Preparing Noyce Scholars in the Rocky Mountain West to Teach Mathematics and Science in Rural Schools

Jacqueline Leonard[1], Saman Aryana[1], Joy B. Johnson[1], & Monica Mitchell[2]
University of Wyoming[1],
MERAssociates (Vienna, VA)[2]

Using Steele's work on stereotype threat among undergraduate students, we are conducting a study to reduce barriers and mitigate factors that may prevent students of color from completing dual majors in STEM and elementary education. This paper focuses on strategies for recruiting and retaining students of color into the Wyoming Interns to Teacher Scholars (WITS) Noyce program through formal and informal mentoring and summer internships. Drawing from the extant literature on mentoring and mitigating stereotype threat, we strategize about how to build programs that promote student resilience, academic success, and communities of trust.

Introduction

The **Wyoming Interns to Teacher Scholars (WITS**) program at the University of Wyoming (UW) is positioned to grow elementary teachers' mathematics and science content knowledge and strengthen their capacity to sustain STEM teaching and learning in rural schools through place-based education (Gruenewald, 2003) and culturally relevant pedagogy (Ladson-Billings, 2009; Leonard, 2008). In order to prepare and support the training of **30 total participants**, the WITS program consists of four components: (1) early recruitment activities with parents and students at regional high schools; (2) training and summer research internships during the sophomore year and scholarship support in the junior, senior, and fifth year of study; (3) mathematics tutoring and mentoring activities that include seminars and retreats with STEM professionals, elders, and community leaders throughout the program; and (4) continued support through professional learning communities (PLCs) and online focus groups (e.g., **blogs** and **Blackboard**) during student teaching.

Wyoming is the ninth largest state in the U.S. geographically, but it has the lowest population of any state with an estimated **582,658 residents**, or 5.8 people per square mile (U.S. Census Bureau, 2014). As such, many of the districts in the state (with the exception of Albany, Laramie, Natrona, and Sheridan) are rural. There are **48 school districts** in Wyoming with a teacher workforce of **7,115** and student enrollment of **89,009 children**. However, enrollment is expected to rise as the number of children under the age of five increased from 31,578 (6.3%) in 2003 to 38,455 (6.6%) in 2013 (U.S. Census, 2014). Thus, new schools and new teachers will be needed in this decade and decades to come.

The **primary goal** of the WITS program is to **recruit and retain diverse teachers** with a background in STEM in order to **increase the number of highly qualified** teachers of mathematics and science who are committed to serving high-need students in rural towns in Wyoming and beyond. The teacher workforce in Wyoming is largely white and female, mirroring the demographics in the United States. Little and Bartlett (2010) describe this workforce as bimodal in terms of age as young (generation Y) and white-haired (Generation X), white women teach primarily at the elementary level. African Americans and Latin@s are underrepresented in the teacher workforce along with immigrants and indigenous teachers of color (Little & Bartlett, 2010). As a result, STEM fields fail to benefit from their potential contributions and alternative perspectives as minority scholars and educators.

Job-related factors that contribute to attrition among all teachers include high-stakes testing, retrenchment of tenure, and increased pressure to improve student outcomes (Moore, 2012). Factors that contributed to fewer minority teachers in the profession have been attributed to inadequate preparation for college (Irvine, 1988), standardized testing for teachers (Leonard & Martin, 2013), and increased access and opportunity to pursue other professional careers (Madkins, 2011). The WITS program is designed as a model in the Rocky Mountain West to study and mitigate factors that deter and inhibit undergraduate students of color from entering STEM and STEM teaching. Placing content specialists who are teachers of color in elementary schools holds great promise for improving STEM education, increasing STEM interest in primary grades, and equipping underrepresented students to persist in STEM content as they progress to middle and high school. Studying barriers such as stereotype threat and mitigating factors by establishing mentoring programs to improve the recruitment and retention of underrepresented minority teachers in Wyoming will add to the literature base.

Rationale

When it comes to mitigating factors that deter students from pursuing STEM and STEM education, the notion of mathematics as a gatekeeper emerges. In order to do well in science, technology, and engineering, students must be literate and knowledgeable of mathematics—calculus in particular. However, school mathematics has traditionally been used as a means to stratify students (Martin, Gholson, & Leonard, 2010) and inadvertently steer underrepresented students away from STEM and STEM-related careers, including STEM teaching. According to Martin et al. (2010), research typically does not focus on "issues of identity, language, power, racialization, and socialization" in mathematics (p. 15). However, we must be cognizant of these issues and address them in programs that aim to recruit and retain students of color in STEM who have been largely underserved in K-12 schools. Efforts to mitigate factors that threaten the recruitment and retention of undergraduate students of color into STEM and STEM-related fields must include scaffolds to enhance their understanding of advanced mathematics. Furthermore, prospective STEM teachers must also be aware of their own mathematics identity as well as engage the children they intend to teach in ways that value their history, community, and place in order to develop mathematics identity in their students.

