Cultural Reactions: Reality Pedagogy in Science Education

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Abstract: The United States and its school systems are becoming increasingly diverse. Science educators are tasked with stimulating the minds of multiple ethnic and cultural groups during their pedagogical career. Some science educators may have the mission of cultivating students in a location where none of the students share the educator's cultural background. Culturally responsive pedagogy assists educators in bridging the cultural gaps between students and presents science content in a method that is relatable. Reality Pedagogy is a subset of culturally responsive education that can be implemented by educators in diverse settings. Reality Pedagogy consists of five foundational blocks: cogenerative dialogues, coteaching, cosmopolitanism, context, and content. Case studies have validated the effectiveness of Reality Pedagogy in diverse pedagogical science environments.

Introduction

Attending a high-needs, urban high school, Preston was a student who possessed an exuberantly inquisitive mind. Preston often asked my colleagues and I questions that were at the forefront of his mind, no matter what the time of day. In his spare time Preston took care of his snake zoo at home, as he owned 23 different snakes. A majority of the questions that Preston asked were about animals, in particular, about snakes. This behavior of strongly pursuing knowledge through questioning was consistently displayed by Preston in all his classes. Despite Preston's highly demonstrated enthusiasm for engaging in classroom discussions, several of his teachers expressed concern over Preston not completing any work that was assigned in their class.

These facts came as a surprise to myself and my mentor teacher. We initially had the same problem with Preston not completing any assigned work during the first few weeks of the school year. However, after discovering Preston's passion for animals, especially snakes, we consistently found ways to integrate relevant animal examples into the content being taught for the physical science class that Preston was in. Shortly after integrating these animal examples early in the school year, Preston rarely missed submitting an assignment, his work was high quality, and he exhibited mastery over a large percentage of the physical science content. My mentor teacher and I became advocates for Preston, sharing with our colleagues that Preston was full of potential and just needed additional scaffolding through linking content to his past experiences.

The concept of linking an individual's past experiences and surrounding environment to a pedagogical setting is one component of culturally responsive pedagogy (Ladson-Billings, 1995). To some students, science is a foreign ideology and way of life from which the student believes she or he are alienated because of her or his background. Presenting science by drawing on the rich history of students breaks down mental and cultural barriers that obstruct student belief in his or her own abil-

ity to utilize science in everyday life. The success of social reform is correlated to scientific development in a cultural group (Krugly-Smolska, 2013). Empowerment of students by incorporating a culturally responsive science curriculum shatters the chains of oppression, rehabilitates physical and mental famine, and spurs students toward achieving their goals.

Diversification of American Schools

The need for culturally responsive pedagogy in science classrooms in the United States has only been growing. Culturally responsive pedagogy benefits any classroom in which it is implemented, especially classrooms where the student demographic majority and educator are of differing cultural backgrounds (Le & Matias, 2018). Over the past two decades, American schools are becoming more and more diverse in student population.

From 2000 to 2017, the percentage of White students sunk from 61% to 48% (NCES, 2020). The percentage of Black students fell slightly while the percentage of Hispanic students rapidly increased from 16% to 27% (NCES, 2020). Incremental increases of students in various cultures or mixes also occurred over the same period (NCES, 2020). From censuses and demographic modeling, experts are predicting that over the next decade the trend of a balancing of racial diversity will continue to occur. While diversity of the student population is growing in the United States, the cultural construction of workers in the education field is predominately monoethnic. More than three-quarters of educators are White. A large percentage of science educators are teaching student demographics that differ from the educators own cultural background.

Borrowing from Le Chatelier's Principles (Ebbing, 2005), if the desired product is student achievement and social reform, then the reactants of teachers, curriculum standards, and students require a catalyst in the form of culturally responsive education to drive the reaction to create students that are active, productive members of the global society. The need for culturally responsive education in science is growing and, while the field is in a stage of infancy, several research-validated methods have been established.

Practicing Culturally Responsive Science Education: Reality Pedagogy

Reality Pedagogy is one research-validated practice of culturally responsive pedagogy that can be implemented in a classroom to legitimize what counts as science and how to assess the artifacts submitted (Emdin, 2016a). Assembling a Reality Pedagogy realm requires the formation of five foundational blocks. Each block supports all activities and artifacts implemented in science pedagogy. Emdin fondly refers to these five foundational blocks as the Five C's of Reality Pedagogy (Emdin, 2016b). The composition of the Five C's of Reality Pedagogy is: cogenerative dialogues, coteaching, cosmopolitanism, context, and content.

