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EMPOWERING GIRLS OF COLOR THROUGH AUTHENTIC SCIENCE INTERNSHIPS

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Abstract

The underrepresentation of girls and students of color in STEM fields, particularly in science, is an ongoing issue that is very well documented. There is a limited amount of research that provides insight on experiences of girls, especially girls of color, who have been exposed to authentic science experiences. This article interrogates the effects of experiential learning on students' science identity and interest in pursuing a career in STEM, specifically for girls of color. This study provides insight into girls of color experience of authentic science internships where they followed a traditional working scientist schedule, the use of, or referencing of specific science knowledge, and use of traditional science lab equipment. Through this study researchers found that after participating in the authentic science internship, students became more confident to pursue careers in STEM-related fields and envisioned the field of science and STEM-related fields as approachable and accessible.

Keywords: science internship, girls in science, science education, urban education

Introduction

Kolb (1984) defines experiential learning as "the process whereby knowledge is created through the transformation of experience." He further argues, "knowledge results from the combination of grasping and transforming experience" (p. 21). In response, this article interrogates the effects of experiential learning on students' science identity and interest in

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pursuing a career in STEM (Science, Technology, Engineering, and Mathematics) for girls of color. We argue that truly enlightening and life changing experiences for urban youth, especially young girls of color, who "envision the field of science as distant and inaccessible" (Basu & Barton, 2007, p. 467) require a shift in traditional STEM education that supplements conventional instruction with powerful experiences doing and working in science.

Over the last two decades educators have been moving away from the traditional notion of the teacher being the sole provider of content knowledge and towards more cognitive, humanistic, social, and constructivist learning models and frameworks that stress opportunities for students to make meaning of content for themselves (Lewis & Williams, 1994). Following this trend, many science educators currently support the use of constructivist approaches to teaching and learning. In these approaches, students construct their own understanding and knowledge of the world and content by experiencing and reflecting on those endeavors. This new trend is a reincarnation of more classic ideas in teaching espoused by Dewey (1938). He emphasized that the creation of new knowledge, or the transformation of oneself through learning, was more fundamental than simply learning and being told how to do something.

Urban youth of color, in particular girls of color, lack encouragement to seek and access advanced learning opportunities, such as experiential learning, in STEM. Studies show that urban youth lack support and encouragement from science teachers and have erroneous preconceptions in regards to their ability, which diminishes their self-confidence, and frequently discourage and inhibits them from proactively seeking advanced learning opportunities (Marshall, McGee, McLaren, & Veal, 2011, p. 18). Therefore as many scholars suggest (Archer et al., 2010; D.M. Sadker, M. Sadker & Zittleman, 2009), girls, especially girls of color in K-12 education, do not identify with science regardless of test scores and success in science in the traditional classroom. Tan et al. (2013) suggest the cause for young girls' disconnect in science is due to the lack of attention addressing the science identity gap as it relates to girls in science.

The experiences of this population in science run counter to the recommendations of the National Research Council (NRC, 1996) and the American Association for the Advancement of Science (AAAS, 1993), both of which argue that science education should move towards providing students with "authentic" experiences to allow them to experience themselves as scientists. We argue that authentic experiences in science should involve providing students with the same or similar work tasks and responsibilities as individuals in science and science-related fields. Roth (2000) supported this view of authentic science experiences when he argued for instruction that considers solving real-world scientific problems, which are complex, but interesting to students. We argue that providing students, especially young girls of color, with authentic science work experiences allows them to envision themselves as scientists and view science as inquiry rather than just memorizing facts and theories, and encourages them to consider pursuing careers in science and STEM-related fields.

