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Abstract

Using consensual qualitative research, the study examines urban high school students' reactions to a science, technology, engineering, and math (STEM) enrichment/career development program, their resources and barriers, their perspectives on the impact of race and gender on their career development, and their overall views of work and their futures. The sample included nine students who participated in a semistructured interview at the end of the 2-week summer program and again 12–18 months later. The results indicate that the students continued to explore STEM fields after the summer program, reported increases in STEM knowledge, described strong identifications with their racial and gender-based identities, and identified relevant resources and barriers affecting their STEM education and career development. Suggestions for further research and program development are discussed, including the development of interventions to enhance the supportive elements of students' relational and educational contexts.

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Keywords

urban high school students, STEM career development, career exploration, resources and barriers, racial and ethnic identity

This study was inspired by recent movements to infuse innovations in science, technology, engineering, and math (STEM) education, a field that is currently suffering from a major shortfall in the number and quality of young people who are studying and contemplating careers in STEM fields (National Research Council, 2007). The current situation in the U.S. STEM labor force is considered a crisis by many in education, government, and industry (National Academies Press, 2007; National Research Council, 2007). A number of potential solutions have been proposed to deal with this crisis, many of which include developing more compelling and relevant science education curriculum and more effective ways of fostering exploration of STEM careers (National Science Board, 2008). In this article, we used a qualitative approach to examine how urban high school students construct meaning about STEM careers after their completion of a 2-week STEM enrichment/career development program and again 12–18 months later.

The challenge facing the United States as well as many other nations is complex and multidimensional. First, the crisis in developing and sustaining students' interests in STEM fields is causing concern regarding the competitiveness of the U.S. economy (National Science Board, 2008). Second, this crisis has a disproportionate impact on marginalized student populations, namely poor and/or ethnic minority students, which is particularly problematic because STEM careers and STEM skills currently provide significant potential for achievement, financial stability, and upward mobility (Barton, Tan, & Rivet, 2008; National Academies Press, 2007).

While STEM programs increasingly include systematic career development programs (e.g., Cordero, Porter, Israel, & Brown, 2010; Fouad, 1995), a key question has remained unanswered. Specifically, *how can we move from helping students explore STEM fields to having them actually consider STEM fields as viable career aspirations?* In this study, we explore this question within a longitudinal context in which we interview a cohort of students immediately after a 2-week STEM/career development program, and then 12–18 months later, thereby embedding this project in the natural context of maturation and exposure to STEM/career development education.

As reflected in recent scholarship on STEM educational and career development (e.g., Ceci & Williams, 2007; Valian, 1998), the development of career interests is one essential component in understanding how to promote and retain students' involvement in STEM careers. Consistent with the most influential perspectives on career interests (i.e., Savickas & Spokane, 1999), interests are generally defined as preferences for particular activities that are associated with feelings of pleasure and satisfaction. The development of career interests begins in early childhood (Bryant, Zvonkovic, & Reynolds, 2006) and is further shaped by socialization,

educational experiences, extracurricular activities, and other environmental influences (Savickas & Spokane, 1999). Children's exploration and curiosity can be encouraged or discouraged by exposure to activities, books, and educational resources. Environmental influences may include family, media, role models, school-based experiences, and access within institutional structures.

Considerable research has been conducted to explicate the impact of new STEM curricula and focused career exploration activities on individual interests and performance in STEM-related courses (e.g., Cordero et al., 2010; Fouad, 1995; Gibson & Chase, 2002). For the most part, these research efforts have relied upon macro-level, aggregate studies, which while informative, do not provide the level of insight and depth that can be obtained in qualitative research. While an exhaustive review of the STEM career development literature is beyond the scope of this article, our analysis of this material reveals a number of relatively consistent trends. In relation to the goals of this study, the existing quantitative literature, when considered collectively, has revealed that nurturing self-efficacy in STEM skills, stimulating students' STEM interest, and illustrating the value of a STEM-enriched education play central roles in mediating educational and career decisions (e.g., Barton et al., 2008; Byars-Winston & Fouad, 2008; Navarro, Flores, & Worthington, 2007).

Despite the richness of the quantitative research, numerous questions remain about the psychological and contextual factors that influence the exploration and consideration of STEM careers. In sum, the quantitative studies have not been able to reveal how students construct meaning about STEM education and career development. The qualitative research in this area has revealed some informative findings. For example, African American college students' decision to persist in their pursuit of a STEM career was related to their perception that a STEM career field is consistent with their life goals and preferences (Lewis & Collins, 2001). In a similar vein, Basu and Barton (2007) found that urban, high-poverty youth sustained science interests when science activities were presented in forms that were meaningful and useful to them and allowed the students to interact with the material in autonomous ways. Using grounded theory, Packard and Nyguen (2003) interviewed 41 women, aged 18–21, who participated in a STEM-enriched summer program during high school to assess their perspective on the impact of the program in their subsequent careers plans. Their results revealed that STEM-based internships, involvement in relevant STEM education, and mentoring relationships were particularly important in helping students develop and sustain interests in STEM careers. When considered collectively, these studies point to the continued importance of qualitative research as a useful tool in advancing STEM/career development research.

