RESEARCH PROJECT

Integrating Feminist Pedagogy into Science Teacher Education

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Abstract

With a growing need to give underrepresented populations equitable opportunities in science, less traditional pathways for science instruction must be considered. Incorporation of feminist pedagogies into secondary science teacher education provides an opportunity for pre-service teachers (PSTs) to help underrepresented minority groups connect to and build an interest in science. A civic engagement project was designed for undergraduate students in a capstone course in a Women and Gender Studies program, in which students were charged with identifying and interviewing a person in their dream career who was involved in feminism. This paper discusses the responses from an interview with a secondary science education methods professor with an intersectionality as an African-American female scientist in a predominately White institution in the Midwest. The interview focused on how different feminist principles affected her goals for the science education courses she teaches, and included a critical analysis and discussion of activities completed in the secondary methods course. In this paper we discuss how a secondary science methods course grounded in inclusionary feminist principles led to the development of activist pre-service science teachers with a commitment to representation and to recognition and discussion of

bias. The data supporting the project are excerpts from the interview questions as well as specific activities implemented in the secondary science methods course that influenced the first author's lesson plan development and philosophy of teaching. Clearly, experiences for PSTs that are grounded in exposure to and awareness of pre-service teacher activism, representation, and recognition and discussion of bias are necessary if we are to create equitable opportunities and to foster an interest in science that is accessible to all students and teachers.

Keywords: feminist pedagogy, secondary pre-service teachers, activism, secondary science education, feminism, inclusion, diversity, STEM

Introduction

The purpose of this paper is to discuss how incorporation of feminist pedagogies and principles such as representation, recognition, discussion of bias, and science educator activism in a secondary science methods course provides a framework for future science educators. The current demographics of the STEM workforce reveal that Black and Hispanic workers are underrepresented, and this indicates a need to ensure that STEM pedagogy is made available to underserved students (Funk & Parker, 2019). Teachers are on the front lines when it comes to encouraging and fostering student interests and must therefore be prepared to meet the diverse needs and experiences of the students in their classrooms. In science education, minority representation is lacking in both the curriculum and in those who teach it. Over 90% of science educators are White, and in the progression from middle school to high school, the percentage of female teachers in science drops from 70% to 54% (Wilson, Schweingruber, & Nielsen, 2015).

Uplifting the next generation of scientists and science educators starts with breaking the cycle of traditional teaching methodology, in which White teachers are prepared to inspire only White students. This shift can occur through applying feminist pedagogy to science education. Many feminist scholars of science education desire a change in how and what students are taught—with a shift in favor of inclusive practices and curricula that encourage underrepresented populations to connect and thrive in science (Brotman & Moore, 2008; Capobianco, 2007; Richmond, Howes, Kurth, & Hazelwood, 1998). Another feminist scholar Karan Barad (2001, p. 237) argues that most scientific literacy projects have failed because society is so scientifically illiterate and believes that scientific literate information is irrelevant. Thus, attempting to help students see science as significant to their lives is paramount and requires practices that fully engage them with the nature of science as a social process (Barad, 2001). This feminist and African-American professor attempted to move toward these goals in her secondary science methods course. The project, called the Training Future Scientist Program (TFS), is embedded in a secondary methods course using culturally responsive teaching and feminist pedagogies to explore how these pedagogies can influence traditional White secondary science pre-service teachers (PSTs) who will teach secondary students during student teaching and in their future classrooms.

This paper highlights how integration of feminist pedagogy into a secondary science methods course will prepare secondary PSTs with the skills they need to foster a passion for science in all students. Using this pedagogy will equip these future secondary school teachers with the tools they need to motivate students who are often underrepresented in the STEM curriculum and in the STEM workforce. For our discussion, "underrepresented" includes both females and students of diverse ethnic groups.