In the WITS program, we will develop **one-on-one and group mentorship programs** with the aim of creating an encouraging and rewarding environment for STEM undergraduate students. These programs will work toward mitigating systematic disadvantages and boosting self-efficacy, particularly in STEM education. Since stereotypes are systematic and institutional, individuals are often not fully aware of their power. An important first step will be the **formation of support groups** where students share their experiences and bring awareness to the harmful impacts of deeply entrenched biases. A crucial aspect of alleviating the impact of discrimination and prejudice is acknowledging it in institutional spaces and recognizing negative feelings that may result from long-term exposure to such situations. The support groups will create a safe and supportive environment for students to explore these feelings and mitigate their effect. Acknowledging stereotype threats and discussing their impact will help the students to actively combat these stereotypes and to reshape their self-image. The one-on-one mentorship will increase visibility of and access to successful minority scholars in STEM fields (e.g., National Association of Black Engineers, Society of Hispanic Professionals and Engineers, etc.). Such counternarratives will help students become more resilient and able to overcome obstacles. Participants will learn to see intelligence and efficacy as malleable, which require attention and nurturing in order to develop, grow, and expand.

The mentorship program will be an experiential learning process that will build cohesiveness in each cohort. It will cultivate peer-to-peer mentorship and build an additional layer of support for the students from STEM faculty and retired teachers to help mitigate the effects of stereotype threat and improve their academic performance. The program strives to develop a culture of mutual understanding, respect, and mentorship among the students that will extend beyond their current education and will build the foundation for improved STEM programs in Wyoming and elsewhere. The tutoring program will also provide the mathematics support needed for success in advanced mathematics and science content courses.

Our contribution to research and practice is empowering a cadre of elementary teachers with content, cultural, and place-based expertise. We will recruit, support, and prepare a diverse group of STEM majors who are more likely to have interest in teaching in high-need school districts, given characteristics of affinity with these districts (Holloway, 2002; Moore, 2012). We will specifically, target underrepresented minorities from indigenous communities in Riverton and Lander, Wyoming, which are near the Wind River Reservation, and African Americans and Latin@s from nearby Denver, Colorado. In order to prepare this cadre of professionals, we make equity "the central issue" in STEM education (Confrey, 2010) to eliminate deficit-based theories and hegemonic practices that have been pervasive in rural and poor communities of color. To address equity in this broad sense, we will provide WITS scholars with seminars to help them understand the systemic issues and shortcomings of the educational system at large "to provide fair and equal opportunities for large segments of the population" (Confrey, 2010, p. 26). Although academic success is predicated upon teachers having a high level of content and pedagogical content knowledge, learning in mathematics classrooms must be dialogic and include all students as partners in their own learning (Confrey, 2010). Thus, we will employ strategies in the WITS program that will arm elementary teacher candidates with strategies that inhibit their own learning such as racial micro-aggression and stereotype threat.

Literature Review

Underrepresented minority groups are disenfranchised by inadequate support systems and face explicit and implicit biases that negatively affect their academic performance, particularly in high-status courses like mathematics and science (Martin, Gholson & Leonard, 2010; McGee 2013). Stereotype threat results from negative perceptions regarding an individual's social group and often acts as limiting barriers for students in their academic endeavors (Block et al., 2011; Steele, 1997). This effect is especially magnified in engineering and science, which require years of rigorous training. In the case of underrepresented minority students, however, stereotype threat is often compounded by other factors, such as lack of adequate preparation for rigorous pursuit of mathematics and science, lack of supportive social networks that encourage students in their studies, and a systematic lack of financial resources. These various factors create a vicious cycle that denies generations of minority students the opportunity to pursue careers in mathematics and science and to realize potential social and economic upward mobility.

Claude Steele (2010) explained how contextual cues, such as being in an environment where there are few students or faculty of color, or where the curriculum marginalizes the experiences of students of color, are enough to trigger a stereotype threat that undermines performance. Steele (2010) contends that African American student underperformance is a national phenomenon that cuts across the curriculum but is especially prevalent in mathematics. Other groups experiencing this phenomenon include Latin@s, Native Americans, and women in advanced college mathematics classes and other courses. Steele suggests that small, feasible interventions can reduce these threats and dramatically narrow racial and gender achievement gaps. He offers practices that educators can employ to help neutralize these threats. Examples include facilitating faculty-to-student or student-to-student mentoring and cross-racial interactions.