The challenges of moving into STEM careers are even more daunting for students of color. Considerable research has documented that a science academic achievement gap persists to the disadvantage of non-Asian ethnic minorities (National Assessment of Educational Progress, 2011). The causes of this achievement gap are multidimensional, including, but not limited to, inadequate preparation due to poorly

resourced schools (Aschbacher, Li, & Roth, 2010), inconsistent or inadequate science instruction (Li, Klahr, & Siler, 2006), and lackluster STEM education (Barton & Tobin, 2001). In addition, for students who start out in the STEM pipeline, academic and cultural isolation creates a notable barrier that is often subtle, but pernicious (Johnson, 2007). By exploring students' experiences in depth, we may be able to derive new inferences that can inform subsequent research and program development that affirms the cultural context of urban high school students.

In order to obtain an in-depth picture of students' consideration of STEM careers, we conducted a qualitative study based on interview data collected at two points in the students' lives. The interview protocol, which changed only slightly in the two data collection points, was constructed to include issues that have emerged as potentially viable factors in previous research on career development and STEM education (Blustein, 2006; Savickas & Spokane, 1999). In addition, we included factors that have been implicated in urban high students' educational experiences in theory and research (e.g., Blustein et al., 2010; Howard et al., 2010), including students' constructions of themselves and work, their experience of resources and barriers, and their views about STEM education, connections between school and future work, planfulness, and students' identities. Using Consensual Qualitative Research (CQR; Hill et al., 2005) as the methodological framework, we initiated this study to chart students' experiences of STEM education, career plans, and exploration, and their experience of their resources and barriers at two points in their high school education.

Method

Participants

The sample for the current study included nine students who were interviewed directly after their participation in the STEM/Career Development summer program and then again 12–18 months later. The demographics of the sample (as summarized in Table 1) reflect a diverse cohort of students that is representative of the broader composition of the city school district. The sample consisted of 55.6% female ($n = 5$) and 44.4% male ($n = 4$) students. Also, 66.7% students ($n = 6$) attended a science-focused public high school and 33.3% students ($n = 3$) attended a comprehensive public high school. The two high schools are part of a large urban school system in which the majority of students are eligible for either free lunch (62%) or reduced lunch (10%).

Comparing the grade point averages (GPAs) and gender distribution for the samples interviewed in Time 1 and Time 2 yielded the following results: GPA (Time 1 = 2.66; Time 2 = 2.86); Gender (Time 1 = 58% male and 42% female; Time 2 = 44% male and 56% female). (Please note that the Time 1 data are based on the larger sample and Time 2 data are based on the nine students who were interviewed.) Statistical analyses with samples that are so disparate with respect to sample sizes are difficult

Table 1. Participant Pseudonyms, Ethnic Backgrounds, and Future Plans

Pseudonym	Ethnic background	Career aspirations	
		Time 1	Time 2
Natalie	African American, Puerto Rican, Trinidadian, and Caucasian	Law	Psychology, Law, Chemistry, Dance, Fashion Design
Jennifer	El Salvadorian	Nursing	Nursing
Latoya	Haitian	Obstetrics/Gynecology	Obstetrics/Gynecology
Elizabeth	Mexican	Biology, Foreign Languages, and Music	International Relations
Sarah	African American	Pediatrics or Nursing	Nursing
Darrell	Jamaican & Cuban	Law or Accounting	Business (Stock Broker)
Jean	Haitian	Architecture, Engineering, or Medicine	Biology/Pre-Med
Sean	African American/Antiguan	Marine Biology	Writing
Andre	Puerto Rican	Teaching, perhaps Chemistry	Diplomacy and International Studies

to interpret meaningfully. That said, the data from these two time frames suggest some differences in the samples that are examined in the Discussion section.

Procedures

Students were recruited for the program and the follow-up interviews by their teachers and program staff. Of the 62 students who took part in the STEM/Career Development program, 57 participated in the interviewing process immediately following their involvement in the program. However, we were able to obtain usable second interviews from only nine of the students. The reasons for the attrition are related to the transient nature of urban high school students, changes in school leadership, and student disinterest in being interviewed again. Interviews were conducted at the university that housed the STEM/Career Development program and the students' high schools. At the start of each interview, interviewers reviewed an assent form that the students signed in addition to the consent form that their parents had signed prior to the interview.

Program Structure

The current study is framed by the participants' involvement in a 2-week STEM/Career Development summer program, which preceded the first round of interviews. The primary goal of the program is to promote a clear pathway from high school through college to STEM careers. Students received modest compensation (\$300) for their involvement in the summer program and a \$15 gift card for participating in the second interview. The program is based on an urban ecology curriculum and emphasizes the relevance of students' current academic work to future careers, thus stimulating students' motivation to succeed in high school. The STEM part of the program capitalizes on the students' local city environment and employs geospatial technology, computer modeling software, and field studies to investigate environmental issues in urban ecosystems. In addition, students regularly interacted with career counselors using a "Transferable Skills" (TS) curriculum. The TS curriculum provides opportunities for students to explore themselves, the world of education and work, and to identify the transferability of the skills learned in STEM contexts to a wide array of careers.

