CULTURAL PERSPECTIVES IN SCIENCE EDUCATION: RESEARCH DIALOGS

Democratic Science Teaching

Building the Expertise to Empower Low-Income Minority Youth in Science

Sreyashi Jhumki Basu, Angela Calabrese Barton, Edna Tan (Eds.)

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RESEARCH DIALOGS

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Scope

Research dialogs consists of books written for undergraduate and graduate students of science education, teachers, parents, policy makers, and the public at large. Research dialogs bridge theory, research, and the practice of science education. Books in the series focus on what we know about key topics in science education – including, teaching, connecting the learning of science to the culture of students, emotions and the learning of science, labs, field trips, involving parents, science and everyday life, scientific literacy, including the latest technologies to facilitate science learning, expanding the roles of students, after school programs, museums and science, doing dissections, etc.

Democratic Science Teaching

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VERNEDA JOHNSON AND EDNA TAN (ALPHABETICAL)

1. INTRODUCTION

JHUMKI'S JOURNAL ENTRY

Each day I would walk into my class at a public school in a Caribbean neighborhood in Brooklyn, I would believe that my students could and would become leading scientists of their generation and smart, articulate citizens able to shape the directions in which science led their world; young people who would use science to make change in the world.

And yet, time and again, I noted reality. Amidst a discussion of radioactivity, a knock-down fight broke out in my classroom between two intelligent, confident girls. A previously-incarcerated student who had spent hours after-school powering motors with solar panels was arrested for assault, moments before he was to proudly present his findings at the annual science fair. This recidivism occurred despite hours of individualized support from his teachers and father. He spent time in prison rather than preparing for his dream career in mechanical engineering. A medicine and engineering course I taught evolved into a time for "literacy-building," undermined by a national emphasis on reading and math. A student deeply engaged with robotics had to "choose" between a science course and his special education services.

Meanwhile, engagement and excellence in my class were episodic. Every student boldly presented "original" work at the annual science fair and developed series and parallel circuits for powering household objects. But I'm quite sure that many students could not imagine how uncertainties about dark energy were relevant to their lives. Homework was likely often not completed because it did not have ties to the substance of students' lives. As a teacher, I probably often assumed that what mattered to me mattered to all my students, that the joys and rewards of learning science were obvious, rather than situated in paradigms that excluded the back-grounds, aspirations and Discourse of many of my students.

These realities are not all realities. My students in Brooklyn cared about academic success. Ask almost any student, and she will tell you that she wants to improve her grades, be on honor roll, pursue a successful career. Ask most parents, and they will want these same things for their children. It seems the issues are more of resources and paradigms. The girls at the elite private school where I taught for two years often came from extremely wealthy families with a history of social and financial success and high-quality private elementary- and middle-school educations. They attended a resource-rich school offering the most challenging classes and

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were told time and again by peers, teachers, families and the world that they had achieved plenty and could be anything they dreamed to be.

Where in their academic life, particularly in science, were the life histories of my students in Brooklyn valued? Were any connections built between how science is traditionally taught and the farm on which one of my students grew up? Clearly not – she said this had nothing to do with science. Did one young man's delight in building toy boats as a child emerge through opportunities in his science classes? Did the young man engrossed with solar panels demonstrate his leadership skill in his science class? Did the 8th grader who tapped his pencil and squirmed endlessly in science class ever get time and space to exhibit his aptitude for building? And were these students told over and over, in what was formally said and offered to them, that they had the potential to learn science and be young scientists? Or instead, were they simply told to either adapt to the way science was taught or give up on their love of inquiry and knowledge?

RE/FRAMING URBAN SCIENCE EDUCATION IN A DEMOCRATIC SOCIETY

The seminal report, A Nation at Risk (1983) (ANAR), laid out the scenario that public schools would face in the coming decades, if significant changes were not made to the public education systems in place. Many of our schools located in growing urban centers were in crisis. Operating in deteriorating buildings, staffed by under prepared and unlicensed teachers, working in under resourced classrooms, not to mention the trend to staff inner city schools, that traditionally serve the academically neediest students, with the newest least prepared teachers. More egregious was the dysfunction in urban schools, the resulting student failure, and the reproduction of a 'culture of failure' within schools and communities. ANAR was published almost twenty years ago. Since that time many studies, narratives, and reports have commented on the factors that most impact upon urban school success and urban student achievement. Additionally, there is no shortage of information on what is 'wrong' in urban centers, including their schools.