Feminist Pedagogy in PST Education

There are many different approaches to the incorporation of feminist pedagogy into science education. Broadly defined, "the tenets of feminist praxis [are combined] with the principles of science teaching" (Barad, 2001, p. 3); at its core, feminist pedagogy focuses on utilizing educational practices that support the diverse needs and experiences of all students, while examining and dismantling the biases within the current educational system (Capobianco, 2007). Examples range from (a) incorporating practices that encourage more female participation and (b) utilizing methods with an emphasis in activism, to (c) analyzing what aspects of science education are currently excluding women and minorities (Capobianco, 2007). Teo (2014) reports newer approaches toward feminist studies

in science education that focus on activism, in which feminist principles like intersectionality, identity, and positionality are used to empower students to take control of their understanding of science. Jackson and Caldwell (2011) attempted a project for non-major biology students that coupled the Science Education for New Civic Engagements and Responsibilities (SENCER) approach with feminist pedagogy. The goal of this project was to encourage students to (a) investigate the production of knowledge, (b) participate in construction of knowledge, and (c) apply these skills to issues requiring civic engagement and responsibility. Through the connection of civic importance to science information, many students gained increased confidence and engagement with the material (Jackson & Caldwell, 2011). Our goal of implementing feminist pedagogy in PST education is similar to the goals of the Jackson and Caldwell project, and includes making the content and connections meaningful and relevant to students and their community.

Our idea of feminist pedagogy for PST education draws upon all students' interests, experiences, and preconceptions. We want to validate the voices and experiences of all, while challenging oppressive practices and structures that are currently in place, in order to eliminate the historic inequity found within the education system (Capobianco, 2007). With that foundation, our PST education would incorporate the following four approaches presented by Brotman and Moore (2008) in an effort to engage underrepresented populations more effectively and meaningfully in science: (a) equity and access (the need to eliminate inequities and provide equitable science opportunities in the classroom), (b) curriculum and pedagogy (changing what is taught to include the experiences, learning styles, and interests of all students), (c) reconstructing the nature and culture of science (changing how science is viewed and defined in school and society), and (d) identity (encouraging all students to incorporate science as a component of their identity) (Brotman & Moore, 2008).

Description of the Interview

For a capstone course in a Women and Gender Studies program, the students were given the following charge: *Identify and interview a person in your dream career involved in feminism.* The first author selected the second author, a Black female secondary science methods assistant professor, because the experiences he had in her secondary science methods course and her research interests published on the university's website included "[providing] authentic science instruction to underrepresented students in grades K-5, by preparing elementary science PSTs in SCI 397" (Ball State University, 2020). This decision led to an interview and post-interview discussion concentrated around how science methods courses can authentically prepare PSTs to recognize and discuss bias, as well as to promote inclusivity in their future classrooms.

The interview included seven questions to reveal how feminist principles including diversity, inclusion, ethnicity, and gender contributed to her pedagogical reasoning. The questions were as follows:

1. What influenced your decision to become a science educator?
2. When and how did you develop an interest in creating a more positive space for underrepresented students in science classrooms?
3. What do you believe are the biggest issues schools are facing in terms of inclusion and diversity?
4. What are your recommendations for how science teachers can get more students, especially minority students, interested in further pursuing science?
5. How have race/ethnicity and gender impacted your goals and career path up to this point?
6. Do you consider yourself a feminist? Do you consider your work to be contributing to feminism?
7. If you could offer two pieces of advice to future science educators looking to pursue a similar pathway (i.e. increasing diversity in the science education classroom, getting more minority/ underrepresented students interested in science,…etc.) what would they be?

Following the interview, four projects that highlighted feminist principles the first author participated in while in the second author's secondary methods course were also discussed. Brief summaries of the projects are provided below.

- **"Shadow-A- Scientist":** Each student identified a STEM research interest, chose a scientist at the

university to shadow and spent a minimum of 12 hours working alongside the scientist in their research lab.

- **DAST (Draw-a-Scientist Test):** Each student drew a scientist and chose a skin-colored crayon to shade in the reverse side of the image. An analysis and discussion of the images drawn, and colors chosen followed the assignment.
- **Black History Month Bingo:** Trivia presented during each class throughout the month of February educated students about prominent African Americans across many different career fields. Students actively participated in discussion and in a process of determining the identified person on their bingo board.
- **Precision versus Accuracy Lab:** Students were given a ruler and a block and asked to take measurements of the length, width, height, and volume. The measurements were compared to the expected results, followed by a discussion of why discrepancies occurred.

Outcomes of the Interview

Analysis of the responses to the interview questions and the activities completed in the course revealed three major themes that should be addressed in PST science methods courses. These themes include representation, recognition and discussion of bias, and creation of activist science educators.