In this article we define authentic science internships as spaces where youth are able to partake in specific science tasks normally relegated to professionals with science degrees. These types of internships require a traditional working scientist schedule, the use of, or referencing of specific science knowledge and use of traditional science lab equipment. Furthermore, we suggest that if students are provided with opportunities to participate in authentic science experiences, they will be more likely to engage in science, pursue careers in science and related STEM fields, and identify as scientists. Given the statistics related to girls of color in science (e.g. Gibbons, 2011; Milgram, 2011) and the larger conclusions that can be drawn from existing research on their engagement in the discipline, this study was designed to provide insight into the

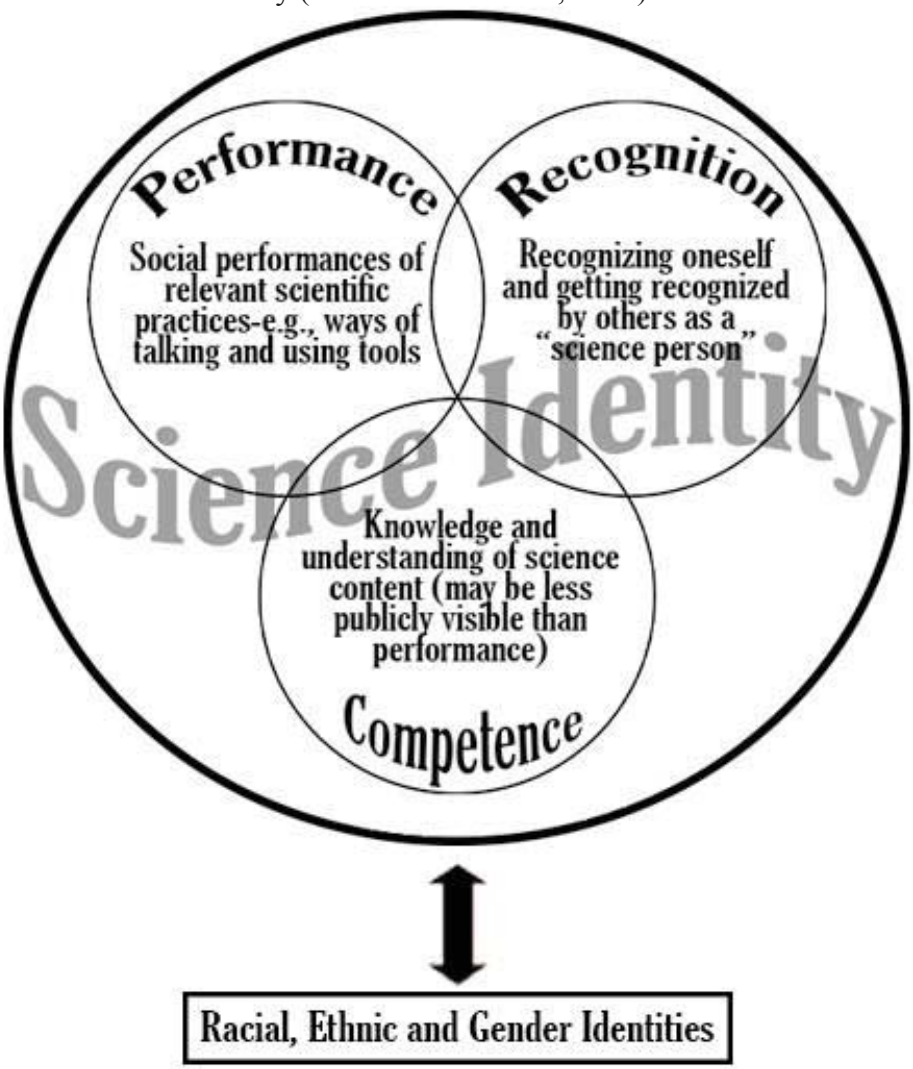
nature of students' experiences who participated in authentic science internships. In particular, we highlight the nature of the everyday experiences during science- work focused internships and students' responses to their engagement in experiential science work. We focus on the experiences of three girls of color who were part of what we define as authentic science internships.