Description of Qualitative Methodology

CQR involves in-depth, individual and cross-case analyses based on data collected through open-ended, semistructured interviews (Hill et al., 2005). Several judges conduct coding of domains and core ideas in order to incorporate multiple perspectives. Domains and core ideas are discussed until consensus is reached by the research team members with an auditor making the final decisions in cases in which a consensus is not readily attained.

Three steps were followed for data analysis prescribed by CQR (Hill et al., 2005): (a) identifying and coding domains or the general themes derived from the interview transcripts; (b) constructing core ideas or the more specific aspects of a given domain; and (c) completing a cross-analysis, including the creation of categories from the core ideas and assessing the frequency of domains and categories across all interviews once data were saturated.

Research Team

The CQR research team was comprised of three doctoral students, four master's students, and one faculty member who functioned as an auditor. The research team was multidisciplinary (one counseling psychology doctoral student, one science education doctoral student, one educational research measurement and evaluation doctoral student, four counseling psychology master's students, and one counseling psychology professor) and ethnically diverse (four Asian/Asian American students, one Black student, two White students, and one White professor).

Training Judges

Training involved 8 weeks of 1-hr meetings during which the primary researcher led discussions about the epistemological aspects of CQR, data analysis procedures as described by Hill et al. (2005), and power dynamics within the interview structure. Prior to the coding of any data, the research team reflected on and discussed biases regarding the content of the interviews and the population that might influence the analysis. Four research team members had little or no exposure to diversity and were not familiar with participants of the study. Two members of the research team believed that urban youth typically would be less interested in STEM fields and higher education. One researcher believed that urban youth would be motivated below their actual ability level. Two researchers stated that lack of support from parents and school would affect urban youths' career trajectory. All expressed concern that their own racial background might influence their coding of student transcripts. After a thorough discussion about these biases, the team members agreed to bracket their suppositions and to approach the data with as much objectivity as possible.

Interview Protocol

An interview protocol was developed by a career development scholar and members of the STEM research group. The interview used at Time 1 contained 38 open-ended questions and the interview protocol used at Time 2 was condensed to 34 questions to reduce redundancy. As reflected in the interview protocol provided in Appendix A (i.e., the Time 2 version), the questions examined students' post-high school goals, self-perceptions, reactions to and experiences in STEM courses, identification of connection between current interests/experiences and future goals, social support,

social identities (gender, race, and ethnicity), perceptions of work, and future expectations. The length of interviews ranged from 16 min to 70 min, with an average of 32 min.

Data Preparation and Analysis

Identifying information was removed from the interview files, and each participant was assigned a code number and a pseudonym to preserve confidentiality. The team members were instructed to type the audio files, including interviewer and student responses verbatim. Another team member then checked the completed transcript against the original audio file to ensure accuracy and make any necessary changes.

Initially, the research team reviewed four randomly selected transcripts in order to derive a list of thematic domains from both the interview protocol and the data. (These transcripts were from interviews with students not included in the final data set.) The first list consisted of nine domains. Over the course of five weekly meetings, 10–15 team members (including additional graduate-level student volunteers) refined the list, collapsed related ideas into single domains, and added two domains, ultimately achieving consensus for a final list of nine domains. The team used these four interviews to further generate core ideas, or summaries of the data that capture the essence of what was said in fewer words and with greater clarity (Hill et al., 2005). The final codebook was then used to code all 18 Time 1 and Time 2 transcripts into domains and core ideas. Six team members worked in rotating pairs to independently code select transcripts. The pair of team members then discussed the individual coding until they achieved consensus. During this coding phase, no new domains were evident, and only one core idea was added. Despite the modest sample, data saturation was obtained, reflecting the point at which no new core ideas are identified for both data sets.

After consensus was reached among coding teams, a third team member audited the codes for domains and core ideas for each case. The audit process entailed checking to ensure the raw data were appropriately coded for domains and core ideas. All three team members then reviewed the audits by going back to the original data, discussing each comment thoroughly until a consensus was reached. Coding teams consisted of rotating members of three (two coders and one auditor) to ensure varying perspectives throughout the data analysis process as recommended by Hill et al. (2005).

The coded data were separated into Time 1 and Time 2 interviews. The occurrence of each domain and core idea within individual interviews was then noted, and the number of interviews in which each theme was present across the data set was determined. We then applied the frequency descriptions detailed in the CQR model. Each domain and core idea was given a label of General (found in all cases), Typical (found in half or more but not all cases), Variant (found in less

than half but more than one or two cases), or Rare (only found one or two cases). Differences in these frequencies were used to identify changes in the results from Time 1 to Time 2.

Results

In the material that follows, we present findings from selected core ideas identified in Table 2 that reflected themes that are central in research and theory in STEM career development (cf. Lent et al., 2003; Navarro et al., 2007). Selected core ideas include: Educational and Career Planning, STEM Experiences, Summer Program (ITEST) Experiences, Impact of Student's Identity, and students' Definition of Work. Each section begins with a summary of the major trends in the interview data, followed by examples of a given student's responses, with Time 1 narratives followed immediately by Time 2 narratives.

