Technology, Engineering, and Mathematics fields. The title of this dissertation research study is: *Nature of Deaf Mentoring Dyads: Role of Subjugated Knowledge*.

Participation benefits include contributing to an understanding of the topic, adding knowledge, and updating research literature. Compensation will include a gift certification to a restaurant.

If you decide to participate in this study, please respond to this email with your consent so we can schedule an interview via email.

Your participation will include:

- Completion of the informed consent and demographic form at time of the interview
- One hour of one-on-one interview (videotaped)
- One hour of a dyad interview (yourself and your selected mentor) (videotaped)

Criteria to participate in this study include:

- Deaf
- Use ASL
- A current or former undergraduate student in STEM fields,
- Experienced mentoring relationship with a deaf faculty member.

The location, date, and time for the interview will be decided via availabilities.

Your participation in this study is completely voluntary and you will have the option of terminating your participation at any time without any penalty. Additionally, your participation will be confidential.

During all aspects of the study, your identity will be protected with use of pseudonyms. Your institution will also be assigned a pseudonym as further effort of protecting privacy.
All documents and videos collected or analyzed for this study will be kept in a secured locked file cabinet that only researcher has access to. These documents and videos will be maintained for two years after the completion of the study after which time, all information will be destroyed by erasure and shredding disposal.

For further information about the study or your role in it, you may contact: Jason Listman via email at jdlnss@rit.edu or my Doctoral Advisor, Dr. Jeannine Dingus-Eason at jdingus@sjfc.edu. The research study is reviewed and approved by St. John Fisher College’s and Rochester Institute of Technology IRB Review Committees.

I look forward to your participation in this study!

Jason Listman
Appendix C

Recruitment Email Template for the Mentors

Dear Name,

Hello, I would like to invite you to consider participating in a study being conducted by Jason Listman, a doctoral candidate at St. John Fisher College. Study seeks to explore the experiences of being in a mentoring relationship, specifically between deaf faculty members and deaf undergraduate students in Science, Technology, Engineering, and Mathematics fields. The title of this dissertation research study is: *Nature of Deaf Mentoring Dyads: Role of Subjugated Knowledge.*

Participation benefits include contributing to an understanding of the topic, adding knowledge, and updating research literature. Compensation will include a gift certificate to a restaurant.

If you decide to participate in this study, please respond to this email with your consent so we can schedule an interview via email.

Your participation will include:

- Completion of the informed consent and demographic form at time of the interview
- One hour of one-on-one interview (videotaped)
- One hour of a dyad interview (yourself and your selected mentee) (videotaped)

Criteria to participate in this study include:

- Deaf
- Use ASL
- Obtained a master or doctoral degree in STEM field.
- Has mentored deaf undergraduate student in STEM field.
- Worked at your workplace for more than one year.

The location, date, and time for the interview will be decided via availabilities.

Your participation in this study is completely voluntary and you will have the option of terminating your participation at any time without any penalty. Additionally, your participation will be confidential.

During all aspects of the study, your identity will be protected with use of pseudonyms.
Your institution will also be assigned a pseudonym as further effort of protecting privacy.

All documents and videos collected or analyzed for this study will be kept in a secured locked file cabinet that only researcher has access to. These documents and videos will be maintained for two years after the completion of the study after which time, all information will be destroyed by erasure and shredding disposal.

For further information about the study or your role in it, you may contact: Jason Listman via email at jdlnss@rit.edu or my Doctoral Advisor, Dr. Jeannine Dingus-Eason at jdingus@sjfc.edu. The research study is reviewed and approved by St. John Fisher College’s and Rochester Institute of Technology IRB Review Committees. I look forward to your participation in this study!

Jason Listman
Appendix D

Mentors’ Background Questionnaire

Pseudonym: _______________

1. Age: _______________

2. Please indicate your gender:
   a. Male
   b. Female

3. Please indicate your race:
   a. Asian / Asian Pacific Islander
   b. American Indian / Alaskan Native
   c. Hispanic / Latino
   d. African American (Black, Afro-Caribbean)
   e. Caucasian (White)
   f. Biracial / Multiracial
   g. Other: _____________________

4. Please indicate your identity:
   a. Deaf
   b. Hard of Hearing

5. Please indicate your academic rank:
   a. Professor
   b. Associate Professor
   c. Assistant Professor
   d. Lecturer
6. Please indicate a highest degree you have earned:
   a. Bachelor’s
   b. Master’s
   c. J. D.
   d. M.D.
   e. Ed.D.
   f. Ph.D.
   g. Other degree

7. List major research or activity you are doing research in:

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

8. K-12 Educational Background
   a. Mainstream
      i. Yes
      ii. No
   b. If yes, how many years: ________
   c. Residential School
      i. Yes
      ii. No
d. If yes, how many years: ________

e. Others: _________________________

   i. How many years: ________

9. Please indicate your parents’ hearing status:

   a. Mother:       Deaf   Hard of Hearing   Hearing

   b. Father:       Deaf   Hard of Hearing   Hearing
Appendix E

Mentees’ Background Questionnaire

Pseudonym: _______________

1. Age: ____________

2. Please indicate your gender:
   a. Female
   b. Male

3. Please indicate your race:
   a. Asian / Asian Pacific Islander
   b. American Indian / Alaskan Native
   c. Hispanic / Latino
   d. African American (Black, Afro-Caribbean)
   e. Caucasian (White)
   f. Biracial / Multiracial
   g. Other: _____________________