Representation

In the interview, the following responses involved representation:

Responses

1. *"I was the first African American and female to earn a Ph.D. in my program and I am the first African American to pursue a tenure-track position in the biology department at BSU. So, a lot is riding on my success so I have to make it so others know they can do it."*

2. *"My ethnicity and gender have provided me access since being an African-American female places me in a diverse and marginalized group to earn a Ph. D. and work at a predominantly white university."*

3. *"Most of my work focuses on reducing the fears of White female PSTs to teach underserved diverse groups with confidence and competency.… I am producing teachers that are not afraid to work with diverse underserved groups."*

In her responses, Dr. Robinson-Hill focuses on how representation has affected her life firsthand (Response 1 & 2) and on the positive impact she is trying to make within the education system (Response 3). The experiences she has had throughout her career have allowed her to recognize the changes needed to create PSTs who are not only prepared to teach underrepresented groups (Response 3) but who can also inspire them to pursue careers in STEM themselves. Women and other underrepresented groups are often disinclined to choose careers in STEM because of the lack of role models (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Brickhouse, Lowery, & Schultz, 2000). Thus, having a Black and female professor for this secondary science methods course could potentially impact both underrepresented demographics of PSTs and inspire their future students to pursue a career in STEM. Boumlik, Jaafar, and Alberts (2016) have alluded to the important influence that role models in higher education can have on students' future academic and career choices. Research has also shown that a more diverse population of science educators can encourage PSTs of color to be more committed to multicultural teaching, social justice, and providing children of color with academically challenging curriculum (Sleeter, 2001, p. 95). Thus, diverse PST educators could lead to a more diverse population of teachers: the cyclical advancement begins when students also learn and connect to STEM because they see themselves represented (Brickhouse et al., 2000).

With her understanding of the need for representation in PST education courses, the second author implemented two activities mentioned above, "Shadow-A- Scientist" and Black History Month Bingo. Incorporation of the "Shadow-A-Scientist" project allow PSTs to be paired with professionals and share in an authentic and positive research experience. This firsthand research experiment and mentorship can affirm PSTs' commitment to pursuing careers in STEM, as it did for the first author. Estrada, Hernandez, and Schultz (2018) have also shown that authentic science research and mentorship have a

positive impact on underrepresented minorities who pursue STEM careers, and thus, recreating this experience in the PST's future classroom, can provide students with a reciprocal learning opportunity. The other representation activity, Black History Month Bingo, can serve as both an implicit and an explicit representation instructional activity, focused on highlighting the achievements and exceptionalities of hidden figures in a minority community. The adaptability of the activity for other meaningful cultural awareness months, including LGBTQ Pride, Women's History, Hispanic Heritage, and more, allows for in-depth coverage of many areas of diversity.

Recognition and Discussion of Bias

In the interview, the following responses involved recognition and discussion of bias:

Responses

1. *"What influenced me to become a science educator were the fears I saw in many of the White female teachers that were hired by my school district in STL. I felt I had the secret to their success in my tool belt, so I decided to leave secondary education and become a professor to train future teachers in grades K-12 that desire to work with underserved diverse groups."*

2. *"My desire to create a positive space for underserved students in science classrooms was to motivate these students to want to do science by allowing them a space to do science without being judged if they did not get the right answer."*

In further discussion of her responses, Dr. Robinson-Hill said that the secret to the success she had with her White female PSTs (Response 1) was providing them with an education grounded in authentic learning experiences coupled with activities preparing them to work and learn with underserved students. Many White PSTs do not understand the level of inherent bias and discrimination, especially regarding race/ethnicity (Sleeter, 2001). The DAST activity brought this phenomenon of inherent bias to light by exposing the stereotypes we hold about those who pursue science. As seen in other studies, even at a young age many students hold masculine ideals of a scientist (Brotman & Moore, 2008). The other bias that was analyzed by this activity was ethnicity. The crayons chosen represented skin tones, and the first author, as did much of the class, chose a color that closely resembled his own skin tone. This in combination with the drawings, allowed for an in-depth discussion about our subconscious association with things that are similar and how to be cognizant of our own inherent biases around gender and ethnicity.