Prior to reviewing the narrative data, the findings are presented using the categorical assessment system articulated by Hill et al. (2005). Based on numerous studies using CQR, Hill et al. recommend that core idea shifts that move more than one category should be considered meaningful. In the present analyses, the only core idea that shifted in a meaningful way was Appropriation of School Knowledge, which shifted from rare in Time 1 to typical in Time 2. However, as reflected by the single asterisk in Table 2, several core ideas shifted one position from Time 1 to Time 2, which, while not significant by CQR standards (Hill et al., 2005), may represent trends that merit further inquiry. A textual analysis of the narratives follows. (Please note that the letter "S" refers to the student/participant and "I" refers to the interviewer.)

Educational and Career Planning

Contemporary educational experience. Many of the students reported efficacious beliefs about their academic work and indicated that they were managing relatively demanding academic work. Students held a range of reactions at both Time 1 and Time 2, ranging from positive to neutral toward their school STEM courses. The students in attendance at the science-focused high school might have already held positive attitudes toward science and math, given their choice of school. Furthermore, many of the participants reported enjoying their STEM courses in school because they were meaningful to their future career paths and the program provided enjoyable, valuable learning experiences that reportedly enhanced the students' inclination toward science. In addition, we observed that students who felt skilled in their STEM classes were engaged in the classroom as active participants, provided assistance to other students, and asked for clarification when they were confused. Another important finding is that the students tended to report increased levels of basic knowledge of STEM course material over time.

Table 2. Domains and Core Ideas in Time 1 and Time 2 Interviews

Domain	Core idea	Frequency of	
		Time 1	Time 2
Educational and career planning	Contemporary educational experience	General	General
	Perception of school or school value	Typical	Typical
	Appropriation of school knowledge**	Rare	Typical
	Application of school knowledge*	Rare	Variant
	Educational aspirations	General	General
	Career aspirations	General	General
	Career exploration	Typical	Typical
	Generic non-STEM exploration	Variant	Variant
	STEM exploration	Typical	Typical
	Lack of exploration	Variant	Variant
	Future expectations	General	General
	Positive outcomes	General	General
	Negative outcomes	General	General
	School and work/goals*	General	Typical
	Personal interests and work/goals	General	General
Attitudes toward STEM courses and careers	General	General	
Identifying connections to future work/goals	Self	General	General
	Family	Typical	Typical
	Peers*	Typical	General
STEM experiences	Self-efficacy in STEM topics	General	General
	ITEST reactions*	Typical	General
	Positive*	Typical	General
	Negative*	Typical	Variant
	Neutral*	Typical	Variant
	Impact of ITEST*	Typical	General
	Increase in competence/knowledge in STEM topics	Typical	Typical
	Increase in motivation to explore STEM careers and topics	Typical	Typical

(continued)

Table 2. (continued)

Domain	Core idea	Frequency of	
		Time 1	Time 2
Impact of student's identity	Ethnicity*	General	Typical
	Impact on career	Typical	Typical
	Impact on school experiences	Variation	Variation
	Active involvement or sustenance*	Typical	Variation
	Race	Typical	Typical
	Impact on career*	Variation	Typical
	Impact on school experiences*	Rare	-
	Active involvement or sustenance	-	-
	Religion	Variation	Variation
	Impact on School Experiences	-	-
	Active Involvement or Sustenance*	Variation	Rare
	Gender*	General	Typical
	Impact on career	Typical	Typical
	Resources	General	General
	Family	General	General
	Peers*	Typical	General
	Educational*	General	Typical
Community/societal influences	Typical	Typical	
Barriers/unsupportive influences	General	General	
Self	Variation	Variation	
Family*	Typical	Variation	
Peers	Typical	Typical	
Educational	Typical	Typical	
Community/societal influences	Variation	Variation	
Logistical	Typical	Typical	

(continued)

Table 2. (continued)

Domain	Core idea	Frequency of	
		Time 1	Time 2
Definition of work	Experience of work*	Variant	Typical
	Perception of work	General	General
	Influence of role models*	General	Typical
Perceptions of self as student	Self-confidence*	Typical	General
	Self-knowledge	Typical	Typical
	Self as student	General	General

Note. Core ideas were considered *general* if they applied to all nine cases, *typical* if they applied to five to eight cases, *variant* if they applied to two to four cases, and *rare* if they applied to one case. Core ideas that applied to none of the cases are represented by an en-dash.

*A difference between the two groups of one frequency description.

**Difference between the two groups of two frequency descriptions.

Darrell

Time 1. S: I thought I wasn't going to like physics freshman year, but I actually did well. That was kind of shocking . . . First, I hated that class. I hated it so much. I couldn't stand to be there. Then I realized that I did well in that class. Usually I had that "I don't care" attitude, but now it's like I did so well. I didn't really pay attention. I did pay attention, but I didn't take it as a big deal. I ended up getting good grades, and I was shocked about that.

Time 2. S: For my AP Chem class . . . at first . . . I was completely lost for the first whole month and a half, and I eventually caught up when I got the book and I got the notes so everything was straightforward and I was getting everything in chemistry. That was last year. Now this year, I have AP stats, where everything is like, "Oh, I did something similar to this like addition, subtraction, variance, standard deviation, stuff like that, oh, I did some of this before, so it's more like you're building on what you know."