Mentoring programs have become a vehicle to support the recruitment and retention minority students in higher education (Strayhorn & Terrell, 2007) and can be used to mitigate stereotype threat. However, all mentoring programs are not equal or focused on issues specific to African American, Latin@, and Native American students. Mentoring programs may be informal or formal as well as university or nationally focused. These informal or formal programs may include faculty-student mentoring, faculty-faculty mentoring, professional-student mentoring, and peer mentoring (Sandford, Armour, & Stanton, 2010; Strayhorn & Terrell, 2007). However, research findings reveal mentoring programs that lack clear goals and objectives and focus merely upon building informal relationships are less effective (Sandford et al., 2010). Strayhorn and Terrell (2007) found Black students rated mentoring experiences positively when they were connected to research-focused opportunities. Moreover, activities that involve the participants in some kind of physical activity that is interactive can provide benefits for both mentors and mentees (Sandford et al., 2010). In the WITS program, we intend to link faculty to an outdoor field-based internship to develop faculty-student mentoring. We also intend to pair students in peer-peer mentoring relationships to help them to build a sense of belonging (Ek, Cerecer, Alanis, & Rodriguez, 2010). Peer mentors can develop the following attributes: competence, confidence, connection, character, caring, (Lerner, Alberts, Jelicic, & Smith, 2006) and contribution (Karcher et al., 2010). Finally, professional mentoring is critical to providing a source of apprenticeship to help teacher candidates understand the role of teaching and job responsibilities. Thus, WITS scholars will also participate in professional-student mentoring (see Figure 1). Through these three types of mentoring experiences and academic and financial support, we will recruit and retain 8-10 WITS participants as dual STEM and elementary majors per year.

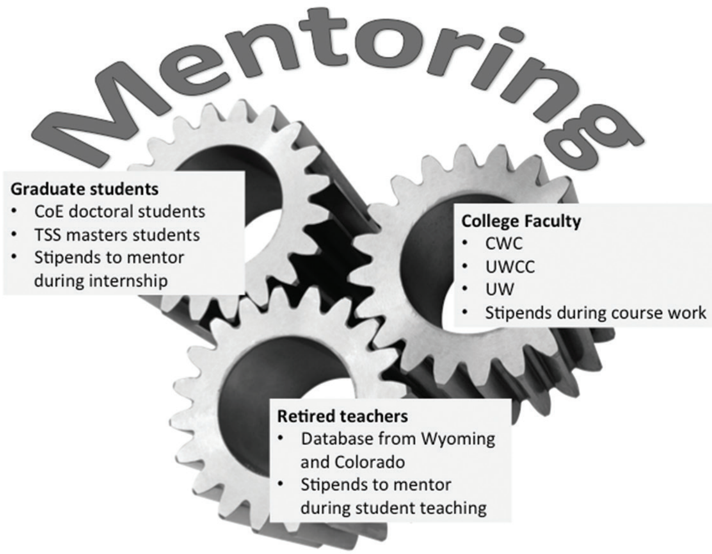

Figure 1. Mentoring model

Theoretical Framework

The theoretical framework that guides the WITS program is self-efficacy theory and the constructs are teacher efficacy and place-based education. Bandura (1977) developed what is now known as self-efficacy theory, which connects the predictive value of an event's success to the confidence that one has to perform it. Efficacy beliefs have tremendous influence over the course of action individuals may take, the amount of effort they will expend, how long they will persevere when challenged, how much stress they will experience, and the level of success they will reach (Bandura, 1997). Bandura identified two factors that affect teacher efficacy: personal efficacy and outcome expectancy. When applied to teaching, personal self-efficacy is defined as perceived judgment about one's ability to teach (Newton, Leonard, Evans, & Eastburn, 2012). Outcome expectancy deals with teacher perceptions of students' ability to learn what is taught. Additionally, Bandura (1997) asserted that there are four factors that influence efficacy beliefs: master experiences, vicarious experiences, verbal persuasion, and affective states. We will address each of these sources of efficacy beliefs through internships/coursework (mastery), seminars/conferences (vicarious), mentoring (persuasion), and mathematics tutoring/support groups (affective). Results of previous research have revealed teacher efficacy in mathematics and science is malleable among pre-service elementary teachers (Leonard, Boakes, & Moore, 2009; Newton et al., 2012).

