Potential Science Teachers’ Understanding about Students and Student Learning: Contrasts across Gender, Ethnicity, First Language, and Major

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Abstract

We investigated potential teachers’ views of students and student learning in an introductory course for undergraduates considering secondary science teaching as a career. This undergraduate course included both a weekly university seminar and field placement hours in a local grade 7-12 science classroom. To better understand the intersection of individual identity and equity issues, we constructed a purposeful sample of 18 potential secondary science teachers across three course sections. Our target undergraduate participants varied by their gender, ethnicity, first language, and academic major. Our qualitative analysis of data collected – undergraduate surveys, videotapes of seminar sessions, interviews, and completed course assignments – yielded both similarities and differences in these undergraduates’ views of students and student learning.
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Introduction

There is a need to recruit more science and mathematics teachers to teach in US public schools. The National Research Council (NRC, 2005, 2010) has called for the annual recruitment of 10,000 new science and mathematics teachers to engage and educate 10 million students. Equally important, there is a need to make our science and mathematics teaching workforce more diverse (NRC, 2011). Only 16% of K-12 public school teachers are African American, Alaska Native, Asian American, Latino/a, Native American, Native Hawaiian, or Pacific Islander while almost half (44%) of public school students are from these ethnic groups. In response to these calls for better prepared and more diverse science and mathematics teachers, a team of faculty at the university under study established STeach to encourage undergraduates to consider careers in secondary science and mathematics teaching. (In California, where this university is located, teacher credential candidates must complete an undergraduate degree before entering a teacher education program.)

In our study, we investigated potential science teachers’ views of students and student learning. Our potential teacher participants were enrolled in one of three sections of the foundational course for the STeach initiative: An Introduction to Secondary Science Teaching. The primary objective of Secondary Science is to introduce reform-based ideas about the teaching and learning of science (NRC, 2012). The course includes both a weekly seminar and 15 to 30 hours of observation in a local secondary science classroom. Our study was shaped by the following research questions: How did potential teacher participants describe secondary science students and their learning? How did their descriptions of students differ by their own gender, ethnicity, first language, and undergraduate major? Our purpose was to provide important insights into preparing secondary science teachers to understand and effectively teach all students.

Conceptual Framework: Studying Diversity in Teacher Education

Teacher education scholars (Ball & Tyson, 2011) and authors of national equity reports (NRC, 2011) make clear that diversity be viewed as an asset – both for teachers and for the students they teach. Science teachers new to the profession, however, face numerous challenges in learning to build instruction from diverse students’ ideas and experiences (Author & Colleague, 2007; Hollins & Guzman, 2005). For example, Brand and Glasson (2004) found that preservice teachers’ early life experiences and ethnic/racial identities constrained their identification and critique of long-held views about who students are and how they learn. Given such challenges, Ladson-Billings (2011) emphasized the need to conduct more research on how to prepare teachers to teach for diversity. Our study contributes to this effort by examining how different dimensions of diversity – gender, first language, and undergraduate major in addition to ethnic/racial background – inform potential teachers’ views of student learning.

We used the powerful lens of intersectionality to examine diverse undergraduates’ views of students. Intersectionality, as defined by McCall (2005), makes visible “the complexity of relationships among multiple social groups within and across analytical categories. . . . The subject is multigroup, and the method is systematically comparative” (p. 1786). Within the
context of science education, this perspective allows researchers to simultaneously complicate and study the multiple, intersecting categories of gender, ethnicity/race, class, and/or sexual orientation to gain an understanding of diverse teachers and students’ lived experiences. Martin, Wassell, and Scantlebury (2013) employed the theoretical framework of intersectionality to describe the challenges English language learners faced in urban middle school science classrooms. Espinosa (2011) used intersectionality to identify those college experiences that helped or hindered women of color in undergraduate STEM majors compared to their White counterparts.

As a complementary theoretical lens, we employed a situated perspective of teacher learning. Lave (1988) argued that learning be viewed as including the person, the activity, and the context. Putnam and Borko (2000) elaborated: Learning results from activity in particular physical and social contexts; requires interactions with others in one’s environment; and is distributed across the person, others, and artifacts. Teacher learning, then, can be understood as acquiring the knowledge, language, skills, and habits of mind needed to become a member of multiple communities of practice (Wenger, 1998). For a beginning science teacher, achieving full participation in science, classroom, and teacher communities is not easy. Feminist science scholars (Figueroa & Harding, 2003; Schiebinger, 1999), for example, make clear that science is culturally situated and shaped by the gender, racial, and political ideologies of societies. To create productive classroom communities, teachers must recognize the complexity of students’ words and actions, as well as work to understand how students engage in science and how their engagement is related to who they are and who they want to be (Brickhouse, 2001). Further, teachers new to the profession must learn that they are both enculturated into an existing teacher community (Borko, 2004) and able to change the community through their participation (Wenger, 1998).