Conceptual Framework

This study is rooted in a sociocultural framework that explores the concepts of culture and social capital as they relate to the experiences of female youth of color with access to authentic science internship experiences. We consider the science internship as experiences within social fields that the students who are a focus of the study are traditionally not privy to, and their experiences within these new fields and science as opportunities for an accumulation of new forms of capital. We draw insight from Bourdieu (2011), who describes capital and its varied forms as necessary for articulating the ways that humans exist in a social world. In particular, we focus on the forms of capital that are acquired in social fields like authentic science spaces where individuals develop a conscious or unconscious personal investment in an activity or process through participating and engaging in the same experiences as professionals in science-related fields. Through their experiences in science-work fields, the girls in this study gain "cultural capital," which in its embodied state, is both inherited and acquired as one engages with either new or familiar experiences. We argue that through participating in an internship in an authentic science space students will gain a new form of cultural capital that they did not have access to at their school or in other any other space. We suggest that students gain forms of cultural capital in the authentic science space ultimately by navigating and working in this new space. Then they can then use these new forms of capital to successfully navigate future science spaces more comfortably, if they choose to. In other words, by participating in their authentic science internship and gaining various forms of cultural capital, students are able to view themselves as scientists and learn how to successfully navigate science spaces. Over time, students have the opportunity to acquire new forms of science content knowledge through navigating authentic science spaces. In addition, the ease with which they engage in, and gain capital within, new science spaces (such as classrooms, science labs, or other science jobs) is increased as a result of their initial engagement within the authentic science-work experience. Although the participants in this study have not been traditionally trained as STEM professionals or in completing science tasks, their lack of traditional training does not inhibit them from successfully completing various tasks in their authentic science internships.

Tan, Calabrese, Kang, and O'Neill (2013) suggest that there is a lack of attention placed on addressing the science identities of young girls, which causes a disconnect for young girls as it relates to science. To define science identity in this study we used Carlone and Johnson's (2007) definition of science identity, which was informed by Gee's theory of identity (1999, 2000–1), to explain how an authentic science space can influence a student's science identity. Carlone and Johnson (2007) explain science identity as encompassing three overlapping dimensions: *competence, performance, and recognition.* These dimensions are informed by gender, racial, and ethnic identities (see figure 1).

Figure 1. Model of science identity (Carlone & Johnson, 2007)



Within this definition of science identity, *performance* relates to the scientific practices in which the student participates in their authentic science workspace. Within this space students are known to use scientific tools and "science colloquialism." *Recognition* refers to recognition of others and the students recognizing themselves as a "science person," by virtue of working *(performing)* daily in the authentic science space. Lastly, *competence* refers to the science-content knowledge that is gained by the student by *performing* authentic science tasks, and by shadowing an actual professional scientist in an authentic science space. One cannot enact a science identity unless they visibly *perform* their *competence* as it relates to science and in turn are *recognized* by others, especially by other individuals who identify as scientists (Carlone & Johnson, 2007). In this paper we argue that once provided with an authentic science internship space, students developed what Carlone and Johnson (2007) refer to as a science identity.

We argue that the goal for science educators is to create contexts that generate new forms of cultural capital that will eventually lead to the acquisition of science content knowledge (Adjapong & Emdin, 2015). This goal can be accomplished if and when students engage in the same or similar daily task completed by professionals who hold degrees in STEM related fields.

As students engage with professionals in STEM-related fields and are solving problems, completing tasks, and gaining experiences, they generate cultural capital that allows them to see themselves in these same authentic spaces in the future. Bourdieu (2011) describes cultural capital as having an unconscious and non-deliberate quality in terms of how the individual generates it. However, he also describes cultural capital as something gained as the result of "conditions of acquisition." The science experience becomes the context that generates the conditions of acquisition that the young people both consciously and subconsciously develop over time. Furthermore, by increasing the cultural capital for girls of color, through providing them with opportunities to comfortably navigate authentic science spaces, they develop a new view of science that shifts from distant and inaccessible to approachable and accessible (Basu & Barton, 2007).

Research Questions

1. Does the participation in an authentic science internship affect the science identity of girls of color?
2. Does the participation in an authentic science internship influence the pursuit of careers in STEM in girls of color?