In addition to teacher efficacy, another construct that undergirds the WITS program is **place-based education**. Placed-based education (PBE) is experiencing resurgence in U.S. schools as a supplement to traditional instruction (Aikenhead, Calabrese Barton, & Chinn, 2006; Akom, 2011; hooks, 2009). PBE can be traced to Dewey (1916) who contended that the experience students bring from out-of-school settings (i.e., place) should be incorporated into meaningful classroom activities (Long, 2009). According to Gruenewald (2003), "place matters to educators, students, and citizens in tangible ways that include providing teachers and students with 'firsthand experience' to link local contexts to learning environments in order to understand sociopolitical processes and shape what happens in the local community"(p. 620). Thus, place and culture are intertwined such that "to live is to live locally, and to know is first of all to know the places one is in" (Casey, 1996, p. 18). Through place, students learn about how the world functions and how their lives fit into the spaces they occupy, which can reinforce motivational ideas such as belonging, reclaiming space, and real-world relevance (Gruenewald, 2003; hooks, 2009). Wyoming's national parks (i.e., Grand Teton and Yellowstone) as well as its wildlife, geysers, and dinosaur fossils provide rich place-based contexts that can be incorporated into informal and formal learning environments.

While no single theory of place exists, place-based practices can be connected to experiential learning, outdoor education, indigenous education, environmental and ecological education, multicultural education, and other approaches that value specific places, locales, and regions where people live and work (Gruenewald, 2003). Underlying these approaches is the notion that pedagogical experiences should be connected to students' lives in meaningful ways (Gay, 2000). Science camps provide a place-based context for children and youth to develop "cognitive abilities to engage in STEM content and problem solving activities" (DeJarnette, 2012, p. 80). However, like other critical pedagogies, many teachers are at a loss regarding how to implement place-based pedagogy in everyday classrooms, especially in mathematics classrooms. We will provide WITS participants with rich experiences via authentic summer research internships to build a foundation to teach place-based mathematics and science education in high-need elementary schools.

The Wyoming Interns to Teacher Scholars' Study

Mathematics tutoring undergirds the WITS program. Success in mathematics coursework is critical not only for mathematics majors, but for engineering and science majors as well. Mathematics identity is formed by a belief in one's ability to do mathematics as well as the motivation and persistence to seek mathematics knowledge (Martin, 2000). There are times when underrepresented students are just not sure that they have done their homework correctly or may have a question about a problem and are too embarrassed to ask questions in the classroom because of stereotype threat. The WITS program will provide mathematics tutoring free of charge for WITS participants. Graduate assistants will be paid stipends to serve as mathematics tutors, offering **face-to-face** tutoring during designated hours, as well as through **telephone hotlines** and **online assistance.**

The following research questions are addressed in the WITS program to study recruitment and retention issues in STEM education:

- What are the barriers to success and mitigating factors for underrepresented minority STEM majors in the WITS program?
- What types of academic support are most effective in alleviating stereotype threat?
- How did the summer research internship influence WITS participants' teacher efficacy and retention in STEM?
- How did the tutoring/mentoring activities provided throughout the WITS program impact Noyce Scholars' teacher efficacy and retention?

Methods

Mixed-methods will be employed to collect and analyze data in this study. Quanti-tative methods will be used to measure change in WITS participants' perceptions of stereotype threat as well as their perceived teacher efficacy in science and mathematics teaching. We will use the Social Identities and Attitudes Scale (SIAS) to measure the degree to which participants are susceptibility to stereotype threat (Picho & Brown, 2011). Additionally, we will use the Science Teaching Efficacy Belief Instrument (STEBI, Enochs & Riggs, 1990) and the Mathematics Teaching Efficacy Belief Instrument (MTEBI, Enochs, Riggs, & Huinker, 2000) as pre-post measures to determine changes in teacher efficacy belief overtime. Qualitative methods will also be used to gather data from field notes, teacher journals, and focus group interviews to determine the impact of the summer internship and mentoring/tutoring programs on retention in the WITS program.

Significance of the Study

The WITS program develops a model that can be replicated in the Rocky Mountain West and elsewhere to address the recruitment and retention of STEM professionals of color, particularly in the education workforce. While the program is in the initial stage of recruiting, responses to our model of building communities of trust and empowerment, managing stereotype threat, and promoting mentoring relationships set us apart from other programs. The findings are mixed concerning the impact that peer-mentoring programs have on mentees as well as the mentors themselves. We engage in social justice by making equity central and by becoming an agency of transformation as we endeavor to change the educational landscape for K-6 students of color by preparing diverse teachers of color in mathematics and science who will learn to embed culture, place, and social justice in mathematics and science content to improve outcomes in high-need classrooms.

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