Almost 20% of the nation's students are living in poverty, with numbers increasing under the recession that begun in 2008. But in large urban centers, like New York City, Atlanta, Houston and Los Angeles, that number more than doubles to 35–45% (Institute for Research on Poverty, 2010). Further, nearly 40% of urban students are attending high poverty schools. Students living in poverty are more likely to attend schools with outdated texts, are offered fewer opportunities to participate in summer or enrichment programs, have less access to certified teachers in math and science, and consequently face higher degrees of academic failure, and also have higher high school drop out rates than their more affluent or suburban counterparts (Oakes, 2005).

Low performing schools in urban centers are characterized by low teacher morale, high rates of teacher turnover and more teachers teaching without or out of their license areas (Ingersoll, 2001; Ingersoll & Perda, 2010). In New York City, recent numbers indicate that they may have as little as a one in two chance of having a certified math or science teacher (Chanc. Harold Levy, Mach 2004).

In the wake of No Child Left Behind (NCLB) many poor, inner city schools/ districts/systems find themselves in the midst of reform to ensure both improved educational outcomes and continued monetary support from the federal, state and city government. Most of these efforts are forced to conflate educational achievement with standardized test scores, even though many researchers point to the dangers of such unions. In addition to lagging behind in achievement, poor urban students are often not presented with the same opportunities to learn science. They are more likely to have unprepared teachers and have fewer chances to enroll in the advanced courses that are on the college bound trajectory (Ingersoll & Perda, 2010). Other studies indicate that poor students are more frequently tracked into low level science courses in which "good student behaviors" and rote memorization are valued more that the acquisition of dynamic science content, skill and process knowledge (Oakes, 1990).

Still, it would be remiss to suggest that lack of resources is the sole or primary barrier to creating and sustaining successful urban schools. The issue is far more complex and there are a myriad of contributing factors as well as societal forces strengthening the tensions that bound urban education.

For the past two hundred years public education has sought to provide basic skills and instruction in citizenry, morality and the 3 R's. In 1830, the workingman's committee of Philadelphia described the aspiration of the Common School this way, "Our main objective is to secure the benefits of education for those who would otherwise be destitute and to place them mentally on a level with the most favored in the world's gifts" (Tyack, 1967). Essentially, it was believed that the greatest challenge was providing the children of all parents the opportunities to study together. Academic achievement was largely seen as a testament to the will and perseverance of the individual. Over the next hundred years these attitudes would persist and grow more deeply rooted in our culture. Students that failed were thought to be of a lesser moral character or to not have the mental capacity for success. In 1920, the superintendent of schools in Newark, New Jersey argued, "All children are not born with the same endowments and possibilities: they cannot be made equal in gifts or development or efficiency…the educational system must therefore be adjusted to meet this condition" (Deschenes, et.al, 2000).

Rarely, if at all, was instruction, its content or design, considered as a source of student failure. Even more absurd was the notion that the context or construct of schooling was to blame. In fact as the nation became more urban and more students enter the schools, rather than developing a variety of approaches to schooling, what developed was a litany of terminology used to label and separate out those students for whom the system fails. In the early 1800's, these names read "dunce, wrong-doer, sluggish, stupid, incorrigible, and idle", to name a few (Deschenes, et.al, 2000). By the beginning of the 1900's, the list of names had expanded and shifted to include "sub-z group, mental deviates, laggards, average, occupational student, backward, and inferior" (Deschenes, et al., 2000). But, even as we look back at he first century of public schooling, our vision is often romanticized.

We envision the one room schoolhouse as some nostalgic harkening to another time and place rather than examining the harsh realities that it represented for the

less affluent family. Students typically only went to school for several months of the year—between planting and harvesting seasons and schools were crowded and under resourced. And although the non-graded culture of the environment allowed students to progress at a pace more in line with individual learning styles, it did little to address the numbers of students who became stagnant in their academic progress or failed to complete school at all (Deschenes, et al., 2000).

