EST-afet: Telling tales from the urban science classroom

Joy Barnes-Johnson, University of Wyoming
Abstract: An estafet is a courier who carries a message to another courier; this paper reports findings from doctoral action research investigating equitable science teaching beliefs and practices in an urban elementary school. Emergent from conversations between administrators and the researcher about ways to sustain science instruction within high-stakes testing environments, the research question that framed this study asked how can science teaching in urban schools be improved to reflect high quality practices? Using field notes and reflections, interview data, observation data, survey data and classroom artifacts, specific indicators of equitable science teaching became clear. The role of self-efficacy in mediating change in practices over the course of an academic year also became clear. In the current catalogue of tools used to evaluate teachers, indicators of equitable practice may provide insight into other important teaching characteristics. Specific tools and strategies in support of Equitable Science Teaching (EST) in urban elementary contexts will be shared for personal reflection and potentially as instruments for teacher evaluation. As theoretical standards of practice for science teaching continue to evolve, clear definitions for equity and benchmarks of excellence derived from research and theory must remain a part of the message conveyed to practitioners.

Subject/Purpose

The need to study equitable science teaching practices is exacerbated in urban schools for multiple reasons. Equitable science teaching encompasses many different yet related discourses, each operating with their own strengths and limitations. These streams of discourse originate from education reform models, teacher education reforms, science teaching reforms, science learning initiatives and general models of best practice in STEM education. Minority-serving communities, especially those serving children of African descent, have found it difficult to embrace these for-all initiatives (Mutegi, 2011). Cultural, social and political belief systems at odds with reform models have constrained essentialist perspectives and perhaps commonly held views about science, math and technology.
Five key issues have informed the long-standing debate over science education in urban schools: 1) disparaging impact of accountability policies (standards and assessment) on science instruction in low performing schools; 2) multiple indicators of low attainment among urban students in science and mathematics; 3) low incidence of engaging (non-textbook based) science instruction at the elementary level; 4) consistent and sustained under-representation of specific groups in STEM, especially low SES, special needs and non-Asian racial/ethnic minority populations and 5) low science teaching efficacy beliefs of urban elementary teachers. Teachers in urban classrooms often find themselves on the ‘front line’ in the battle to improve science education in the United States with few resources or worse, resources they are untrained to use.

Persell (1994) suggests “however vague or divisive its language, the concepts of multiculturalism deeply inform the current, still disparate efforts to improve science education” (p. 250) for marginalized groups. His argument, based on dissimilar student participation in academic or professional science, also applies to discussions about K-12 education and the sixteen year “pipeline” required to grow science thinkers (Committee on underrepresented groups, 2010; Greenfield, 1997; National Science Board, 2004; National Science Foundation, 1996). This view remains true today. More recent debates about this problem place teaching and teachers at the center of this issue. According to the National Science Foundation (2010) teacher quality is a major part of the challenge. They report a narrowing of achievement gaps by race in general and at specific grades but confirm that underrepresented populations are more likely to be taught mathematics and science by teachers that do not have advanced or continued education beyond the bachelor’s degree. This report underscores a few important contexts: the need to address the persistent gap in science education resourcing in urban schools, the continual problem of student attrition for Black and Latino youth and the need for efforts to address science teaching in elementary schools.

The present study took place in an urban elementary school in New Jersey important to this discussion primarily because desegregation efforts undertaken in New Jersey between 1950 and 1971 make it among the “most venerable and strongest state law [programs] prohibiting racially segregated schooling...yet simultaneously it has had the worst record on racially imbalanced schools” (Flaxman et al., 2013). In 1996, the State of New Jersey published and widely distributed a science curriculum framework that included teaching resources designed to address the specialized needs of diverse student groups. Placing the needs of teachers equal with needs of students makes New Jersey even more interesting from a policy and education research perspective.