Cogenerative Dialogues

The first of the Five C's is cogenerative dialogues, or commonly abbreviated as cogens. "Cogens occur with the goal of reaching collective decisions about the rules, roles, and responsibilities that govern students' lives (Roth, Tobin & Zimmerman, 2002) and lend themselves to discussions with students about the inhibitors to their engagement in the classroom." (Emdin, 2016b). Removing inhibitors is critical to encouraging growth of all students in scientific knowledge, including those of minorities who are underrepresented in scientific fields. Minority groups in the United States such as Hispanics possess a lower percentage of employment in scientific fields than the corresponding percentage of Hispanics in the United States population demographic (Funk, 2019). Creating and infusing belief in minorities that science is an achievable field to craft a living in is one such barrier that can be broken down. While this barrier can be addressed in a cogen, cogens are more useful to the educator in order to formulate a classroom model that positions the students to best relate with scientific concepts (Emdin, 2016b).

By periodically meeting with a rotating group of students, the teacher receives honest, relevant feedback as to how the students are interacting with the material being presented in the class. Cogens create sounding board for future lesson plans, allowing the educator to maximize the time spent in the classroom with students (Emdin, 2016b). Understanding the culture of the students, how students best learn, receiving honest feedback on class structure, and planning for future lessons that engage the students' interest all are established benefits of implementing cogenerative dialogues in science.

Coteaching

The process of coteaching involves pairing a novice teacher with an experienced teacher from the culture in which the novice teacher is placed (Emdin, 2016b). Performing an understudy with an experienced teacher provides insights as to common misconceptions about science held by students. For example, some of the most challenging science topics to introduce are those where science terminology possesses alternate meanings in the surrounding community culture (Hayden, Singh & Baird, 2019). Expanding the vernacular definition of words such as compound, speed, energy, and classification to include a science-specific definition to pre-established applications of the word was accomplished with strategic lesson planning. The wealth of experience gained from the coteaching process greatly eases the growing pains of a novice science teacher.

From personal experience while teaching in a high-needs, urban school the past year, I was paired with an experienced teacher that was well-versed in the culture of my placement. The experienced teacher helped guide me to awareness of a myriad of nuances of the community I was working for and with. In one such instance, I had accidentally scuffed the side of one of my student's shoes, which was a new shoe, while walking past him in the classroom. After issuing a quick apology and proceeding on with the task at hand, I noticed that the student was still visibly distraught over the ordeal.

At the end of the day, I asked the experienced teacher that I was working with about the situation. She proceeded to inform me that shoe fashion was extremely important in the African American culture that we were working in. Not wanting to have the shoe scuff become an inhibitor to the student from being open to interact with science, I privately pulled the student aside the next day before class. After apologizing to the student again, I demonstrated interest to the student about shoe culture and gave him opportunity to share about the specific shoe he selected. While listening to the student, I was able to reciprocally share a link between the knowledge he was sharing about shoes and science. A relationship with a student was saved because of the insight of an experienced teacher through coteaching.

Cosmopolitanism

No matter what path in life an individual takes, at some point the individual must be able to function in a team setting. More than likely, students have already experienced a myriad of encounters in which they were required to work together. Utilizing the basic human desire to feel appreciated and possessing a need to belong, cosmopolitanism translates psychology to the classroom (Emdin, 2016b). Cosmopolitanism is an excellent tool for conveying worth and value to members of a classroom community through establishing roles for students in a classroom. By assigning essential classroom duties such as a Safety Specialist for labs to ensure all students receive a pair of safety glasses, Materials Experts to deliver lab equipment to and from storage locations and lab tables, or Data Analysts to chart class results, students are placed in positions of responsibility. Unique roles for group assignments and project-based learning activities can be designed for each group member, conveying the cardinal value of each student in the team (Elmesky & Tobin, 2005). Creating an atmosphere in which each student feels treasured and that the class cannot function without them generates strong engagement in science.