Research Methods

We conducted our study at an emerging Hispanic Serving Institution (HSI) located in California. This university was recently recognized as one of 25 top institutions graduating Latinos/as in STEM disciplines (Santiago & Soliz, 2012). We focused our investigation on potential science teachers enrolled in the STeach Secondary Science course during Winter and Fall 2011 and Fall 2012. Sixty-one of 62 undergraduates in these sections agreed to participate in our study. We constructed a purposeful sample (Patton, 1990) of 18 undergraduates based on their gender, ethnicity, first language, and undergraduate major. We did not have sufficient numbers of female or male undergraduates from ethnicities other than Asian American, European American, and Latino/a to include in our study. (See Table 1.)

Table 1
Potential Science Teacher Participants by Gender, Ethnicity, First Language, and Major

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>First Language</th>
<th>Undergraduate Major(s)</th>
<th>School Placement</th>
<th>Will/Have Completed a Minor in Education</th>
<th>Later Enrolled in University’s Teacher Ed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marta</td>
<td>Female</td>
<td>Latina</td>
<td>Spanish</td>
<td>STEM (Environmental Science)</td>
<td>La Gama High School</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Marien</td>
<td>Female</td>
<td>Latina</td>
<td>Spanish</td>
<td>STEM and Non-STEM (Psychology)</td>
<td>Beachside Middle School</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
We collected four types of data. Surveys constituted one type. Questions asked about prior K-12 teaching experiences; participation in the larger STeach initiative; understanding of the processes of teaching and learning science; and personal and family background. A second data type was individual, semi-structured interviews conducted at the course’s end. As part of this interview, undergraduates drew a concept map (Novak & Gowin, 1984) about the teaching and learning of science. Interviews lasted from 15 to 40 minutes and were digitally recorded. A third type of data was video: We used two video cameras to document each of the 10 two-hour seminar sessions. Undergraduates’ assignments were our fourth data type: These included in-class journals, school placement reflections, and final lesson plans.

We focused our qualitative analysis of data (Emerson, Fretz, & Shaw, 1995) on undergraduates’ understanding of students and student learning. We did so because, to teach science for all, teachers must move students to the center and build instruction from their ideas and experiences (Calabrese Barton, Tan, & Rivet, 2008; Rosebery & Warren, 2008). We began by transcribing interviews and seminars. We then open coded all four types of data for views of students, student learning, and student diversity. Next, we looked across these initial codes to

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Race/Ethnicity</th>
<th>Language</th>
<th>Field</th>
<th>School</th>
<th>STEM?</th>
<th>Non-STEM?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jadyn</td>
<td>Female</td>
<td>Latina</td>
<td>Spanish</td>
<td>Non-STEM (Sociology)</td>
<td>Grove Junior High</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Katie</td>
<td>Female</td>
<td>European American</td>
<td>English</td>
<td>STEM (Biological Sciences)</td>
<td>La Gama High School</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Catheryn</td>
<td>Female</td>
<td>European American</td>
<td>English</td>
<td>STEM (Chemistry)</td>
<td>La Gama High School</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Taylor</td>
<td>Female</td>
<td>European American</td>
<td>Ukrainian</td>
<td>Non-STEM (Italian)</td>
<td>Santa Rosa High School</td>
<td>Yes</td>
<td>N/A*</td>
</tr>
<tr>
<td>Betsy</td>
<td>Female</td>
<td>Asian American</td>
<td>English</td>
<td>STEM (Pharmacology)</td>
<td>La Gama High School</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Penny</td>
<td>Female</td>
<td>Asian American</td>
<td>English</td>
<td>STEM (Zoology)</td>
<td>Santa Rosa High School</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Amber</td>
<td>Female</td>
<td>Asian American/European American</td>
<td>English</td>
<td>Non-STEM (Physical Anthropology)</td>
<td>Santa Rosa High School</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Diego</td>
<td>Male</td>
<td>Latino</td>
<td>English</td>
<td>STEM (Biological Sciences)</td>
<td>La Gama High School</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Otelo</td>
<td>Male</td>
<td>Latino</td>
<td>English</td>
<td>STEM (Biochemistry)</td>
<td>Cabrillo Junior School</td>
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<td>N/A</td>
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<tr>
<td>Odon</td>
<td>Male</td>
<td>Latino</td>
<td>Spanish</td>
<td>Non-STEM (Anthropology)</td>
<td>Grove Junior High</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ashton</td>
<td>Male</td>
<td>European American</td>
<td>Italian</td>
<td>STEM (Biological Sciences)</td>
<td>La Gama High School</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>David</td>
<td>Male</td>
<td>European American</td>
<td>English</td>
<td>Non-STEM (Communication)</td>
<td>Santa Rosa High School</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hunter</td>
<td>Male</td>
<td>European American</td>
<td>English</td>
<td>STEM (Environmental Science)</td>
<td>Beachside High School</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Brent</td>
<td>Male</td>
<td>Asian American</td>
<td>English</td>
<td>STEM (Chemical Engineering)</td>
<td>La Gama High School</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>John</td>
<td>Male</td>
<td>Asian American</td>
<td>Cantonese</td>
<td>STEM and Non-STEM (Physics and Philosophy)</td>
<td>La Gama High School</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Kenny</td>
<td>Male</td>
<td>Asian American</td>
<td>Mandarin</td>
<td>STEM (Statistics)</td>
<td>Grove Junior High</td>
<td>No</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*N/A* note students who are still enrolled as undergraduates.
select salient themes and conducted more focused coding. Our final four themes were: (1) the role of students’ ideas in science teaching and learning; (2) connections across student motivation, hands-on instruction, and student ownership; (3) the use of tracking to manage student diversity; and (4) reasons students mis/behave in science classes.