Methodology

Research Context

Science Laboratory. "Science Lab" is a science-learning center that has been home to several Nobel Prize winners that is devoted entirely to genetics education. The center translates current biological research into hands-on learning activities for students and provides them with a more well-rounded science education experience than they would get in traditional schools. The participant at this site worked as a lab assistant to a science instructor who was responsible for implementing the Science Lab curriculum with secondary students in a hands-on science summer camp experience. The Science Lab is an authentic science workspace and laboratory that is equipped with the same science lab equipment used in college science laboratories and science industry. At this site, there was one participant who assisted the instructor in preparing all materials needed for the lab. The participant prepared stock chemical solutions and performed demonstrations for student campers on how to use science lab equipment.

Science Museum. The Science Museum actively engages its target population in educational and entertaining experiences through innovation and excellence in exhibitions, programs, and its animal and plant collection. The Science Museum encourages children to develop an understanding of and respect for themselves, others, and the world around them by exploring culture and the arts through science and the environment. Participants in this study interned in the science education department of the museum where they were in charge of maintaining animals such as insects and petting snakes. Participants also assisted in maintaining the museum's community garden and facilitated science workshops with visiting children, sharing with them scientific facts about animals.

Participants

Three girls of color participated in this study at one of the two authentic science workspaces described above. These girls are high school students who attend the same urban public school in the most densely populated city in the northeast region of the United States. Participants worked at the same site for six weeks during the summer, and were engaged in a number of tasks directly related to science work traditionally reserved to science professionals with either science degrees and/or some experience working in and with the discipline. All three participants were generally interested in science. They attended a school where exposure to science is limited, girls of color traditionally underperform in science, and the nature of the curriculum limits opportunities for youth to experience science or actively engage in science activities. Students at this school take a living environment course during their first year, earth science during their second year, and chemistry during their third year. There are no required science courses for fourth year students and no advanced science courses or science electives offered at this school. Students were selected based on interest in participating in a paid authentic science internship and had to complete an application, which included a resume and two professional references.

Erica. Erica is a first generation Haitian-American, who lives in a single parent household with two other sisters. Erica completed her second year of high school a few weeks before the start of her authentic science internship and self reported a 3.7 grade point average (4.0 scale). Erica was placed at the science museum to complete her six-week authentic science experience. Erica had no interest in pursuing a career in STEM, rather she was fixed on pursuing a career in the music industry as a recording artist. Erica saw the summer internship as an opportunity to gain experience that would look good for college applications and as a way to earn money during the summer.

Kim. Kim is also a first generation Haitian-American who lives in a two-parent household with two other sisters and one brother. Kim also completed her second year of high school a few weeks before the start of her authentic science internship and self reported a 3.5 grade point average (4.0 scale). Kim was not interested in pursuing a career in STEM before participating in her summer internship. On her application for the summer internship, Kim explained that she was familiar with the word STEM and that she understood that careers in STEM are secure and more profitable than other careers. Kim was also placed to complete her six-week authentic science experience at the science museum.

Tamara. Tamara is a first generation American who identifies as a Latina as her parents are Dominican and Puerto Rican immigrants. She began her senior year of high school upon completing her summer authentic science internship. Tamara self reported a 3.5 grade point average (4.0 scale). Tamara is different from the other two participants of this study, as she was interested in becoming a forensic scientist before her participation in the authentic science internship. Tamar completed her six-week authentic science experience at the science laboratory.

Data Collection

The primary data sources for this study were student interviews and students' weekly journal entries. All student interviews were transcribed in their entirety.

Interviews. Students who participated in the authentic science work experience were interviewed about their experiences at the end of the program. The goal of the interviews was to

understand the impact that the authentic science internship had on students' science identities and on their interest in pursuing a career in STEM. Among the questions asked during the interviews, the following questions are particularly significant for this study: What were your daily tasks as a student intern? What obstacles did you overcome during your internship? Explain whether or not you plan on pursuing a career in STEM after your authentic science work experience.