By the early twentieth century, members of the progressive education movement sought to challenge some of the political assumptions undergirding the notions of education as a means to equality. They were not prepared to disrupt the notion of the "age-graded" school that in its division of tasks mirrored the ever-growing factory culture that the US was becoming world renown for. But educators were beginning to question the efficiency of educating everyone the same way at the same time around the same subject matter. It was in this era that tracking became a formal part of public education and that we began to use the developing field of cognitive understanding to determine who would study what, and ultimately begin to orchestrate who will have the opportunity to become what (Deschenes, et al., 2000). Put nicely, we began to use aspects of cognition and assessment to remove those students who might slow or retard the progress of the normal student. From a purely efficacy-oriented perspective, this use of our evaluative tools was a smart one. But considering the desire to view school as a tool toward promoting equality among the American public, it must be called into question. What do we mean by equal? And who do we consider to be the citizenry? The waters are further muddied when we take into account the levels of achievement in certain subject areas compared to others, as well as the commodity-like values of certain discipline-based knowledge in the constantly morphing global economy.

When contemplating the purposes of public schooling in the postmodern era we can still place at its core, its role in the assimilation of new cultural groups and students into American culture. Society is told that the education provided can also be a tool to level the playing field and to prepare children of color and recent immigrants for greater opportunities in their future. However, as we review school and school system report cards nationwide, we see that the schools, especially those that serve the traditionally marginalized located in poor urban centers continue to fall short.

Competition, meritocracy and individual accomplishment drive success in American public schools and frame the "democratic" way of life for American school children. For those students living in and/or attending schools in poverty, most of whom are children of color, these values are often in direct opposition to the cultural norms and capital that is most appreciated within their own communities. If we consider, as Coburn suggests, "that a persons' worldview is not just a philosophical by product of their cultural origins, but rather the very skeletal structure on which we hang our flesh of customary behavior", then we must pose the question, "When a child's' worldview is left unvalued and expressionless in an educational setting, what should we expect in terms of engagement, investment and learning from that child?" Boykin insists that some of the cultural inconsistencies between students and schools and teachers may be to blame for student failure and lack of

motivation (Lynch, 2000). We extend this argument to include the culture of science as it is taught in schools, from a primarily positivist perspective that suggests its empirical, objective and linear attributes are most salient. We are forced to examine the questions, "What are the goals and purposes of public schools?", "What role does the teaching and learning of science play in attaining those goals?" and finally, "Are schools in poor urban areas designed, organized and allowed to function toward meeting those goals"?

Since the early 1900's educators have continually sought to reform science education. Yet, no matter how or whom, the intent of the reformers has been to create more effective science instruction that leads to more scientifically literate citizens. Put simply, regardless of the students ability to engage or not and experience success or not, we, the members of the educational community continue to allow merely a superficial analysis of our failures in science education and we continue to blame and punish children for them. Our failures, are due in no small part to the curriculum and pedagogies employed in current public school science classrooms.

BUILDING A MORE EMPOWERING SCIENCE EDUCATION THROUGH DEMOCRATIC IDEALS

As the last section suggests, the great democratic legacy of American education has been to create (or at the very least maintain) a sub-class of citizens who are barely learning basic literacy and mathematics skills and are completely marginalized from opportunities to engage in critical, analytic thinking. Schools have regimented their learning such that they have no voice in what they learn, no space to shape the space, topics and process of their education.

And yet, schooling has oft been written about a place where students learn to engage and experience the ideals of democracy (Dewey, 1916; Giroux, 1989; Goodman, 1992). How have the ideals of democracy given way to sub inequality? How might youth come to experience schools in democratic ways when the history of urban science education in American frames youth as in need of fixing, and schools as ways to standardize experience?

Democracy is a challenging word to use in our postmodern world. In contemporary discourse, democracy has come to mean the right to free speech, to vote, a method of decision-making, a political culture, a form of government, an historical perspective, to name only a few referents. Global events, including war, increased deforestation, the collapse of the global economy, has helped to further redefined democracy as a political ideology.

Democratic education has been grounded not in a political process or ideology but in a way of seeking a common good through schooling. The work on democratic classrooms arises from a political literature (Lane & Errson, 2003) and includes a commitment to social justice (Satz, 2007; Rawls, 1971). In the US, the democratic classrooms and schools movement emerged in the late 1980s. Democratic classrooms have been described as "those where all participants – teachers and students alike – have equal right and responsibility to participate in the decision making which frames classroom life" (Apple & Beanne, 1995). Such decisions include curricular scope and focus, classroom participation structures, and rewards and

punishments. Yet such rights and responsibilities are much more expansive than decisions around how classrooms activities happen. More deeply embedded in life in classrooms are the social and cultural structures that maintain relations of power among students and teachers. It is also necessarily part of the democratic classroom that the responsibility for shared power and the protection of marginalized voices and perspectives is also elemental.