Findings

We identified similarities and differences across potential teachers’ understanding of students and student learning. Due to limited space, we briefly discuss findings from our third theme here. We found that eight of our 18 undergraduate participants discussed the tracking of secondary students into different kinds of science classes. They noted differences in students who populated the high versus low, Advanced Placement versus regular, or honors versus college preparatory classes at the secondary school where they observed. These eight undergraduates cut across gender, ethnicity, first language, and coursework categories. For example, in his field placement reflections, one undergraduate noted that the Beachside students enrolled in Advanced Placement (AP) Environmental Science were different from those in the high school’s regular science courses. AP students entered the course already invested in the environmental science material they were expected to learn.

After the class, I spoke with [the teacher] for a while about teaching and the involvement of students in the classroom. He told me that the interest level of students is very important to him and that in his case [he teaches only AP classes], pretty much all of the students are invested because they have chosen to be there, unlike most other classes at the high school level.

Even the AP students at this public high school, the undergraduate continued, appeared much less interested and motivated than he and his classmates had been at a private boarding school.

However, only three of the eight undergraduate participants who discussed tracking raised concerns about inequities in opportunities afforded students across different tracks. These three undergraduates – Jadyn, Odon, and Ashton – spoke a first language other than English and had enrolled in at least two other courses in the education minor. In his field placement reflections, for example, Ashton noted that his mentor teacher taught both standard Biology and a remedial Life Science course “designed for people who have failed or will fail Biology.” He noted that the Life Science course covered the Biology content in a less “intensive” fashion even though the Life Science students were as capable as the Biology students. He wrote: “Intelligence isn't an issue [for the Life Science students]. . . . These students don't seem like they belong in a class like this – for people who can't handle Biology.” He wondered how he could encourage them “to care” more, “especially when you put it in terms of their future.”

Further, only one undergraduate, Odon, explicitly described differences in the ethnic background of students tracked into the high versus low science classes – and linked such differences to larger societal issues. More specifically, at the beginning of a Secondary Science seminar, during a whole class discussion about social dynamics in classrooms, Odon noted that there were substantially fewer ethnic minority students in the honors versus regular science courses at Grove Junior High. Odon’s concerns expressed during class were echoed in his field placement reflection:

I mainly observed and provided support for the sub[stitute today]. I took the opportunity to examine the socioeconomic dynamics that are present in the classroom. I noticed that the non-honors class held lots more minority groups than the honors class did. I hope
that the State’s initiative to better represent the minorities is helping. It is tough to be a teacher and get to balance these social issues that these students are not yet aware of. I must note once again it is hard being a kid. Helping the students struggle throw this moment in there life is challenging. It takes a very talented teacher to do this.

**Study’s Significance**

As stated above, we conducted this study in response to calls for additional research at the intersection of teacher education and diversity (Ladson-Billings, 2011). We built our investigation of potential science teachers on the assumption that diversity be viewed as an asset – both in the education of teachers and the teaching of students (Ball & Tyson, 2011; NRC, 2011). Findings from this study underscore the importance of encouraging undergraduates from diverse backgrounds to consider science teaching as a career. Undergraduates who spoke a first language other than English, for example, were better able to articulate negative consequences of tracking for secondary science students and expressed a stronger desire to teach students in low tracks compared to their English only counterparts. Findings also reiterate the need to pay more careful attention to field experiences (Grant & Gibson, 2011) – both in terms of how teacher educators can make field experiences more central components of their courses and of how researchers can more carefully study what potential and preservice teachers learn from them (Yerrick & Hoving, 2003). In our full paper, we discuss additional implications for the recruitment and preparation of science teachers – for ways to continue to move science teacher education closer toward the goal of science for all students.

**References**