Student Journals. Students who participated in this study were encouraged to consistently reflect on their experiences throughout the duration of the program. Students completed weekly reflective journals answering the following questions/prompts: 1) Explain what you learned during this last week from your internship in regards to STEM, 2) What's one challenge you faced/overcame this week at your internship? and 3) Based on your experience at your internship do you plan on pursuing a career in STEM?

Data Analysis

Different data analysis strategies were used to efficiently and effectively analyze data collected during this study through student interviews and journal entries. The data was then studied and coded for emerging themes that highlighted students' experiences in the authentic science space. Qualitative coding techniques, including member checking and coding for recurring themes, were used to analyze all the data generated from this study (Guba & Lincoln, 1989; Creswell, 2013). All student interview data were entered into a word document for word-by-word coding for emergent themes by the first author. Once these emergent themes were identified the data was entered into Nvivo to be organized, and was then grouped into recurring emergent themes. The two themes that emerged from data analysis were (1) The influence of authentic science experiences on students' science identity and (2) students' increased interest in pursuing a career in STEM.

Results and Findings

The findings of this study are organized by recurring themes that emerged during the data analysis process. Moments from transcripts that served as exemplars, and participant's journals that reflect students' experiences individually and collectively provided insight on the experiences of three girls of color who were provided authentic science internships. Consequently these exemplars are highlighted in the results and finding below. Through the analysis of themes from students' interview responses and journal entries, results indicated that the (1) authentic science space work experience positively influenced students' science identities and (2) students' showed increased interest in pursuing a career in STEM.

Authentic science space's influence on students' science identity

Through participation in their authentic science internship, each of the three student interns reported changes in their perceptions of their own science identities. All students reported self-doubt in regards to their ability to excel and succeed in the pursuit of STEM careers due to limited access to authentic science spaces, and perceived gender and racial identities. Students spoke in depth to the stereotypes, which exist both for women and people of color, which impact their ability to excel within STEM fields. For example, in an initial journal entry at the start of her science internship, Erica wrote:

> People of color are not usually found engaging within the subject of science but allowing them to get a feel of what a job that pertains to science feels like, breaks barriers. As a woman who is also kind of left out of the loop when it comes to pursuing science it feels good to take a step in breaking some more barriers.

In this response Erica shines light on two pieces of her identity, which she feels distance her from STEM fields. Erica specifically says, "people of color are not usually found engaging with the subject of science" and that "as a woman" she feels "left out of the loop" in regards to pursuing a career in science. Where traditionally Erica has found herself unable to fully engage in STEM subjects based on her race and gender, participating in this internship allowed her to "take a step in breaking some more barriers." It appears the internship has empowered her to push back against larger systemic issues that would traditionally distance her from pursuing a career in a STEM related field. In addition, another student, Tamara, affirms Erica's sentiment towards pursuing a career in STEM by stating:

> Science internships are important for people of color because it seems like everything is against us. We're told we're too dumb, too lazy, too uneducated to do what we can set our minds to do. Internships give us incentives to be better, it gives us the opportunities we never had.

Tamara reports that as a person of color, "it seems like everything is against" her. In past experiences attempting to engage in science, she felt as if the world was telling her she was "too dumb," "too lazy," or "too uneducated to do what [she] can set [her] mind too." However, this authentic science internship experience provided her with "incentive to be better," and "gave [her] the opportunities" she felt she never had. Overall, engagement in the authentic science internship has allowed Tamara to push back against the very pieces of her identity the world has conditioned her to believe. These beliefs have encouraged her to see the field of science as inaccessible and distant. A third student, Kim, stated:

> As a woman pursuing science, I feel like it's going to be very hard for me, but the rewards, be it the career that I choose, would be worth it, especially with all the hardships I probably would face.

Kim speaks here to the issues she faces based on gender. Similar to Erica, Kim feels stunted by the fact that she is a woman pursuing a career in science. Kim believes that being a woman makes her feel as if "it's going to be very hard" for her to successfully achieve her goal. However, her engagement in the authentic science internship gives her an opportunity to push back against "all the hardships," which she believes will function as "rewards" and make her journey "worth it." By participating in the authentic science work experience, Kim appears able to reframe the capacity in which she thinks about the obstacles she may encounter in science in the future. Whereas traditionally Kim's gender makes her feel as if she cannot be successful in science domains, the science internship encouraged her to work through those struggles in order to be successful. The authentic science work experience allowed Kim the chance to reframe this cognition.