Context

Traditional science artifacts such as laboratory equipment, tools, charts and tables, or simulations while at first glance are sound pedagogical materials; however, these science artifacts may not be the most applicable or relatable to students' experiential knowledge. Context is the method of providing relevant artifacts to students from their culture that enhances students' pedagogical experiences in science (Emdin, 2016b). As science constructs and manipulates all that we can see or interact with, providing familiar context for students to interact with develops a deeper understanding of how their surrounding environment functions. Employing artifacts of familiar context confirms the usefulness of the content studied for students. Chemically analyzing hair styling products, experimentally calculating friction using dice and sporting equipment, or testing favorite snack foods for energy are just some examples of potential items found in students' lives that can be used to generate context. Finding artifacts from students' past experiences that provide relatable science context for the culture the educator is placed in may initially be challenging. However, this challenge helps grow the educator's perspective and expertise in their scientific field, resulting in engaging lessons for the students.

Content

Content is not strictly the science material but rather the creation of a classroom mindset. In this mindset, the teacher displays the fact of not possessing an infinite knowledge of science and the students are encouraged to explore and discover science material with the teacher together (Emdin, 2016b). Displaying a willingness to identify with and assist students in mastering science builds a setting where the student can witness the teacher's authenticity and genuine interest in their development. Demonstrating that science is not about one person holding all the answers and others absorbing and regurgitating the information, but rather a group discovery and validation of situational truths spurs on cognitive adventures for students. Through modeling, the educator shows that failure is part of the discovery process and that experimentation holds the key to unlocking new connections, inventions, and scientific principles.

Expressing openness and vulnerability as an educator while demonstrating qualification as a subject matter expert builds trust, excitement, and engagement in the classroom. While questions such as, "Do black holes have gravity?", or "How far down can you drill into the Earth's surface before overheating?" are not convenient to answer while guiding the class through a lesson about air resistance, quickly redirecting students permanently away from their questions conveys the aura that the students' thoughts do not matter. If the answer to the question is unknown at the present or if time is limited, one potential option is to utilize the research-proven technique of the Wonder Wall. The Wonder Wall captures the curiosities of students and encourages problem-solving collaboration in the classroom (Driscoll, 2007). Acknowledgement of the students' questions demonstrates the inherent value of each student and their thoughts. Ignoring or insensitively dismissing any form of scientific thought belittles the individual and propagates a negative disposition by the student toward the teacher and subject.

Conclusion

The Five C's of Reality Pedagogy are just one research-validated method for implementing a science pedagogy that is culturally responsive. Studies have shown the benefits of implementing Reality Pedagogy (Ramirez, 2018) and culturally responsive education (Goff, 2012) in science pedagogy. While no conclusive evidence has been provided yet that strongly correlates grade performance improvement with Reality Pedagogy, an increased understanding of the nature of science and a mastery of connecting science to everyday life has consistently been demonstrated in comparison to control groups (Borges, 2016). At a macroscopic level, the absence of culturally responsive science pedagogy can yield a loss of cultural identity resulting in students feeling alienated from their home culture and environment. Alternatively, the absence of one's home culture in science leads to the rejection of science by some ethnic groups (Lee, 2017). Scientific advancement is curtailed when culture is not included in formal or alternative assessments (Banks, 2004).

Much like the pyramid of Bloom's Taxonomy, if the base cultural needs of a student are not met, the foundation is missing on which to build the content and cognitive skills of a student. It is the students' surrounding environments, their

culture, that provide physical proof and building blocks for scientific concepts. Students are able to intrinsically recognize when science pedagogy is personalized to their experiences. After completing a Chemistry course that was culturally responsively designed, one student stated:

> It was kind of like looking at chemistry from a different angle, and it was looking at it like— we don't have to sit there with a textbook, we can think about how things were in the past, how it relates to now, and that there isn't just one way to look at chemistry. (Goff, 2012)

This is when science comes to life. Providing a culturally relevant, engaging science pedagogy may require additional time to construct, but will save the educator time in the long run by reducing the need for classroom management interventions.

As the student demographic continues to increase in diversity, so do the pedagogical content and artifacts needed to align with the demographic. Whether the student body and teacher are of the same ethnic or cultural background or not, culturally responsive education enhances the interaction of the student with science. For Preston, once he was stimulated through connecting science content to his love for animals, his enjoyment with science was a night and day difference to observe. Reality Pedagogy allows educators to meet students where they are at and help guide students to achieving their goals. Simply teaching content without considering culture is too low of a bar to set in science.

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