It is not hard to imagine why democratic science classrooms have not gained much traction. Science teachers working in urban schools face the formidable task of preparing increasingly diverse students from low-income, minority backgrounds for competitive science careers in a high-tech global economy and for citizenship in a world rich with scientific debate. Science teachers facing this mandate are likely to be young and new to teaching. They often are well prepared in science but lack sufficient preparation in teaching in urban contexts to be successful, leading many to abandon the profession because of feelings of failure and isolation. Furthermore, schooling is framed around traditional models of education, where classrooms limit students to being consumers of knowledge who are expected to memorize facts selected as important by their teacher. The traditional relationship between teachers and students leave students with limited opportunities to participate in classroom decisions. In traditional classrooms, teachers are engaged in a power relationship with students in which they profoundly constrain the actions and choices of students. And yet, teachers themselves are caught in a world where they are expected to be the sole authority, both positionally and intellectually.

In addition to these challenges, little attention has been given to what it means to have the right and the responsibility to participate in decision making for either the individual or the social collective in which they take part. One can envision the importance of rights in classrooms by looking at the case of the respect for students' intellectual property, the prior knowledge of science that students bring to the classroom from their cultures and home lives, their "funds of knowledge" (Moll, Amanti, Neff & Gonzalez, 1992). Recognition of students' funds of knowledge is in contrast to common classroom practices where low-income, minority students are seen as deficient in knowledge and skills. To evaluate how teachers value and use students' intellectual property, one can document when and how often curriculum is situated in students' life experiences, home life, background, and cultural and social identities – their funds of knowledge.

While the history of research and development done on building democratic classrooms is important, our concern is more with how we – as researchers, teachers, curriculum developers and assessors – come to understand student participation in science learning and its impact on life beyond school. This book is written to describe frames for advancing critical democracy in science education. What it means to bring student voice into science classrooms in ways that foster critical democracy – not only in how teachers and students enact classroom life together, but also in how students (and teachers) are supported in leveraging their school experiences towards building a more just world?

Specifically, we use the ideal of democratic education in science to call attention to ways of being in the classroom that positions youth as important and powerful

participants in their own learning and that of their peers and teachers, and also as members of a larger global society who can leverage their lives in schools towards making a change. We step back to John Dewey to call attention to democracy as "a mode of associated living, of conjoint communicated experience" (Dewey, 1916, p. 87). "Conjoint communicated experiences" seem to be at such odds with schooling today for it calls direct attention to equitable ways of being in the classrooms and moving forth with and through education– a commitment to social consciousness and social reconstruction.

This framing deviates from much of the literature on democratic classrooms where the focus is on how the process of learning itself can become more democratic or in how classrooms can foster deeper understandings of and experiences with democracy. This distinction is important. Democratic classrooms position learning as a dialectic process, where students and teachers learn to "read the word and the world." This means that one both views the world with a critical mindset and envisions how to advance in the world or change the world into a more socially just and equitable place with and through science, while considering oneself as powerful scientific thinker and doer of science.

Thus, the aim of our text is not to provide a "how to" guide to building democratic classrooms. Such classrooms are locally contingent; there is no recipe for designing democratic science education. Rather, we are concerned with the tools that teachers and researchers might use to foster ways of being that lead to conjoint communicated experiences.

DEMOCRATIC SCIENCE CLASSROOMS: VOICE, AUTHORITY AND CRITICAL SCIENCE LITERACY

Consider a girl, who attends middle school in the poorest congressional district in the country, and is failing science in the fall of 6th grade, but then builds a strong relationship with her science teacher through caring for animals in his classroom during recess and after school. He leverages her animal caring experiences to position her as a science expert during science class. She moves to an A student and refers to herself as "a science poster child." The experiences that students bring to the classroom and how they are able to voice them towards the creation of empowering science education matters.

Consider another girl, whose has struggled with school attendance and success but who also considers herself a "make a difference expert" because she helped to design and collect over 200 surveys on the local community's energy practices, analyzed them in excel, and presented the findings to the mayor's energy policy council, who then made changes in how they distribute recycling bins to Lansing residents. Youth are experts and working with them to author transformational authority matters in building a more just world.

Consider a middle school boy, who likes math but wants to open a t-shirt shop when he grows up. He does not know what engineers are or what they do, and his mom is worried if her son gets too much into science and math he may get picked on. Yet, after conducting an energy audit in his school along with his classmates