Students increased interest in pursuing a career in STEM

Through participation in the science internship, each of the three student interns reported increased levels of interest in pursuing a career in STEM. Tamara reports that the internship:

> Opened my eyes to even more like different branches of science. Like I wanted pursue forensics and that's what I wanted to do but…[the internship] made me look like maybe I could be a chemist or a bioengineer.

In the aforementioned statement, Tamara mentions that the internship opened up her eyes to alternative STEM career options. Whereas she originally believed "forensics" was "what [she] wanted to do," her experience in the internship showed her that options such as "a chemist," or "a bioengineer" are potential career fields, which she can pursue. Erica seconds these sentiments explaining,

> My internship kind of encourages me to pursue a career in STEM because over the course of my internship I've gotten to see a hand full of careers that are in STEM that aren't too bad. I will say that this internship has opened my eyes to STEM careers and I wouldn't be surprised if 5 years from now I'd be graduating college with a masters in a STEM field.

In this statement, Erica, who in her initial journal entry stated that, "science is a subject that I am not too fond of," explains that the internship allowed her "to see a hand full of careers that are in STEM" which she perceived as not being "too bad." Erica goes on to explain that this exposure to alternative career options has her feeling as if "5 years from now [she'd] be graduating college with a masters in a STEM career." Kim expressed similar feelings, in her interview she reported that the internship:

> Does encourage me to pursue a career in STEM, because I see how interesting and fun it could be. I simply need to do more research on the different kinds of career paths that I could have. I learned that in STEM, there are so many subcategories, that I don't have to limit myself to biology.

Kim tells us that she felt encouraged "to pursue a career in STEM, because [she] sees how interesting and fun it could be." It appears her engagement in the internship stemmed from enjoyment, and allowed her to open her mind to new possibilities. Kim also mirrors the feelings of both Tamara and Erica, saying that "I learned that in STEM, there are so many subcategories, that I don't have to limit myself." All in all, each of the three participating students appeared to see new possibilities for themselves after participating in this internship. Each student felt as if there were various career paths available to them, which they had previously not considered.

Conclusion

The fact that girls of color from an urban setting, who did not find interest in science as a subject, could become encouraged to pursue a STEM career in the future is a testament to how beneficial and crucial authentic science work experiences are for them. The girls who participated in this study have increased their cultural capital through participating in the

authentic science internship as it relates to navigating science spaces and envision themselves able to successfully navigate similar spaces comfortably. These girls of color have developed a personal investment in science while engaging in authentic science work experiences, which encouraged them to identify as scientists and understand their potential in pursuing a career in a STEM-related field. Through their summer internship experiences, students have gained new forms of cultural capital in authentic science spaces, as they understand how to successfully navigate authentic science spaces. Also, by virtue of effectively working in an authentic science space, students are provided a space to develop a science identity, as defined by Carlone and Johnson (2007), as they are performing science duties, developing a new science competence through the performance of these duties all while being recognized as scientist.

This study provides insight on how girls of color are impacted by authentic science work experiences and is beneficial to understanding how to better engage them in science and STEM-related content. Although there was a small sample size of participants used for this study, the implications of creating and providing authentic science internships for urban girls of color are beneficial to positively influencing their science identities and creating a pipeline of girls of color to pursue careers in STEM. After conducting this study, we are not suggesting a complete overhaul of the education system, rather we want to draw attention to the importance of creating opportunities and authentic science spaces for students of color from urban communities, especially girls, to imagine themselves as STEM professionals and to develop science identities. This study demonstrates that through participating in the authentic science work experience, participants were able to envision themselves as scientists, claim a positive science identity, and better understand and reframe the capacity in which they think about the challenges that they may face as they pursue a career in a STEM-related field.

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