Bias can be seen outside of gender and racial categories as well, as is exemplified by the Precision versus Accuracy lab. The Precision versus Accuracy lab addressed assumptions and misconceptions in science education regarding previously obtained knowledge. Even though using a ruler is a presumed basic skill, this activity revealed to the first author the diversity of knowledge on how to read and use a ruler, and thus the possibility for misunderstanding and confusion. This experience resulted in the first author's recognition of the inherent value of beginning a lesson with a basic fundamental skill review that provides every student an equitable foundation. Dr. Robinson- Hill mentioned in their discussion how the Precision versus Accuracy lab was so important in creating the infrastructure for success in a science classroom. Through this activity, Dr. Robinson-Hill instilled in the first author the need to provide students the opportunity to learn—no matter what their previous background knowledge—while supporting them through success and failure without judgement (Response 2). Creating an equitable base for all students to build their knowledge upon while thwarting biases is a central approach of our feminist pedagogy.

Creation of Activist Science Educators

In the interview, the following responses involved the creation of activist science educators:

Responses

1. *"The biggest issue we are facing in schools in terms of inclusion and diversity is the lack of access to authentic science instruction for diverse populations of students."*

2. *"Some possible recommendations for how science teachers can get more diverse students interested in pursuing science is allowing them access to*

inquiry-based science in their schools, then access to authentic science experiences in the summer at BSU and other universities."

3. *"Two pieces of advice I would give to future science education majors would be: 1) to make sure you advocate for diverse students in your school to have access to science and science enrichment opportunities: and 2) make sure you stay connected to university researchers that are willing to invite secondary students and/or teachers into their lab to perform research."*

The theme of activism was present in Dr. Robinson-Hill's responses through her determination to provide her students, and especially her underserved students, with the best possible instruction, (Response 1 and 3). Teacher preparation programs that emphasized advocacy for students and families and incorporated it into fieldwork led to PSTs who were advocates both in and out of the classroom (Whipp, 2013). By getting more underrepresented students interested in STEM, we create growth in schools and in the community. When students of color choose to pursue STEM, the experiences are usually service oriented, affording these students with opportunities to volunteer and participate in their communities (McGee & Bentley, 2017).

Dr. Robinson-Hill also instilled authentic science opportunities through guided and open inquiry (Response 2). Inquiry-based lessons focus on student engagement and give students the opportunity to find solutions through individual input and collaboration. Inquiry lessons allow teachers to function as facilitators of high-quality prompts while not dominating the classroom conversation (Bulba, 2015). It is highly effective in conjunction with feminist pedagogy, where teachers function as collaborators, negotiators, and facilitators (Capobianco, 2007). This process can amplify student voices and provide associated mentorship, which leads to students' investing in and impacting their own education.

It was important to analyze the topics of representation and bias in order to allow the first author, a White male secondary PST, the chance to grasp the value of advocating for and becoming an activist educator for underrepresented students. Studies have shown that many White PSTs rarely discern discrimination, especially racism, and these challenges can then appear in the classroom (Sleeter, 2001). It has also been noted that many PSTs and in-service teachers have low efficacy in terms of teaching African-American children successfully (Sleeter, 2001). Discussion about representation, bias, and equity are essential if PSTs are to appreciate the needs of all students and thus properly educate and advocate for them. Having a secondary methods course that incorporates modeled activities with a basis in the three themes mentioned above allows for the success of PSTs, especially those who are White, in realizing the changes that need to occur within science education in order to influence underrepresented groups to enter. This realization also comes with understanding the importance of transferring the knowledge and skills learned in their teacher preparation programs to their future classrooms.

Conclusion

As a result of this entire process, the first author realized the value of connecting research to real-life practice. The meaningful connections in one-on-one conversations with professionals in the field can have a greater impact on teacher pedagogy than traditional classroom instruction. The interview was an epiphany in the first author's own understanding of science education and comprehension of the skills needed to improve as a future science educator. Boumik et al. (2016) found that perceptions of gender inequalities in the sciences are related to a person's attitudes and behaviors, and, especially if their culture is different from the majority culture, this can impact their viewpoint in specific sectors of STEM. Indeed, further research may show that inclusion of personal reflection and direct interaction with passionate secondary science methods professors could have a significant impact on skill development and the future success of secondary science PSTs. Potential outcomes from these relationships might include the creation of meaningful experiences, the ability to directly relate to students, and an opportunity to bring real-world meaningful experiences into the classroom.

About the Authors

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