**Design/Methods**

Some underlying assumptions about equitable science teaching inform this study. The first is that equitable science teaching practices can be related to quality science teaching practices. This assumption is implied by the grand tour question but is supported by scholarship about multicultural science education and teacher professional development (Zozakiewicz & Rodriguez, 2007). A second underlying assumption about equitable science teaching is that it is a difficult reality in urban schools. This assumption is born out of research that suggests that there
are persistent inequities with regard to science teaching and learning in urban schools (Barton, 2002; Haberman, 2004a; 2010b; Kahle, 1998; Lee, 2004; Lee & Houseal, 2003; Lee & Luykx, 2006; Rodriguez, 2001; Settlage, Southerland, Smith, & Ceglie, 2009) and that teachers may not feel like they have the capacity to bring about student success (Lee & Houseal, 2003; Settlage, 2004; Settlage, Madsen, Rustad, 2005; Settlage, Southerland, Smith & Ceglie, 2009; Tucker et al., 2005). A variety of data from multiple sources is necessary to gain insight into these assumptions and the questions that they espouse. This study used a variety of data sources and research strategies to explore equitable science teaching in a single urban school.

Table 1. Research Instruments by study phase and date

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Sample size</th>
<th>Instruments</th>
<th>Data collection dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I</td>
<td>n = 29</td>
<td>1. Background information survey</td>
<td>April 2008</td>
</tr>
<tr>
<td></td>
<td>n = 9</td>
<td>2. Self Efficacy Beliefs about Equitable Science Teaching (SEBEST)</td>
<td></td>
</tr>
<tr>
<td>Phase II</td>
<td>n = 5</td>
<td>Vignettes interview</td>
<td>April 2008 – June 2008</td>
</tr>
<tr>
<td>Phase III</td>
<td>n = 4</td>
<td>Observation guide, naturalistic data</td>
<td>September 2008 – December 2008</td>
</tr>
<tr>
<td>Phase IV</td>
<td>n = 3</td>
<td>Follow up focus group and post study SEBEST administration</td>
<td>February 2009 – April 2009</td>
</tr>
</tbody>
</table>

Table 3. Data collection by phase & informant

<table>
<thead>
<tr>
<th>Role</th>
<th>Construct</th>
<th>Data collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole school</td>
<td>School climate for science</td>
<td>Demographic; General beliefs about science teaching; Artifacts</td>
</tr>
<tr>
<td>(Preliminary)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrator 1</td>
<td>Principal</td>
<td>Quality science</td>
</tr>
<tr>
<td>(Phase I)</td>
<td></td>
<td>General definition of quality science</td>
</tr>
<tr>
<td>Administrator 2</td>
<td>Vice-principal</td>
<td>Quality science</td>
</tr>
<tr>
<td>(Phase I)</td>
<td></td>
<td>General definition of quality science</td>
</tr>
<tr>
<td>Teacher 1*</td>
<td>Pre-K teacher</td>
<td>Beliefs &amp; Practices</td>
</tr>
<tr>
<td>(All phases)</td>
<td></td>
<td>Specific beliefs about science teaching; Artifacts; Field notes from observation</td>
</tr>
<tr>
<td>Teacher 2*</td>
<td>Pre-K teacher</td>
<td>Beliefs &amp; Practices</td>
</tr>
<tr>
<td>(All phases)</td>
<td></td>
<td>Specific beliefs about science teaching; Artifacts; Field notes from observation</td>
</tr>
<tr>
<td>Teacher 3*</td>
<td>Kindergarten teacher</td>
<td>Beliefs &amp; Practices</td>
</tr>
<tr>
<td>(All phases)</td>
<td></td>
<td>Specific beliefs about science teaching; Artifacts; Field notes from observation</td>
</tr>
</tbody>
</table>

*Case study teacher
Two scales for measuring efficacy beliefs were proposed by Bandura (1982): personal efficacy and outcome expectancy. Science teaching outcome expectancy (STOE) is a construct that relates a teacher’s belief that his or her teaching will impact student understanding. A teacher that has a high science teaching outcome expectancy probably believes that students can learn concepts as a result of instruction and in spite of external issues (like class or ability). A modified version of the Science Teacher Efficacy Beliefs Instrument (STEBI) that investigates equity beliefs was used for this study. In response to statements participants would indicate the degree to which they agreed or disagreed with the statement (SA: strongly agree, A: agree, U: uncertain, D: disagree, SD: strongly disagree). The Self Efficacy Beliefs about Equitable Science Teaching (SEBSEST) purposefully positions the “most easy to agree with” statements at the top of the survey and the “least easy to agree with” statements near the bottom (Ritter, Boone, & Rubba, 2001, p. 192). Data collected in the present study show stark contrasts between personal science teaching efficacy (PSTE) and STOE. Additional data collected from semi-structured vignette-style interviews, observations, field notes and classroom artifacts helped develop a typology for efficacy beliefs about equitable teaching.