4. Please indicate your identity:
   a. Deaf
b. Hard of Hearing

5. Please indicate year of enrollment ____________________________

6. Mark the item that best describes your undergraduate grade point average:
   a. A (3.75-4.0)
   b. A- (3.25-3.74)
   c. B (2.75-3.24)
   d. B- - C+ (2.25-2.74)
   e. C (1.75-2.24)
   f. C- or less (below 1.75)

7. Please indicate your primary and secondary undergraduate majors (if you only have one major, indicate your primary major):
   a. Primary: _____________________________________________
   b. Secondary: ___________________________________________

8. List major research or activity you are doing research in:
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________
   __________________________________________________________________

9. K-12 Educational Background
   a. Mainstream
      i. Yes
ii. No

b. If yes, how many years: ________

c. Residential School

   i. Yes

   ii. No.

d. If yes, how many years: ________

e. Others: _________________________

   i. How many years: ________

10. Please indicate your parents’ hearing status:

   a. Mother:   Deaf   Hard of Hearing   Hearing

   b. Father:   Deaf   Hard of Hearing   Hearing
Appendix F

Guiding Individual Interview Questions for the Mentors

1. How did you become acquainted or paired with this mentee?

2. How often and for how long do you meet your mentee?

3. Can you describe your initial “getting to know you “meetings or were you very familiar with the student before the mentoring process began?

4. In subsequent mentoring meetings, what kinds of issues typically arise or are discussed?

5. As a deaf mentor, you have some experiences that are peculiar to deaf people. How do you share this kind of knowledge/experiences with your mentee?

6. Do you think that sharing such knowledge will help your mentee to be better prepared for life and work environments?

7. Describe your experiences in the mentoring relationship.

8. What aspirations do you have for your mentee’s academic future in the STEM field?

9. Have you had mentees that you can specifically claim that your advice and insights as a deaf mentor have helped them better navigate the academy?
Appendix G

Guiding Individual Interview Questions for the Mentees

1. How did you become acquainted or paired with a mentor?

2. Can you describe your initial experience during the mentoring process? What were your initial meetings like?

3. How often and for how long does each meeting typically last?

4. How would you describe your interaction with your mentor (Did you look forward to meeting with your mentor? If so, explain why you look forward to the meetings, if not explain).

5. What kinds of topic do you discuss during such meetings and what did you take away from such discussions?

6. In what ways did your mentoring experience help you to navigate your undergraduate studies?

7. As a student in the STEM field, what specific help do you get from your mentor?

8. What are your future educational aspirations? Are you going to enroll in graduate studies? If so, why do you think it is necessary to go further in your education and if not, why not?

9. How does your mentoring experience affect your overall undergraduate experience?

10. What specific benefits do you think accrues from having a deaf mentor?

11. If your mentor is someone who is not deaf, how do you envisage the dynamics in a mentoring relationship? Would you have preferred it?
12. Perhaps a deaf mentor knows something about life and deaf people and can advise you better than a non-deaf mentor. Would you agree with this statement? Can you explain why this may be so?
Appendix H

Dyad Interview Protocol

1. Review the interview videos and field notes from both participating mentors and mentees.
2. Identify the areas where there was a need more clarification from either or both of the participants.
3. Create follow-up questions to obtain richer information about the mentoring relationship and the role of subjugated knowledge.
4. Contact both the participating mentors and mentees for a dyad interview to obtain more information about the mentoring experiences
Appendix I

Examples of current trends in laboratory design with design firms designated:

Anachemia Mining Lab Design  
Bio Asset Design 1  
Bio Asset Design 2

Lab Design United Design  
Labconco Design  
Lab Design and Construction Design 1

Lab Design and Construction Design 2
Architectural Renderings for Lab Design:
Appendix J

Resources for Mentors & Mentees

ASL-STEM Forum. This is a resource website for American Sign Language users to support the establishment of consistent and appropriate signs for STEM concepts. The goal for this website is to draw educators, interpreters, captioners, students, and others to contribute to, learn from and build technical vocabulary in ASL.

Link: http://aslstem.cs.washington.edu/

Deaf TEC: Technological Education Center for Deaf and Hard-of-Hearing Students. This center has a website that provides resources for high schools and community colleges that educate deaf and hard-of-hearing students in STEM related programs. There are also resources for employers hiring deaf and hard-of-hearing individuals.

Link: www.deaftec.org

ClassACT. This is a resource site designed to support instructors and staff who work with deaf and hard of hearing students in all levels of mainstreamed academic environments. The website provides information to support communication strategies, support services, and the classroom environment.

The goal of ClassACT is to improve existing teaching practices by providing access to best practices for the instruction of deaf and hard-of-hearing students in mainstreamed classes.
Link: www.deaftec.org/classact

The Center on Access Technology. This is a resource site sharing information about ways to improve educational opportunities in the classroom using access technologies, mobile technologies, and audio and sound technologies.

Link: http://www.ntid.rit.edu/cat/resources