Future expectations. The students appeared to be optimistic, ambitious, and hopeful for the future, believing that if they remain focused and disciplined, they will be able to achieve their educational and career goals. However, they tended to express concern about losing discipline as a result of peer pressure, financing college, or experiencing some unexpected disruptions. Hopeful future expectations were expressed of providing for their family members financially as they felt supported by these people throughout their lives and during school. Many students showed passion for striving toward a successful career and believed it was attainable.

Latoya

Time 1. S: At the end of next year, I want to go to college, of course, not sure where exactly, but maybe UPenn or BC [Boston College], and study [obstetrics].

Time 2. S: I hope that I will graduate college . . . and become the woman who becomes the obstetrician and that I will have enough money saved up to retire early and . . . travel.

STEM Experiences

Family and peer attitudes toward STEM. As students matured and progressed through high school, conversations with families incorporated future careers plans. Although family members identified and encouraged STEM careers, citing the financial reward of STEM fields as the motivating factor, their classmates and peers held mixed reactions to STEM. Many students felt negatively influenced by their peers, and as a result, some students went as far as associating with a new group of friends in order to stay focused and motivated in school.

Jean

Time 1. S: All the friends I have are . . . into like science and math and careers. Two of my friends, they wanted to do like doctor for eyes. They both want to be eye doctors. My . . . other friend . . . he wants to do aerospace . . . Everybody else is thinking about medicine or like science. They want to like be a chemist or like a doctor or something.

Time 2. S: That was a big like maturing step for me like freshman and sophomore year, I was always like the guy who was like just chilling, and wanted to . . . trying to be a jock and all that stuff. But then like, I realized what was real, what the real world was about. And then I changed my whole cluster of friends, and I guess they call them the “geeks,” but they’re not geeks to me.

Summer Program Experiences

Impact of the summer program. Youth participation in urban ecology field studies was believed to make science meaningful to the students, support STEM career exploration, and sustain future career and educational aspirations. Even those students with plans for non-STEM careers found the academic content and experiences beneficial. The narrative data indicated that the students enjoyed the hands-on aspect of the program, which encouraged an immediate and salient level of engagement in STEM education. In addition, the students reported that the curriculum was intriguing, and at times, fun.

Natalie

Time 1. S: For a minute, when I was in the summer program, I was like . . . I never really liked science, but this is really fun. It made me think of kind of becoming a doctor, but in the back of my mind I always have that goal of being a lawyer.

Time 2. S: [S]cience is everywhere. Like, science is everything. The littlest thing is scientific. I don’t know. It was crazy to me, cause science to me was just earthly stuff, like worms and ecosystem and all that, but after being in the program . . . when I did the birds and the sound, everything is science. It just amazed me.

Increase in content knowledge. With respect to the academic impact of the program, there was an increase in program-specific urban ecology knowledge. Students were able to recall content such as global warming, tree impact on air quality and temperature regulation, and biodiversity. Additionally, there was a positive impact on students’ knowledge of and interest in STEM careers in that many students discovered a wider range of career opportunities in STEM fields.

Andre

Time 1. S: [The program] made a great deal about picking out pollutants from the air and that they make a really big impact. People take it for granted. Most of the oxygen in the world comes from trees.

Time 2. S: [The program] made us think about our environment in a whole different way. Most people that I know that I've talked to, they really don't think about birds that much. They don't think about trees that much in our neighborhood. . . . [W]e looked at it narrowly, we just went to the store, went to school back and forth. Now, we look at everything around us, and how everything's affecting us. It's like, "Oh, why is it so hot?" We know now—the pavement, and then if there was more tree cover, like that—things would be cooler.

Increase in motivation to explore STEM careers. Positive STEM and science experiences within the Summer Program led students to consider STEM career paths that they were not aware of prior to the program. By engaging in STEM activities that seemed relevant and interesting, students reported an increased level of motivation to explore STEM-related careers. In addition, the narratives indicated that the career development interventions provided students with skills in exploring STEM careers.

Latoya

Time 1. I: How has the STEM program shaped your thoughts and plans about future careers in STEM?

S: I guess it gave me a different look on things. Like, there was another part where they learned about trees. That was pretty interesting because it was sound versus trees and different groups were talking about it. I kind of got interested in the trees and how old they are and how tall they are by not cutting them down and not measuring them with a measuring tape. It's very cool.

Time 2. S: Like the whole STEM education and how I want to become an obstetrician and how that has to do a lot with uh, just like correct math and you know how everything I learn right now is going to go into what I want to become.

Impact of Students' Identities

Ethnicity and race. The narrative data with respect to ethnicity and race revealed that the students reported clear and internalized racial, ethnic, and cultural identities. These identity dimensions were viewed, for the most part, as important resources for the students' educational lives and career planning. The students generally eschewed the potential for racism to inhibit their goals; that said, they did acknowledge the existence of racism within their communities.

Natalie

Time 1. I: How does your sense of yourself racially and ethnically affect your career exploration and options?

S: I don't know. I don't feel like I'm a certain race or a mixture of races that I'm better qualified for certain jobs. It's just like if I feel like I can do it, then I can do it and I'm going to do it. Nobody's going to stop me. Nobody's going to get in my way. I'm going to get over all of the obstacles. I'm going to achieve that.

Time 2. I: As a black woman, how do your friends and family support you, what you want to do in terms of education, in terms of careers? Do they have certain expectations of you because of your race?

S: I don't necessarily think so, cause the way my family is, is like, anything is possible, you put your mind to it, you can do it, and it's like, as far as race goes, I don't think they view anything like you can't do that, I don't think that's going to happen, because you're Black or you can't be president cause you're Black, because it can happen, look at Obama, exactly. I don't think they, I guess they just feel if I put my mind to it, I can do it.

Educational resources. Within the high schools, teachers are important, positive supports for the students with most teachers being described as encouraging and supportive, as well as holding high expectations. However, because of the limited resources of some schools, math and science teachers are not able to provide students with more information about the science field. Some students expressed that they have only learned the basic principles in these courses. By comparing students' Time 1 and Time 2 responses, we found that students seemed to be better able to articulate what they have benefited from the school and their teachers during Time 2.

Sean

Time 1. S: I only had one teacher that actually ever talked to me about it. That was my freshman physics teacher. He taught me some stuff about bioacoustics on bird sounds and he told me about it. And that's how it all started because he talked to us about it and decided we should do it.

Time 2. S: [T]he teachers are really helpful in school, like, the teachers go out on a limb to make sure you get some of the work done and make sure you understand what's going on. Really, yeah. Like, they take the students' learning really personally, or like, my teachers will meet up with me outside of school to make sure that I understand the material.

Educational barriers. The barriers to the students' educational experiences and career planning that emerged in the narratives included financing college, the long and tiring commutes to school, time and energy commitments from working after school, family responsibilities, and supporting younger siblings. A lack of structured support for career exploration from guidance counselors was identified. The students described few meaningful interactions with their counselors with respect to career development. Most interactions between students and guidance counselors have been focusing on college applications. The gap between students' needs and the support from school counselors was consistent in Time 1 and Time 2 interviews.

Elizabeth

Time 1. I: What have you learned from your counselors about STEM courses and fields?

S: I don't go to my counselors . . . I don't talk to them.

Time 2. S: Oh, well there's not much I could have really learned because I didn't talk to [the counselors] much about it; they mostly talk to me about which college I am going to.

Definition of Work

Experience of work. Working experiences for a few students as student leaders in the urban ecology program and in other settings were seen to provide some influence in their career exploration. For instance, work has helped students think about the kind of work environment they prefer as well as introducing students to the STEM careers.

Jean

Time 1. I: What experiences in school or in your free time do you think have influenced your work interests?

S: Well yeah, like the (name of college) programs. . . . I thought about architecture and I know that's like a really good job so I was thinking about that.

Time 2. I: Was there any sort of summer jobs or extracurricular activities that influenced your work interests at all?

S: (The urban ecology program) . . . and, we got a job shadow my sophomore year. I followed a surgeon. . . . I love science, that's the purpose. I feel like college is really gonna help me truly decide where I want to go with the science, but I feel like I just love science and all, I'm going to stay in the science area.

Influence of role models. Due to students' lack of work experience, when talking about their definition of work, most students are greatly impacted by their parents' and family's experience of work. Many of the students saw their parents working hard and believed that work was an arduous, difficult experience. Some students focused on the taxing aspects of work such as stress and irritability experienced by families. Others, however, believed that working has the potential to be enjoyable. In this respect, some students described work as being a means to make a living financially and support one's family, while a career was described as doing what one enjoys. Many of their parents were described as "working," while the students hoped to attain satisfying careers and to make their family members proud. They believed that a college education was the key to that pathway. The students consistently believed that positive career achievements would be difficult, but would be possible if they work hard in school.

Jennifer

Time 1. I: [W]hat have you learned from your family about work?

S: They work hard. They have to get up in the morning even though they don't want to.

Time 2. S: [I]f you really want a good job and like not kill yourself and work so hard, you have to go to college and get a good job and get paid well.

Discussion

The narratives from both Time 1 and Time 2 suggest that the students seemed to be in the thick of learning about STEM and exploring a future infused by STEM skills and/or careers; these experiences took place both within their schools, and to a lesser extent, in their communities. In general, the students described relatively positive reactions to the summer program and to their overall interactions with STEM educational and career exploration across both time frames. A number of the students remarked that program participation expanded their understanding of STEM beyond superficial notions that they may have held prior to their participation. In addition, the findings, when considered collectively, point to the range of factors that support students' interest in and consideration of STEM careers.

The findings reported here contrast with considerable research and public policy that have highlighted the lack of interest that urban high school students have in STEM courses and careers (e.g., National Science Board, 2008). Of course, the self-selection of the sample in this study colors the findings, suggesting that this study is examining a relatively unique cohort of urban high school students who are embedded in a relatively supportive context in relation to STEM. That said, the students who participated in this project have managed to become immersed in STEM exploration and skill development, despite attending relatively underresourced

public high schools. The results may reflect the importance of a STEM-infused educational context, both during the academic year and the summer. As indicated earlier, two thirds of the students in the sample were attending high school programs that provided enriched STEM courses and experiences, linking naturally to the summer program. Consistent with research and theory (Barton et al., 2008; Cordero et al., 2010; Packard & Nguyen, 2003), the student narratives suggest that a STEM-enriched school and community environment may be important in promoting greater consideration of STEM careers. In addition, the students' attendance at the 2-week summer program provided further exposure to STEM-related experiences outside of traditional school.

For education and career planning, the narratives, in general, do not reflect much difference between the two data collection points. However, the Hill et al. (2005) taxonomy for considering differences in categories indicates that there were notable distinctions in the report of school appropriation. Students in Time 2 reported a greater likelihood of incorporating knowledge of school (and STEM courses in particular) 12–18 months after the STEM intervention. This finding echoes the results reported by Barton, Tan, and Rivet (2008) and Packard and Nguyen (2003), who describe the importance of students' internalization of STEM-related knowledge as a significant factor in the exploration of STEM careers.

An interesting trend emerged in the interview data with respect to race and gender. In accordance with the findings presented by Blustein et al. (2010), the students tended to report a strong sense of pride and comfort with their racial and ethnic identities; moreover, they did not believe that racism would inhibit their career plans. Consistent with relational theory (Blustein, 2011), students noted that support (notably family members and teachers) provided them with fortitude to manage racism. Students' reactions to sexism were similar in that they acknowledged it as a social ill, but did not view it as a major barrier in their educational lives and career planning.

Students also described the importance of relational resources, particularly from their families and other community members, both at Time 1 and Time 2, a finding that is consistent with considerable research and theory regarding the central role of relationships across a full range of work-based tasks (e.g., Blustein, 2011). In addition, students highlighted the importance of some of their teachers and the curriculum in providing the foundation for further STEM exploration. Students also described their own personal attributes as potential resources and barriers. On the resource side, students noted that their motivation and perseverance could help them to overcome barriers and stay the course in their education. However, they also acknowledged that their motivation can waiver, leaving them open to external influences that may not support their educational plans. The barriers included concerns about financing college, commuting long distances to high school, and some potentially aversive peer relationships. Furthermore, the students expressed concerns in that the actual exploration of careers in general, and STEM careers in specific, did not take shape in a systematic way in their schools. School counselors

were generally described as disengaged from career development with a greater focus on general college planning and social support at both Time 1 and Time 2.

The section devoted to experiences of work reveals that the students typically described work as an arduous process that primarily reflects the need for survival; in contrast, working as a means of fulfilling one's dreams seemed to be less common. Consistent with much of the literature on the meaning of work for people without much volition in their work lives (e.g., Blustein, 2006), many urban students view work as a generally unpleasant task that is required in order to have the basics of survival. The relative pervasiveness of this finding, coupled with its prevalence in the literature (cf. Blustein), suggests that the limited view of work may be playing a role in circumscribing the students' career exploration. As such, students may have some difficulty in conceptualizing work as a means of self-determination and a source of satisfaction. This finding points to the need for STEM educators to underscore the importance of enhancing students' volition in their work life, which involves systemic changes so that educational affordances are available for people across the spectrum of privilege and deprivation.

While the findings reported here are rich and informative, there are some limitations that need to be embedded in the interpretation of the data. First, the sample size is modest in Time 2. As noted earlier, maintaining a larger sample size was difficult as the student population with whom we worked was highly transient and long-term communication with a majority of the participants proved to be challenging. Limitations due to sample size, however, are mitigated by the fact that we obtained data saturation in the qualitative analyses. However, another complication of the attrition is the possibility that the students in Time 2 differed in a number of ways from the larger sample. The GPA, gender, and racial/ethnic distributions reported earlier point to modest differences between the samples. One possibility is that the students in Time 2 may have had somewhat more stability in their educational and family lives, which allowed our team to stay in contact with them over the course of a year.

Second, the sample has been obtained from one specific geographic area and includes students who participated in one particular STEM project. Third, the interviewers, coders, and authors of this report may have introduced biases into the process of deriving meaning from the narratives. The use of the bracketing process provides some means of reducing the impact of these biases. Finally, the interpretation of the narratives is not an objective process. These points notwithstanding, we offer the findings with some degree of confidence given that we adopted each safeguard that defines CQR (cf. Hill et al., 2005).

In sum, the narratives have provided some initial answers to the questions posed at the outset of the project. The hands-on nature of the urban ecology curriculum coupled with its focus on enhancing the relevance of the STEM curriculum is clearly an asset. Moreover, the infusion of career development education seems central to moving STEM curriculum into a broader context that fosters exploration of STEM careers. The narrative data also point to additional supports and resources that seem

to be needed to consolidate the impact of an organized STEM infusion program. These resources include relational support, active and engaged teachers, a strong racial and gender-based identity, competence in STEM courses, and systematic career exploration opportunities. Results from this study unpack the notion of context to include families, communities, peers, and engaged teachers as well as programs like the one described in this project. Taken together, these elements create a nurturing climate for students to explore their STEM interests and to enhance their STEM skills.

In relation to the question that guided this study, the complexity of the results suggests that a mosaic of internal and external supports, career development education, and rigorous and relevant STEM education are useful in promoting students' interest in STEM careers. The fact that students' interest seemed to become stronger over time underscores the importance of the factors identified in this study. Of course, the students themselves brought a lot to the table; these students seem to be resilient adolescents who are able to effectively a complex array of obstacles.

The results reported here suggest several next steps. One important trajectory would be to follow students beyond 1 year, ideally into college, to discern how contextual and individual factors further shape their interests and exploratory activities. Another productive step would be to develop STEM enrichment programs designed to enhance contextual supports for students, including psychoeducation on STEM education for parents and further training for teachers and counselors. The importance of race and gender in the narratives underscores a component of STEM education and career development process that also necessitates further attention.

In closing, we hope that these findings, coupled with further research and program development, will contribute to the knowledge base that will help ameliorate the crisis in the STEM pipeline that threatens the U.S. economy and our capacity to generate a socially just society.

Appendix A

Interview Protocol

Post-high school goals

1. A lot of students have some idea about what they would like to do after high school. For example, some students want to attend college, some want to join the military, and some students want to get a job right away. Do you have some ideas of what you'd like to do after this year, immediately after you graduate from high school?
2. What are your career goals at this point?
 - a. Please specify the job you would most like to have after you finish your education.

- b. If you cannot name the job, perhaps you can tell us about the field that you are interested in (e.g., I am interested in a health career, but I am not sure which job).
3. If you plan to go to college, what type of courses/classes do you think you will be taking?
 - a. What do you think your major will be? (If the student does not know what a major is, you can elaborate as follows: the area that you will focus on in college)?
4. If you could do whatever you wanted for a career, regardless of the preparation required or talents, what would you do?

Description of self as student.

5. Can you tell me a little bit about yourself as a student? (Prompts include attendance and class participation, how well you do in school, general interest in and motivation in school.)
6. What do you think helps you the most to do well in school?
7. What is the connection, if any, between how you are as a student now and your life in the future? (Prompt: do you think there is a connection? Please elaborate.)

Reactions to STEM courses and experiences.

8. What has your experience been in school with courses/classes in science, technology, engineering and math (STEM)? (Please let the student know that we will call this area STEM at this point.)
9. What did you like and not like about these courses/classes?
10. How skilled do you feel in your STEM classes? (Please elaborate.)
11. How interested are you in exploring or pursuing a STEM career in the future? (Please elaborate.)
12. Have you explored any career interests in STEM fields in the past few months, except this summer program? (Please let us know which STEM areas you have explored.)
 - a. If you have explored STEM fields, what prompted you to do so?
 - b. If you have not explored STEM fields, is there anything that has kept you from considering these fields further?

Social support and relational influences.

13. What have you learned from your teachers in high school (not the ITEST program) about STEM courses and fields?
 - a. How do your teachers support you in school and with thinking about careers?

14. Also, what have you learned from your counselors about STEM courses and fields?
15. What sort of conversations do you have with your parents or guardians about your future education and career plans?
 - a. How do they help you think about future careers?
 - b. What work do your parents do for a living?
 - c. Are any of your family members involved in a STEM-related career? What type of work do they do?
16. Are any of your family members currently in or was in the past enrolled in college? Where were they enrolled? What did they study?
17. How do your parents or guardians feel about STEM fields in general? To what extent do they talk about science and technology at home?
18. How have your parents or guardians talked about STEM courses and fields in your conversations with them?
19. What sort of conversations do you have with your friends on STEM-related issues?
20. If you were to express an interest in STEM classes or a STEM career, how would your friends react?
21. If your friends thought that you should not focus so much on school, how would you respond?
 - a. Also, how would you respond if your friends told you not to explore STEM fields?
 - i. For example, let's say your friends thought that studying STEM courses was just not cool, how would you react?
22. Can you think of a time when your interest in something was different from your friends' interests?
 - a. If yes: what was that like?
 - b. How did you maintain that interest and your friendships? (Students might need an example of what we mean by "interest," which could include a certain class, a hobby or future career aspiration [i.e., taking a special summer math class for advanced standing, writing poetry, wanting to become a marine biologist, etc.])
23. Do you ever feel as though you have to choose between doing well in school and maintaining your friendships? If yes, how do you handle those situations?

Gender, race, and ethnicity and stem exploration.

24. To what extent do your family, friends and people in your community support your educational and career plans? (If not, what would they like to see you do?)
25. How do you think your family's expectations about your future plans are shaped by the fact that you are a woman/man?

26. How does your sense of yourself as a man or woman affect your career exploration and options? How do you think your gender influences your interests and what you believe you can do in the future?
27. Counselors and teachers have become much more aware of how important it is to understand the cultural background of each student. Please tell us about your cultural, ethnic, and racial background. How do you identify yourself in terms of race and ethnicity?
28. How does your sense of yourself racially and ethnically affect your career exploration and options?
 - a. In your opinion, how have your cultural beliefs influenced your career interests and expectations for what you can accomplish in the future?
 - b. What are your family and community's expectations about what you are going to do in the future as a person from (Insert ethnicity) background?

Future goals/expectations/fears.

29. When you think about the future (e.g., a few years from now), what do you most hope that you will do or that will happen to you?
30. When you think about the future, is there anything that you are afraid that you might do /not do or that might happen to you?
31. What kinds of events, situations, and people might prevent you or others you know from reaching their/your goals?
32. What do you think will help you reach your goals?
33. Can you reflect on any particularly difficult time in your life? How did you handle or overcome this difficult time? Please, include only as many details as you feel comfortable.
34. Would you like to add anything about your future plans that we didn't get to today?

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