**Contributions:**

Observations in these two classrooms helped me to better understand two constructs: teacher efficacy in practice and effective science teaching for diverse classrooms. Teachers’ self-efficacy, their belief in their capacity to do a specific task and cause positive student outcomes as a result of that task, is related to several factors. Highly efficacious teachers exhibit behaviors distinct from their lower efficacy peers including greater levels of planning and organization, openness to new ideas; openness to instructional “experiments” that show direct student benefit; less critical response to student errors; willingness to work longer with struggling students; fewer referrals to special education; greater commitment to teaching; greater likelihood of staying in teaching profession and high level of enthusiasm for teaching according to several researcher perspectives (Carter, Larke, Singleton-Taylor, & Santos, 2003; Haberman, 2004 and Tschannen-Moran & Hoy; 2001). Using these observable indicators as a guide, differentiation between high efficacy (Teacher 1), middle-range (Teacher 2) and low efficacy (Teacher 3) teachers can be determined. Teacher 1 was the more efficacious according to general indicators but may not have been the most efficacious with regard to equitable teaching practices related to race, gender and class. Teacher 2 demonstrated great facility with teaching and learning considered culturally responsive and adaptive to the particular learning needs of students of color (Atwater M. M., 1996; Banks, 1996; Carnes, 1998; Haberman, 2004). Teacher 3 on the other hand, demonstrated the least efficacious beliefs in the beginning of the study—waiting for me to deliver instruction or no depth of science teaching—but ended up demonstrating very efficacious beliefs and practices—regular and open communication with me (a factor I relate to enthusiasm to do science), unscripted science that was less dependent on commercially produced curriculum materials and increased willingness to do more inquiry in the classroom.

**USING THE FINDINGS TO DEVELOP AN ACTION PLAN**

One of the reasons why action research is so often used in education is the expectation for immediate application to the in vivo research setting (Creswell, 2005; Sagor, 2010; Wagner, 1997). For the present study, the development of practical tools for creating and evaluating quality instruction were important. In this study, quality science teaching was connected to equitable practice. Quality science teaching was also linked to teacher efficacy. In the current
reform climate that is looking to classify teaching along a continuum of effect, understandings gained by teachers and administrators about equitable teaching practices may help leverage performance data collected solely based on standardized test data. As a framework, EST is a clear indicator of the kinds of 21st century skills (in general), science and engineering practices and cross-cutting concepts that appropriately build disciplinary core ideas within school-based learning communities. Figure 10. below was developed to visually represent the relationship between these efficacy beliefs and observable teaching and learning moments in the classroom.

Figure 2. Equitable Science Teaching Continuum in Urban Classrooms

The first feature represented in this schematic is the dynamic nature of equitable science teaching. Even though it is based on a beliefs-practices system, it is not static. Rather, equitable science teaching can be fostered and supported. The second feature of the schematic worth describing is the terms used to describe the continuum: from improbable to likely. The third feature of this schematic implies the differences between teachers and students in the classroom. Further examination of this quality of the continuum might take each of the diversity texts described earlier and develop activities (training and implementation) that are designed to force specific actions.

In thinking about categories of equitable science teaching (EST), it is helpful to think of the dynamic nature of the science classroom. This study shows that efficacy can be developed over time with appropriate supports. Along this continuum, the most favorable state is the EST condition: high efficacy students and high efficacy teachers. The least favorable conditions exist when students feel incapable of finding success, whether the teacher feels capable or not. When the student is the low efficacy actor in the classroom, equitable education is constrained. In cases where the teacher is the low efficacy actor, it may be possible to overcome this constraint. Efficacy is developed through experience, mastery, verbal persuasion and psychological response (Bandura, 1977, 1982, 1997). Each of these factors shapes beliefs about self. When these beliefs are substantiated by practices, realization of observable equity is possible.

References:


