Increasing Diversity:

Modeling of Social Capital for Navigating the Science and Health Professions Pipeline

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ABSTRACT

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Social capital theory states that resources, both actual and prospective, are inherently linked to networks and relationships that can be used as opportunities. Therefore, a basic tenet of social capital theory is that "relationships matter." In the science and health profession pipeline, strong mentoring relationships and collaborative research networks are critical elements in developing an individual's capacity for navigating the pipeline and for success and advancement in these fields. However, underrepresented minorities are often bereft of social capital because they lack proper mentorships and are often not part of "inner" circles for networking. Additionally, social capital can be leveraged to develop organizational capacity that supports diversity. In this dissertation, social capital theory is examined through the lens of three pipeline initiatives targeting pre-high school, high school, undergraduate, and graduate-level populations. The three initiatives (E-matching, achieving Successful Productive Academic Research Careers, and Mentoring in Medicine) were evaluated and the results are presented here as three related but unique manuscripts.

The particular forms of social capital examined are knowledge, mentorship, and networks needed to navigate the pipeline for science and health professions careers. All three initiatives had significant impact on increasing social capital via the social capital indicators of increased knowledge, mentorship, networks, information and resources. Study results suggest that it would be useful to replicate these initiatives on a larger scale to build social capital at earlier levels of the pipeline to enhance diversity in the science and health professions. Additionally study results suggest that the social capital obtained from brief interactions in short duration initiatives is valuable as a factor in assisting students to navigate the pipeline; therefore this should not be underestimated. Lastly, a logic model framework is provided for measuring social capital for navigating the STEM and health professions pipeline.

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B. B. R.

Dedication

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Chapter I

INTRODUCTION

Social capital has become one of the major socio-cultural concepts to appear recently in science education literature, and this topic is treated in much more depth in Chapter II. Within this domain of research, social capital refers to the collective value of all "social networks," that is, all the people whom one knows and communicates with, and the inclinations that arise from these networks to do things for each other in mutually supportive ways. Additional definitions of major terms are provided at the end of this chapter.

Having attempted to navigate the science and medicine pipeline since the ninth grade, only recently did I realize the key role that social capital played in achieving successful outcomes in these fields. When I reflect on my journey to science and medicine, I realize that having access to certain networks, such as informational conferences, mentors, and summer research programs, all collectively contributed to the amount of social capital that I possessed for navigating the pipeline. Similarly, elitism, lack of access, lack of support, and negative mentorship experiences served as an impediment for me in this navigation.

Through my volunteer efforts with a science outreach program at a major biomedical university, I became increasingly aware of the similarities in the students who participated in the program, many of whom were coming from elite private schools and were neither underrepresented minorities nor disadvantaged groups. I wondered how such disparities in underrepresented minority participation could exist at a major biomedical university in one of the most diverse cities in the nation. Essentially, the participant pool did not reflect the diversity of the urban area in which the science program was located. Furthermore, with a documented paucity of underrepresented minorities (Black/African Americans, Hispanics, and Native Americans) in the science and health professions, why were these groups not purposefully represented in the selection pool? As a result, I wrote a proposal targeting under-resourced schools serving large numbers of underrepresented minority students in the selected urban area. This proposal highlighted the use of E-matching utilizing a Community Based Participatory Approach (CBPA) as a way to enhance access for underrepresented minority groups. Chapter III further highlights this initiative as a way to increase social capital. Considering the dearth of Underrepresented Minorities (URM) in the science outreach pipeline at this urban biomedical institution, my proposed program was meant to capture students early and serve as an information pipeline to science outreach programs as well as to increase science literacy awareness, regardless of a student's career trajectory.

Having participated in a number of science and medicine pipeline programs in my academic journey, this participation was not only valuable in terms of my research and science exposure, but it also increased my peer network and mentorship network for both my short-term and long-term goals. For many URM and disadvantaged students, such participation can be life-changing. Of note, institutional agents, such as university administrators, scientists, health professionals, and counselors, can play an instrumental role in increasing resources, access, and networks, hence building students' capacity and social capital.

In this dissertation, I used a mixed methods approach to investigate the construct of social capital in navigating the science and health professions pipeline through the lens of three diversity initiatives. The purpose of the study was to explore ways in which the three programs impart social capital to a target underrepresented minority and disadvantaged student group. The particular forms of social capital explored were knowledge, information, access, networks, and resources needed to navigate the science and health professions pipeline. The overarching research question was: What roles do these science and health professions pipeline programs play in building social capital for URM participants?

This dissertation is presented in a manuscript format that includes three publication-ready papers. The second chapter is an introduction to the social capital theoretical framework, its application to the science and health professions pipeline, and an introduction to the included manuscripts. Chapters III through V contain each of the manuscripts. Each manuscript addresses a common theme of social capital in science and the health professions pipeline, and each is meant to stand on its own. There may be overlap among the manuscripts, but only sufficient overlap to provide an appropriate context for each manuscript. The last chapter summarizes results from all of the manuscripts and offers recommendations for future research.

Research Purpose

Science and health professional pipeline programs play an instrumental role in the recruitment of URM and disadvantaged groups to science and health careers. These educational pipeline programs can inspire interest in students, particularly those from underrepresented minority and disadvantaged groups, who may come from a social, cultural or educational environment that hinders the individual from obtaining the knowledge, skills, and abilities necessary to develop and participate in a science and health professions career. These programs also play a role in increasing social capital through greater access and broader networks. Moreover, these programs should be accessible to all, regardless of science interest, to increase science literacy. Unfortunately, students from underrepresented minority and socio-economically disadvantaged groups risk being excluded based on an inadequate level of mentoring and networks. Science should be open, accessible, and non-elitist (Bianchini, Cavazos, & Rivas, 2003). Therefore, understanding the role that science and health professions pipeline programs play in social capital will be a useful contribution to the literature.

Research Aim

The broader research aim of this dissertation was to understand the role that science and health professions pipeline programs play in imparting social capital to participants.

Research Question

The major research question for this study was: What roles do science and health professions pipeline programs play in building social capital for participants?

Background

STEM Pipeline Disparities

Pipeline programs aim to increase the exposure, recruitment, and retention of URM into the Science, Technology, Engineering, and Mathematics (STEM) and health professions fields. Unfortunately, low participation and performance in STEM fields are widely recognized as major problems with substantial economic, political, and social ramifications (National Research Council, 2011; National Science Foundation, 2011). Most strikingly, research indicates that low participation and performance in science, technology, engineering, and mathematics have become an increasingly severe issue for underrepresented minorities (URMs), including Black/African Americans, Hispanics, and Native Americans, Alaskan citizens, and Native Pacific Islanders (National Science Foundation, 2011). Though Hispanics, Black/African

Americans, and Native Americans together represent one-third of the U.S. population, these groups are disproportionally underrepresented in their attainment of STEM bachelor’s, master’s, and doctorate degrees and in their participation in the STEM workforce (U.S. Census Bureau, 2011). Specifically, Hispanics and Black/African Americans hold only 3.4% and 4.4%, respectively, of science and engineering jobs (National Science Foundation, 2011).

In response to these alarming statistics, a number of initiatives and policies have been established to increase participation of underrepresented populations in the STEM and health professions fields (National Science Foundation, 2011). Policies calling for funding increases for STEM education reform at the K-12, undergraduate, and graduate levels have aided in the development of numerous initiatives to build the STEM and health professions pipeline workforce (National Research Council, 2011). This will be discussed in the next section.

K-12 STEM Education

Efforts to increase participation and performance in K-12 STEM education focus primarily on improving teacher quality and quantity, changing the curriculum, and providing a variety of STEM outreach programs to students (National Research Council, 2011). In terms of teacher quality and quantity, efforts have focused on using qualified teachers to teach science and math subject areas at the K-12 level. Unfortunately, in many under-resourced schools, students are taught science and math by teachers who are not expert in the field. A number of policy and curriculum changes have also been implemented to improve STEM participation at the K-12 level, such as awarding grants to states to create math and science high schools, advanced placement class options in under-resourced schools, matching K-12 curriculum with

STEM knowledge needed further in the pipeline, and K-12 partnerships with industry- and university-based labs (National Research Council, 2011).

K-12 STEM partnerships have played a major role in educational reform efforts to increase the number of students in the STEM pipeline (National Science Foundation, 2011). These pipeline programs are supported by private entities, such as industry, and federal and state grants, and can take place during the school year or summer. These programs help to enhance participants' problem-solving, and analytical and critical thinking skills, all of which are important in the STEM and health professions fields (National Research Council, 2011).

STEM and Health Professions' Educational Efforts in Higher Education

To increase URM participation in STEM and health profession disciplines in higher education, efforts have focused on two areas: 1) increasing the number of URM students in the pipeline, and 2) retaining URM students in the pipeline toward successful careers. Efforts to increase the number of URM undergraduate students in the pipeline include, but are not limited to, creative science and math instruction, provision of scholarships and financial assistance to students who declare STEM majors, and undergraduate research opportunities. Additionally, a number of federal, state, and privately-funded programs are specifically targeted toward groups underrepresented in science. Typical undergraduate research experiences include those offered through the NSF Research Experiences for Undergraduates (REU), and the Research Initiative for Scientific Enhancement (RISE) programs. At the federal level, programs such as Minority Access to Research Careers (MARC) are aimed at increasing the number of underrepresented minority students in the biomedical research pipeline who pursue both Ph.D. and M.D./Ph.D. degrees. This program is funded by the National Institute of General Medical Sciences, an institute within the federally-supported National Institutes of Health. As a former recipient of the MARC medal from the National Institute of General Medical Sciences for receiving first place for a research presentation, I recognize the important role this program has played in my journey through the science pipeline.

In terms of retention, a variety of factors can impede students' progression, such as lack of proper preparation, poor study skills, and inadequate instruction, all of which can lead to students' inability to succeed in these courses. Also, students who initially express an interest might be "weeded" out in first year science classes because of low performance. However, some innovative programs are addressing this problem; one of these is the Meyerhoff STEM recruitment and retention program, established at the University of Maryland, Baltimore County (UMBC). This recruitment and retention program is a national model for helping minorities become interested in the STEM disciplines. Dr. Freeman Hrabowski established the Meyerhoff program as a way to increase STEM interest, and I also had the honor of meeting and discussing these topics with him during the annual insight lecture given at The Rockefeller University in April 2012. His holistic approach to recruiting more minorities into science explains the immense success of the Meyerhoff scholars who go on to pursue Ph.D., M.D., and M.D./Ph.D. degrees (F. Hrabowski, personal communication). His program essentially gave these students social capital, a construct further explored through the lens of the three manuscripts presented in Chapters III, IV, and V of this dissertation.

The goal of the Meyerhoff program is to increase the number of underrepresented minority scientists and engineers, especially Black/African American. The retention efforts of this program include, among other affordances, a comprehensive financial package contingent upon maintaining a B average in a STEM major; a pre-freshman year 6-week Summer Bridge

Program; full-time advisors who monitor and support students on a regular basis; a family-like social and academic support system; widespread faculty involvement (including research mentor roles); and participation in summer research internships. This holistic approach aids in increasing social capital for success and upward mobility in the science and health professions pipeline. UMBC and other university retention efforts often include a variety of enrichment activities, including adding learning laboratories and supplemental instruction to improve performance of students in large first- and second-year science courses that frequently act as barriers to student success in the sciences (Hrabowski, personal communication). This holistic approach prevents what is traditionally known as “weed-out” during entry-level science courses. It is all too common for a professor to instruct students to look to their left and to their right, and then tell them that by the end of the academic year, those seats will likely be empty due to student dropout. By contrast, the UMBC model is for students to look to their left and right and be told they are all expected to succeed in the course, and that additional resources are available to support their success. They are also informed that the university fails if the students do not succeed (Hrabowski, personal communication). Through this model, Hrabowski endorses an empowerment rather than a deficit perspective. These science centers and discovery laboratories have effectively improved student performance in entry-level and advanced science courses, increased course pass rates, and fostered retention in science majors (Summers & Hrabowski, 2006). Many universities also offer programs that target high-potential but at-risk students, such as first-generation college students, undeclared majors, and those from rural or urban environments (National Science Foundation, 2011). Additionally, financial assistance is provided to high-performing students interested in science and engineering (U.S. Department of Education, 2009).

Undergraduate research programs share the goal of increasing the number of STEM degree recipients by increasing exposure and experience in undergraduate research in STEM. The premise of these undergraduate research efforts is that these experiences will increase the number of successful graduates, enhance their performance in STEM, and prepare them to conduct research successfully as graduate students (Maton et al., 2009). Various researchers have also developed sociological, psychological or student learning models to explain what students experience while participating in undergraduate research (Balster, Pfund, Rediske, & Branchaw, 2010; Estrada, Woodcock, Hernandez, & Schultz, 2011). Estrada, Balster, and their colleagues highlight the role of undergraduate research programs in creating a community of practice which aids in students' socialization into scientific communities and increases students' self-efficacy and confidence. This community of practice in effect builds new networks and enhances existing ones, thereby increasing social capital.

Diversity in Science Education and Access

As mentioned previously, groups traditionally underserved in science education, and thus underrepresented in the STEM fields, include: low-income, racial/ethnic minorities (Black/African Americans, Hispanics, American Indian/Native Americans), and females of all ethnic and racial backgrounds (American Association for the Advancement of Science [AAAS], 1998; National Research Council, 2011). Despite the number of these students who are initially interested in science, very few of them thrive in STEM disciplines. Research suggests that students' declining interest in science is traceable to K-12 grade learning experiences and access to participation in quality science research experiences (Zacharia & Barton, 2004).

Consequently, the diminishing interest of minorities and women in science contributes negatively to the representation of these groups in the STEM fields.

A recent landmark study shows that even among those who successfully navigate the STEM pipeline to become research investigators, disparities exist in attainment of R01 grants by racial/ethnic minorities (Ginther et al., 2011). Specifically, the study indicated that Black/African Americans were 10% less likely than their White peers to receive an R01 award after controlling for background and qualifications. Therefore, one must consider other factors that might be contributing to these disparities. One of the factors to consider is social capital in the form of adequate mentoring and networks. As a response to the landmark study, Francis Collins, Director of the National Institutes of Health, called for the following recommendations: 1) revisiting the NIH grant review process; 2) including more diverse representation among NIH leadership, scientific review officers, NIH review committees, and board of scientific counselors; 3) supporting innovations to encourage more local mentoring of junior faculty; and 4) evaluating existing programs to see what has worked and what has not worked (Tabak & Collins, 2011). The aspect of Collins's recommendation which encourages support for local mentoring and more diverse leadership on committees is the most likely to influence social capital.

The National Research Council states that science education is supposed to provide opportunities for students to develop decision-making skills so that they might understand situations that are scientific in nature and autonomously make informed decisions in their everyday lives (National Research Council, 2011). As the world becomes more advanced in science and technology, there is a high need for a scientifically- and technologically-literate population. In the United States, a problem previously overlooked in increasing the total number of scientifically-literate citizens is the lack of diversity in advanced science classes and in STEM fields (AAAS, 1998).

Previous studies examining racial barriers have found that despite interest, many low-income racial/ethnic minorities are not represented in STEM fields. As stated previously, barriers commonly associated with the underrepresentation of these groups in science and mathematics often center on K-12 learning experiences. Further barriers experienced by URMs include inequalities of social capital, inequality of resources in neighborhoods and communities, academic and cultural isolation, lack of peer support for academic achievement, discrimination (perceived or actual), inequalities in K-12 schools including unequal distribution of well-qualified teachers, segregation of Black/African American and Hispanic students, poor high school counseling, low expectations and aspirations, high dropout rates, and limited financial resources (Gandara & Bial, 2001; Summers & Hrabowski, 2006).

Need for Science Outreach Programs

Students who cannot see themselves as scientists are less likely to pursue scientific fields. Furthermore, students who received inadequate academic preparation in the sciences are less likely to succeed in these courses in the future. The National Science Education Standards (1996) recommends more hands-on, inquiry-based learning that promotes open-ended questions and discussions as a way of teaching and learning science (National Research Council, 2011). However, the science teaching and learning presented in many classrooms do not accurately account for learning and doing quality science (AAAS, 1998). Rather, the classes portray experiments in which one follows instructions and arrives at one definite answer, which is contrary to the nature of science practice in the real world. Therefore, exposure to science in the real world is important at the K-12 levels. Science outreach programs play an instrumental role in providing this exposure.

Studies in science education indicate that exposure to science and science in practice may increase students' interest in the discipline (AAAS, 1998; Cregler, 1993). Consequently, pre-college science outreach programs have grown to become an integral component of creating a generation of students who are scientifically-literate and interested in pursuing science careers (Felix et al., 2004; Friedman & Quinn, 2006). Considering advances in science and technology around the world, scientific literacy enables students to make informed decisions (Hurd, 1998). Additionally, pre-college science and health professions programs can serve as a pipeline to science careers, particularly among underrepresented minority groups who may have previously experienced inadequate access to science education. A common goal of these programs is an increased focus on helping all students learn and access science, with special attention given to the underrepresentation of minorities and women in the field.

Although the National Science Education Standards (1996) recommends more hands-on inquiry in science to engaged students, many under-resourced schools do not have adequate funding for laboratory science experiences and exposure, but rather teaching is heavily reliant on textbooks. Especially affected, because of the lack of local funding, are inner-city and rural schools (National Science Foundation, 2011). Science and health professions pipeline programs have been a vehicle for students to receive further science enrichment to bridge the exposure gap. As mentioned previously, many science outreach programs also target URMs as a way to increase interest in the STEM fields. Therefore, it is important to understand how these programs impart social capital on their participants. This dissertation sought to further understand this construct through three pipeline programs.

Definition of Terms

- **Building Capacity:** In the context of this study, building capacity is information, resources, and tools needed to navigate the science, medicine, and research pipeline. This is also a subcategory of social capital.
- **Disadvantaged:** In the context of this study, disadvantaged status is defined as economically disadvantaged, educationally disadvantaged or environmentally disadvantaged.
- **E-matching:** A process of matching teachers and students with STEM experts.
- **Institutional Agents:** Institutional agents in the context of this study are defined as program administrators, teachers, professors, and affiliates of institutions who provide information about or have access to institutional resources. It is the capacity and commitment to transmit directly, or negotiate the transmission of, institutional resources and opportunities.
- **Pipeline Programs:** In the context of this study, these programs aim to increase exposure, recruitment, and retention of URMs into the STEM and health profession fields.
- **Social Capital:** In the context of this study, social capital is defined as resources generated from social networks, social relationships, and social interactions.
- **Underrepresented Minority:** The National Institutes of Health and National Science Foundation criteria are used for defining racial/ethnic underrepresented minority. This includes individuals from the following groups: Black/African American, Hispanic, Native Hawaiian/Pacific Islander, and Native American.

Chapter II

THEORETICAL AND CONCEPTUAL FRAMEWORK

This dissertation used a Social Capital Theoretical framework. In this chapter, I will highlight the foundations of social capital and provide an overview of social capital in the context of STEM educational pipeline programs.

Foundation of Social Capital

Social capital was first used by Lyda Judson Hanifan in the context of rural and community centers (Hanifan, 1916). He used the term *social capital* to describe fellowship and social interaction among members of a group which he described as a social unit. Pierre Bourdieu (1973) was the first to use social capital in the context of human and individual achievement. Bourdieu wrote that three types of capital (i.e., economic, cultural, social) worked together to influence an individual's disposition. His concept of social capital was intended to explain the perseverance of social groups' access to resources and has been used extensively in educational research to explain differences in schools based on class, gender, and ethnicity (Dika, 2002; Stanton-Salazar, 1997). While cultural capital describes the knowledge, assets, and experiences that families impart to their children, social capital addresses the resources that result from relationships among people (Bourdieu, 1973). Social capital is most well known in the context of educational research (Coleman, 1988; Horvat, Weininger, & Lareau, 2003; Stanton-Salazar, 1997).

Since Bourdieu and Coleman are most frequently cited for social capital in the context of educational research, this section identifies Bourdieu's and Coleman's foundations of social capital in the role of significant others to provide a network of resources and support for first-generation, low-income students attempting to enter an institution of higher education. The general concept of social capital is viewed as the social networks or relationships with individuals or institutions that provide sources of value (Bourdieu, 1986; Coleman, 1988).

Bourdieu (1973) viewed social capital as a resource that stems from group membership or connections with others. Thus, social capital is a form of power that is available based on the quality of one's social networks. Bourdieu's concept of social capital is often equated with the investment of the dominant class to maintain their position and status in society (Lin, 2000). He viewed social capital as a way to explain disparate experiences based on class, gender, race, and ethnicity (Lareau, 2001). For Bourdieu, social capital is an attribute of elites that is consistent with social reproduction. Higher socioeconomic families are more likely to introduce their children to environments and opportunities that develop strong social networks (Lareau & Weininger, 2003). Similarly, this elitism is likely to take place in the academic research realm, where institutional environments and strength of networks can foster or hinder progression toward advancement. Bourdieu suggested that people are limited in social capital and beneficial opportunities if they do not have access to appropriate networks of support.

Coleman (1988) defined social capital as the resources obtainable within the social structures of a person's community such as norms, social networks, and interpersonal relationships that contribute to personal development and attainment. He suggested that social capital is a positive form of social control and that its function is to offer the structure necessary to manage individual pursuits. Thus, this social structure provides the resources that assist people to achieve their goals and pursue their interests. Social capital is defined by its function, meaning that it is inherently social and, by necessity, structural. This quality involves a sense of trust between imparting and receiving agents that mutual obligations will be upheld. A combination of trust and mutual goals creates a greater power and possibility of accomplishment that may be beyond what an individual can achieve acting alone. Hence, the strength of networks in the academic research realm assists in upward mobility. These social acts of trust and reciprocity, along with the defined norms and networks of a society, facilitate the coordinated effort to achieve desired goals. Coleman specifies the three elements of social capital to include forms, norms, and resources. Forms refer to the nature and structural aspects of social ties and relations. Norms refer to the shared feelings of trust, obligation, and expectations of reciprocity. Resources refer to access to social networks and relationships.

Social capital allows events to happen that would otherwise not likely occur without intervention (Coleman, 1988). Social capital provides the opportunity to employ other forms of capital through relationships. Coleman (1988) has stated that social capital is created when the relationships between people change in ways that facilitate them to take action. This action can be intentional or unintentional; for example, one member of a group may randomly acquire a skill or knowledge that is passed on to other members of the group and a social benefit is noticed. In some instances, one member of a group may intentionally seek out skills and/or knowledge with the intention of passing it on to the rest of the group. This person is deliberately trying to create social capital within the structure. This effort must occur within a structured social situation. Social capital is not possible within a disorganized or dysfunctional social group. Hence, the three pipeline programs being examined as part of this dissertation create a form of social capital through access to institutional agents and networking within an organized group membership. In the next section, Stanton-Salazar's work on the role of institutional agents in activating social capital is discussed.

Institutional Agents of Social Capital

Social capital can be enhanced by institutional agents; hence, schools can play a greater role in ensuring students have these resources and connections (Stanton-Salazar, 1997). This notion challenges Bourdieu's focus on the advantages of the elite and suggests that social capital can be provided and activated by institutional agents (Horvat et al., 2003). Stanton-Salazar states that institutional agents are those who have the capacity and commitment to transmit directly, or to negotiate the transmission of, institutional resources and opportunities.

To address STEM educational disparities, an array of pre-college intervention programs has been designed to aid in preparing low-income and educationally-disadvantaged students for college. To remedy the inconsistencies that exist for low socioeconomic populations, pre-college preparation programs should provide necessary knowledge, skills, and resources that will prepare students for the challenges of higher education. These programs utilize strategies such as academic and test-taking preparation, mentoring and tutoring, academic and career counseling, study and life skills, and outreach to parents and educators about the college experience (Tierney, Corwin, & Colyar, 2004). Students need access an understanding of what is expected of them; this requires connecting to information about college, applying to college, and understanding the necessary curriculum requirements for gaining access to a postsecondary institution (Tierney et al., 2004). Institutional agents can serve as conduits of the social capital needed to navigate and advance in the form of mentoring, knowledge, support, and information. Gaps in the literature left questions regarding development of social capital for underrepresented students, particularly the role of social capital in helping them to navigate the science and health professions pipeline.

The U.S. Department of Education's NCES 2008 report on K-12 intervention strategies identified six common elements of intervention programs that have been most successful in doubling the college attendance rates of program participants: 1) providing a key person such as a mentor, director or guidance counselor to monitor and guide a student over a long period of time; 2) providing instruction through access to the most challenging courses offered by the school, through special coursework that supports the regular curricular offerings or by revamping the curriculum to better address the learning needs of students; 3) making long-term investments in students; 4) recognizing the cultural background of students; 5) providing a peer group to provide social and emotional support; and 6) providing financial assistance and incentives such as college visits, standardized test preparation courses, and scholarship support. All of the aforementioned elements, while not described as social capital in the literature, are indeed social capital indicators facilitated by institutional agents for recruitment and retention based on Bourdieu's (1973), Coleman's (1988), and Stanton-Salazar's (1997) definitions of social capital.

Definition of Social Capital

Social capital has been primarily defined in two ways. Some, such as Bourdieu (1973), define social capital as a means of reproduction for the dominant culture. Advantages accumulated by groups are often based on gender, class or race. Characteristics and behaviors of the dominant group are passed on to ensure long-term success and power. An alternative view stems from Coleman (1988), who has defined social capital in a more optimistic manner, describing social networks as systems of trust that lead to advantageous behaviors or outcomes within the network. Though advantages accumulated in groups are often based on similar classifications (class, gender, race), the accumulation of social capital is viewed as needed or necessary for the group to advance. Social capital can explain the relative success of some and the failure of others in attaining a common goal. Individuals who successfully acquire and use social capital are able to develop and sustain social relationships that generate beneficial outcomes through norms and trust.

A variety of examples of social groups imparting social capital exist. Groups such as professional organizations, cultural organizations, religious organizations, academic organizations, and many others form a collective for unity and strength of shared vision and goals. The success of disseminating social capital hinges on the group's ability to have existing members effectively transmit the desired skills and information (Coleman, 1990; Gonzalez, Stone, & Jovel, 2003; Stanton-Salazar, 1997). Hence, social capital benefits those who are members of the group and are willing to share information. Given the critical role that group membership plays in social capital, pipeline programs—the focus of this dissertation—provide an environmental context in which social capital can be enhanced.

Definition in context of this study. Although varying definitions for social capital exist, Stanton-Salazar (1997) captured the essence of the concept for this study's purposes by defining social capital as relationships with institutional agents that can be converted into socially-valued resources, opportunities, networks, and emotional support. Stanton-Salazar reinforced the idea that possessing social capital does not imply its utilization. In his study, Stanton-Salazar outlined the strategies parents use to convey to their children the importance of education. He goes on to describe the social networks created within the social environment to help promote success. These supportive relationships are vital to securing the educational success of these students. Hence, in the context of the three pipeline initiatives which are explored as part of this study, the social networks created within the social environment of these pipeline programs enhance opportunities for success.

For students preparing for STEM and health profession careers, the preexisting cultural value of an education is evident. However, these students need to acquire social capital in the form of social networks that will provide the tools and guidance necessary to navigate the pipeline. Specifically, social capital needs to be established to enhance a student's ability to prepare for, apply to, and successfully compete for programs. Students use social capital to navigate the road of access, while being supported by peers, teachers, counselors, and parents (Coleman, 1988; Dika, 2002; McDonough, 1997). This study examines social capital as knowledge, mentoring, networks, and information resources that result from relationships with institutional agents and membership within a specific group to navigate the science and health professions pipeline.

Measurement and Use of Social Capital

As a result of varying definitions for social capital, there is no consensus on the measurement and use of social capital. Coleman (1988) states that it is in our thoughts, language, and behavior. Bourdieu (1986) states that it is behavior that is institutionalized and otherwise adapted. In the context of this study, social capital is defined more specifically as knowledge, access, and broader networks with institutional agents for navigating the science and health professions career pathway. Researchers predominately review and measure social capital in three categories: individuals, groups, and society at large. These three areas of research are based on the initial findings of Coleman, Bourdieu, and Stanton-Salazar, respectively. As mentioned previously, this study examined social capital as the knowledge, mentoring, networks, and information resources needed to navigate the health professions pipeline.

Social Capital in the Context of Science and Health Professions (STEM) Pipeline Programs

Research on social capital is lacking in the context of navigating science and health professions pipeline programs. The present research sought to bridge the gap in the literature by examining various forms of social capital through the lens of three pipeline initiatives. In this dissertation social capital for navigating the science and health professions pipeline is examined through the following indicators: networks, access, knowledge, information, resources and social support. The importance of having access to social capital utilizing frameworks of Bourdieu and Coleman were explored. Additionally, the activation of social capital via institutional agents was also explored.

Role of Social Capital in Access

Substantial inequities exist in K-12 students' access to science, specifically in underrepresented minority and socio-economically disadvantaged populations. The inequities might be partially attributed to inadequate mentoring and gate-keeping, a phenomenon whereby students are not able to participate or navigate pipeline programs, hence reducing access to opportunities. This lack of access can be an obstacle to social capital.

The explanation of social capital as access to institutional resources and institutional agents has its roots in the works of Bourdieu (1977) and Stanton-Salazar (1997), respectively. Stanton-Salazar's work has been highlighted in this regard in the previous section. Bourdieu

(1977) states that while individuals occupy various dimensions within their social environments, it is not necessarily their original or inherent positions which define them, but rather the amount of social capital they are able to amass through social exchanges or networking. These beneficial relationships and connections enhance social capital. Coleman and Lin also played an instrumental role in defining social capital. Coleman (1988) built upon Bourdieu's framework of social capital, defining it as a public resource enforcing the desired social norms and sanctions within families and communities. Lin (2000) states that one of the greatest challenges confronting minority students is their awareness of and access to social networks rich in potential sources of social capital.

Pipeline programs and group membership can increase students' networks, opportunities, and access. They provide opportunities for those who have the ability to do well in science (increased human capital), but are unable to gain access to those who are in a position to help them (decreased social capital). Coleman (1988) characterizes human capital as the accumulation of knowledge and abilities. However, Coleman believes that an abundance of human capital with little social capital would have minimal benefit. For example, in my experience in science outreach, some students do well in science but are unable to gain access to those who can write strong letters of recommendation to gain further access to science outreach programs which could potentially increase their social capital and network. Unfortunately, underrepresented minority and disadvantaged students do not often have access to institutional support that students with much social capital have access to. Increasing social capital networks of underrepresented minorities might have an influence on increasing achievement.

Institutional agents such as teachers, scientists, health professionals, counselors, peers, and school/university administrators can play a role in increasing the network of students as well as increasing students' social mobility and, hence, their social capital. Institutional agents can play a role in mentoring, advising, and accessing opportunities for advancement. They also play a role in shaping policies for recruitment of students into their programs, thereby serving as gatekeepers for the science and health professions pipeline. Equitable access to this information is crucial in increasing social capital.

Introduction to the Three Manuscripts

Chapter III contains a manuscript reporting research conducted as a collaboration between an urban biomedical research university and an under-resourced high school. This manuscript examines tailoring science outreach and increasing social capital through E-matching using a community-based participatory approach. E-matching is defined as electronic web-based matching of teachers and their students with STEM experts. Utilizing E-matching and a community-based participatory approach to tailor science outreach allows for highly specific, targeted, and collaborative coordination of science outreach endeavors to meet the needs of all stakeholders. E-matching can address some of the science exposure disparities seen in many urban classroom settings. This approach may also serve as a pipeline to increase diversity in the STEM fields.

Chapter IV addresses research on the application of social capital theory to build individual capacity for diversity in biomedical research, specifically looking at the Achieving Successful and Productive Academic Research Careers (SPARC) initiative. Social capital theory states that resources, both actual and prospective, are inherently linked to networks. Therefore, a basic tenet of social capital theory is that “relationships matter.” In the academic research realm, social capital, such as strong mentorship relationships and collaborative research networks, are critical elements for developing an individual's capacity for a strong research career. SPARC is a tri-institutional partnership between an academic medical center (Weill Cornell Medical College), a translational research center (The Rockefeller University Center for Clinical and Translational Science), and a cancer center (Memorial Sloan-Kettering Cancer Center [MSK-CC]). The mission of SPARC was to create an infrastructure to increase capacity for research career development of underrepresented minority (URM) trainees and faculty who are in different stages of their science career paths by facilitating networking opportunities. A second objective was to leverage resources and build partnerships that could sustain future initiatives. Since its inception, the SPARC initiative has reached over 200 pre-college students, undergraduates, and junior faculty from URM backgrounds. Additionally, results of the process evaluation points to key levers for garnering sustainable institutional support and provides a framework for other biomedical institutions to enhance individual and institutional capacity to support diversity.

Chapter V provides a report on increasing underrepresented minority participation in the STEM and health professions through the Mentoring in Medicine initiative, with a closer look using a social capital theoretical framework. Mentoring in Medicine was initially founded to provide mentorship and support to underrepresented minorities, and over the years it has expanded to across different spectra of the pipeline, providing a holistic and comprehensive approach to pipeline diversity for health profession careers. This paper examines the role of the Mentoring in Medicine initiative in building capacity and, hence, social capital across all educational levels for health profession careers.

Chapter III

SCIENCE E-MATCHING AS SOCIAL CAPITAL

Tailoring Science Outreach through E-matching Using a Community-Based Participatory Approach

Abstract

Social capital in education is linked to relationships with institutional agents that can be converted into socially-valued resources and opportunities. In an effort to increase science exposure for pre-college (K-12) students and as part of the science education reform agenda, many biomedical research institutions have established university-community partnerships. Typically, these science outreach programs consist of pre-structured, generic exposure for students, with little community engagement. E-matching is defined as electronic web-based matching of teachers and their students with Science, Technology, Engineering, and Mathematics experts. E-matching is a timely and urgent endeavor which provides a rapid connection for science engagement between teachers/students and experts in an effort to fill the science outreach gap and increase access, thus increasing social capital for both teachers and students. We describe a case study of a tailored science outreach activity, in which a public school that serves mostly underrepresented minority students from disadvantaged backgrounds were E-matched with a university, and subsequently became equal partners in the development of the science outreach plan. In addition, we show how global science outreach endeavors may utilize a Community-Based Participatory Approach, like E-matching, to support a pipeline to science among underrepresented minority students and students from disadvantaged

backgrounds. Merging the Community-Based Participatory Approach concept with a practical case example, we hope to inform science outreach practices via the lens of a tailored E-matching approach. Lastly, preliminary results show an increase in social capital for both teachers and students via the E-matching network.

This statement by a tenth grade student I met in Brooklyn is a reminder of the need that underrepresented populations in under-resourced schools have for programs which impart social capital to successfully navigate the science and health professions pipeline:

> …Someday I want to be a scientist in the medical field and be successful in life. For that to become a reality, I will have to take several steps in life. I know some of them but not all, so I would love for you to become my mentor and guide me through some of the necessary steps for my dreams to become my life in the future. Like you, I don't come from the best neighborhood, so not many people around are the best role models for me to look up to. I'm not really sure which medical field just yet. I'm still trying to decide, but I just know that I want to make people feel better and possibly save lives. I really want to be in the science field because you don't really see many Latino or Latina doctors walking around.… I want you to know that at my school, they don't give the science classes that I'm supposed to have by this time in my tenth grade year. This is very disappointing and scares me because I'll be behind everyone else in my later years. At times I wonder if I had the science classes that other students are getting, if I would be interested in becoming part of the science field as I am now.

Background

The author started working at a prestigious urban biomedical research university in the capacity of a translational researcher and noticed the disparity in participation of underrepresented minority groups in the summer research program with fewer than ten percent URM. The author inquired further and was informed of two reasons for this disparity: 1) Not enough URMs were applying and 2) URMs who did apply were under-qualified. The author made further inquiries regarding the under-qualifications of URMs who applied and noticed upon review of the data that URMs were attending under-resourced where advanced placement courses were not offered. Since taking advanced placement courses was listed among the selection criteria for this university, students who did not have these courses were placed at a disadvantage even prior to submitting their applications. As a follow-up, the author spoke with the selection committee about holistic review of the applications, taking into account whether students took the most challenging courses available at their school if advanced placement courses were not offered. The author was subsequently invited to sit on the selection committee.

To address the first issue of not enough URMs applicants, the author saw that indeed this was a fact and wrote a proposal to increase access for URMs in under-resourced schools through the E-matching initiative. This paper expands on the author's previously published paper (Rumala et al., 2011) and describes a first step of increasing access through a social capital theoretical framework.

Introduction

Studies in science education indicate that exposure to science and science in practice may increase students' interest in the discipline (AAAS, 1998; Cregler, 1993). Consequently, pre-college science outreach programs have grown to become an integral component of creating a generation of students who are scientifically-literate and interested in pursuing science careers (Felix et al., 2004; Friedman & Quinn, 2006). As reliance on the efforts of pre-college programs has increased, and the visibility and outreach of these programs have been expanded, the need to ensure that these programs meet their goals and target the specific concerns of the school community is more necessary than ever (Lynch, 2000). To address this need, the author suggests that E-matching is a useful tool to ensure mutually beneficial partnerships between students and scientists that meet the needs of both of these parties. E-matching, a term coined in this paper, is the electronic web-based matching of teachers and their students with Science, Technology, Engineering, Mathematics (STEM) experts, who serve as role models, sources of STEM expertise, and a reference group of established researchers who can support teachers and inspire their students. E-matching can occur based on interest, need or geography. The E-matching approach focuses on the needs of students both within and outside of the classroom, and has the goal of increasing students' participation in science and specifically catering to pre-college science outreach needs. Since the discipline of science consists of multiple entry points and various sub-disciplines, E-matching allows students to explore their specific interests by gaining access to mentors and experts within these specific domains. In addition, it helps to harness their scientific interests by providing biomedical expertise that will be beneficial throughout their academic careers.

Literature Review

STEM Pipeline Disparities

Pipeline programs aim to increase the exposure, recruitment, and retention of URMs into the STEM and health professions fields. Unfortunately, low participation and performance in STEM fields are widely recognized as major problems with substantial economic, political, and social ramifications (National Research Council, 2011; National Science Foundation, 2011). Most strikingly, research indicates that low participation and performance in science, technology, engineering, and mathematics have become an increasingly severe issue for underrepresented minorities, including Black/African Americans, Hispanics, and Native Americans, Alaskan citizens, and Native Pacific Islanders (National Science Foundation, 2011). Though Hispanics, Black/African Americans, and Native Americans together represent one-third of the U.S. population, these groups are disproportionally underrepresented in their attainment of STEM bachelor's, master's, and doctorate degrees and in their participation in the STEM workforce (U.S. Census Bureau, 2011). Specifically, Hispanics and Black/African Americans hold only 3.4% and 4.4%, respectively, of science and engineering jobs (National Science Foundation, 2011).

In response to these alarming statistics, a number of initiatives and policies have been established to increase participation of underrepresented populations in the STEM and health professions fields (National Science Foundation, 2011). Policies calling for funding increases for STEM education reform at the K-12, undergraduate, and graduate levels have aided in the development of numerous initiatives to build the STEM and health professions pipeline workforce (National Research Council, 2011). This will be discussed in the next section.

K-12 STEM Education

Efforts to increase participation and performance in K-12 STEM education focus primarily on improving teacher quality and quantity, changing the curriculum, and providing a variety of STEM outreach programs to students (National Research Council, 2011). In terms of teacher quality and quantity, efforts have focused on using qualified teachers to teach science and math subject areas at the K-12 level. Unfortunately, in many under-resourced schools, students are taught science and math by teachers who are not expert in the field. A number of policy and curriculum changes have also been implemented to improve STEM participation at the K-12 level, such as awarding grants to states to create math and science high schools, advanced placement class options in under-resourced schools, matching K-12 curriculum with STEM knowledge needed further in the pipeline, and K-12 partnerships with industry- and university-based labs (National Research Council, 2011).

K-12 STEM partnerships have played a major role in educational reform efforts to increase the number of students in the STEM pipeline (National Science Foundation, 2011). These pipeline programs are supported by private entities, such as industry, and federal and state grants and can take place during the school year or summer. These programs help to enhance participants' problem-solving, and analytical and critical thinking skills, all of which are important in the STEM and health professions fields (National Research Council, 2011).

Role of Social Capital in Access

Substantial inequities exist in K-12 students' access to science, specifically in underrepresented minority and socio-economically disadvantaged populations. The inequities might be partially attributed to inadequate mentoring and gate-keeping, a phenomenon whereby students are not able to participate or navigate pipeline programs, hence reducing access to opportunities. This lack of access can be an obstacle to social capital.

The explanation of social capital as access to institutional resources and institutional agents has its roots in the works of Bourdieu (1977) and Stanton-Salazar (1997). Stanton-Salazar's work has been highlighted in this regard in the previous section. Bourdieu (1977) states that while individuals occupy various dimensions within their social environments, it is not necessarily their original or inherent positions which define them, but rather the amount of social capital they are able to amass through social exchanges or networking. These beneficial relationships and connections enhance social capital. Coleman and Lin also played an instrumental role in defining social capital. Coleman (1988) built upon Bourdieu's framework of social capital, defining it as a public resource enforcing the desired social norms and sanctions within families and communities. Lin (2000) stated that one of the greatest challenges confronting minority students is their awareness of and access to social networks rich in potential sources of social capital.

Pipeline programs and group membership can increase students' networks, opportunities, and access. They provide opportunities for those who have the ability to do well in science (increased human capital), but are unable to gain access to those who are in a position to help them (decreased social capital). Coleman (1988) characterizes human capital as the accumulation of knowledge and abilities. However, Coleman believes that an abundance of human capital with little social capital would have minimal benefit. For example, in my experience in science outreach, some students do well in science but are unable to gain access to those who can write strong letters of recommendation to gain further access to science outreach programs which could potentially increase their social capital and network. Unfortunately, underrepresented minority and disadvantaged students do not often have access to institutional support that students with much social capital have access to. Increasing social capital networks of underrepresented minorities might have an influence on increasing achievement.

Institutional agents such as teachers, scientists, health professionals, counselors, peers, and school/university administrators can play a role in increasing the network of students and increasing students' social mobility and, hence, their social capital. Institutional agents can play a role in mentoring, advising, and accessing opportunities for advancement. They also play a role in shaping policies for recruitment of students into their programs, thereby serving as gatekeepers for the science and health professions pipeline. Equitable access to this information is crucial in increasing social capital. The E-matching initiative that is described in this paper provides an avenue for students to expand their informational resources about pipeline initiatives in an effort to gain more access.

Methods

Given that E-matching is a new concept, this is a conceptual study highlighting social capital as access via E-matching, with some exploratory qualitative data in the form of a case study of the teacher's account. Teacher and students were identified via E-matching through the National Lab Network website. This website has over five thousand advertisements from teachers advertising the needs of their students. This website is endorsed by several organizations including the National Institutes of Health, National Science Teacher Association, and National Science Foundation. The teacher was selected by the author as a result of this teacher’s advertised needs reflecting some of the gaps that the author faced in her STEM educational journey. The teacher’s needs fell into three areas (these needs are discussed in the case study section). The author collaborated with the teacher using a Community-Based Participatory Approach in which all scientists, administrators and teachers are equal stakeholders in planning the outreach. This is explained further in the next section. This teacher’s students were subsequently invited to the urban biomedical research university as a way to enhance social capital through social interactions with institutional agents. Data were collected in the form of the teacher’s account of the social capital her students received.

Tailoring Science Outreach: Community-Based Participatory Approach

E-matching embraces the Community-Based Participatory Approach (CBPA), which has its roots in the social sciences, public health, and education (Israel, Schultz, Parker, & Becker, 1998; Wallerstein & Duran, 2003). Most recently, the CBPA has become a major focus of the Clinical Translational Science Award community engagement initiative (National Center for

Research Resources [NCRR], 2009). Traditional science outreach programs typically involve pre-structured science experiences with little input from the teachers and students in the planning and implementation of these experiences. However, applying CBPA to science outreach involves a collaborative approach, which engages all partners and stakeholders equally in the development of the science outreach. In this project, the stakeholders included high school science teachers, scientists, and science outreach administrators. Unlike the traditional approach, CBPA acknowledges that each stakeholder has unique needs and contributes a unique strength that mutually benefits the partnership (see Table 1). The school benefits from a tailored science outreach and the scientists benefit from the stimulation of sharing research with inquisitive young minds while also fulfilling broader impact objectives often required in grant submissions.

CBPA begins by assessing the primary interest of the school. E-matching allows a school to advertise its needs so that outside institutions that can provide resources may contact schools and subsequently tailor an agenda to fulfill those needs. This approach has many components designed to lead to more successful science outreach outcomes: 1) it empowers the teacher with tools and resources to shape the science exposure needs of his or her students; 2) it puts the needs of the school first; and 3) it facilitates a dynamic endeavor since each relationship is tailored to the needs of the school and the resources of the scientist. Table 1 describes the process of tailoring science outreach endeavors utilizing a Community-Based Participatory Approach via E-matching, and compares it to the traditional approach to science outreach.

Table 1

Traditional Approach vs. Community-Based Participatory Approach (CBPA) through Science Outreach E-matching

Traditional	CBPA
University* has pre-structured outreach which may be formulated in consultation with members of the university.	Outreach is tailored and formulated in collaboration with representatives of the K-12 school to ensure that the needs of the student population are met. The university and the K-12 school are equal partners in the development of the science outreach plan. The K-12 school approaches the university with a science outreach need. Or The university can approach the K-12 school with a science outreach proposal that can be tailored to the K-12 school's needs.
Impacts of science outreach are shared with members of the university.	Impacts of science outreach are shared with both members of the university and representatives of the K-12 school as part of collaborative partnership.
Sometimes relationship with the K-12 school ends after the outreach, especially if it is short duration.	Relationship with the K-12 school continues.
Debriefing often occurs with members of the university.	Debriefing often occurs with the K-12 school and university as part of the collaborative endeavor.
Evaluation is done by the university by examining the K-12 school and shared with members of the institution.	Evaluation is done by the university in collaboration with the K-12 school. The results are shared with both the K-12 school and members of the university.
Less time is required to set up the program.	More time is required to set up program as a result of tailored approach.

*Note: For the purposes of this paper, university is used as the collaborating organization. However, the collaborating organization can extend beyond the university.

Discussion: E-matching with National Lab Network

The National Lab Network (NLN) initiative, formerly National Lab Day, is a worthwhile model for outreach initiatives that employs an e-learning approach. Recognizing a critical need to increase science equity and literacy, and employing a Community-Based Participatory Approach, NLN was created in 2009 as a national call to action. NLN tailors its outreach to the needs of the target student population via an E-matching service which links K-12 teachers with STEM professionals, organizations, and resources. However, NLN is more than just a day; it is an ongoing effort to increase the number of K-12 schools receiving outreach in the STEM disciplines.

The E-matching process occurs on the NLN website (www.nationallabnetwork.org) linking projects that teachers propose with scientists and their resources, thereby building local communities of support. Scientists and teachers are matched based on a variety of parameters including subject matter, geographic location, grade level, interests, need, and other factors (see Figure 1). This model allows for teachers to connect with STEM experts who can tailor an outreach based on the specific needs of teachers and students. In addition to this linking process, all projects and registered users on the NLN website are accessible beyond suggested matches. This process serves as a model that allows for a Community-Based Participatory Approach that complements the traditional approach. Figure 2 shows archived ads from teachers on the NLN website.

Figure 1. National Lab Network E-matching diagram

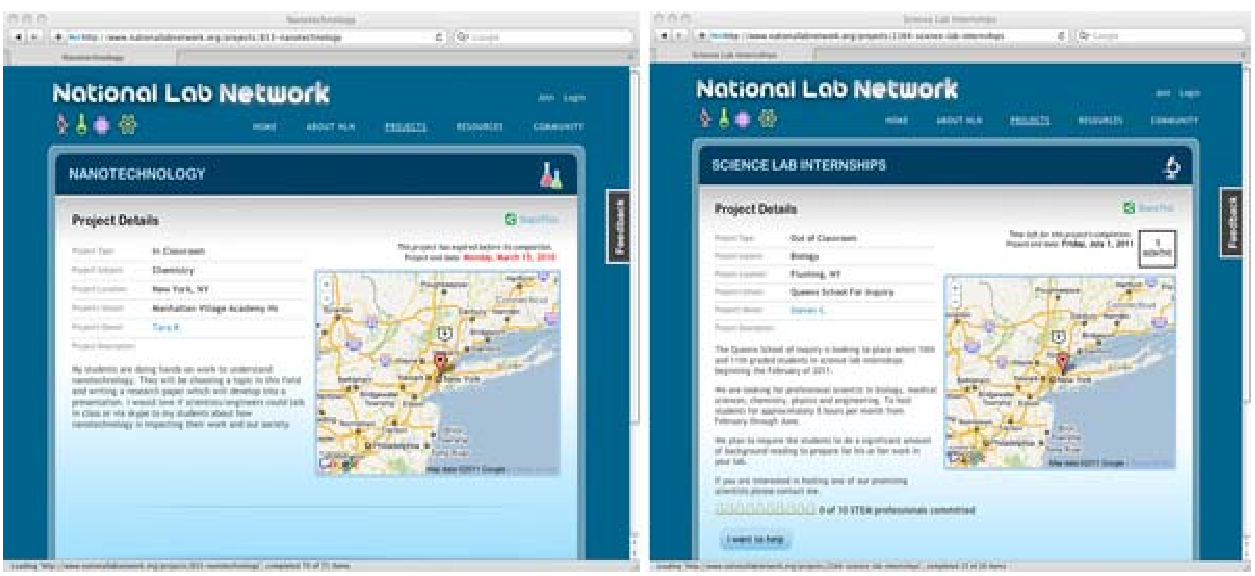


Figure 2. Ads from National Lab Network site

Collaboration: An E-matching Case Study

Through the E-matching platform provided by NLN, The Rockefeller University collaborated with a New York City public high school in the Bronx. This Bronx high school's student body was largely composed of underrepresented minority students and those from socioeconomically disadvantaged backgrounds. A teacher submitted a profile on the NLN website that indicated three major objectives: 1) an exposure to racially/ethnically and gender diverse scientists; 2) an exposure to diverse career options in the sciences; and 3) an opportunity to see "real-life science" at work as a complement to the existing science curriculum.

The urban biomedical research university Community Engagement Specialist accessed the NLN site, and chose the school based on the following broader urban biomedical research university National Lab Network objectives: 1) provide science outreach to schools serving predominantly underrepresented minority and/or disadvantaged students; 2) tailor each outreach according to the specific needs of the school; 3) serve as an information pipeline to inform students of research opportunities at the urban biomedical research university and other institutions; 4) connect students with mentors; 5) expose students to diverse scientists/trainees with an emphasis on underrepresented minority scientists/trainees; and 6) emphasize the importance of science and science literacy regardless of a student's career trajectory. After discussions with the stakeholders, a tailored agenda was formulated addressing the K-12 school areas of interest (see Table 2 below).

To initiate the collaboration through a CBPA, we recognized that both the K-12 school and the research institution were bringing unique strengths to the endeavor. This approach also met the needs of all stakeholders in the partnership. To illustrate the efficacy of the E-matching initiative, the case of teacher L.E. is given as a context for a more systematic analysis of the case using the lens of social capital.

K-12 Teacher's Perspective (Ecology and Chemistry High School Teacher): Science Outreach to Urban Youth via E-matching

> The chances of my urban high school students interacting with science professionals increased dramatically with E-matching. The ability to propose a project on the internet, which entailed the interaction of science professionals with urban youth, allowed for the publication of the needs of my chemistry and ecology class. In addition, the logistics of physical location, grade-level appropriateness, and diversity which were apparent within the proposal allowed for feasible responses. Communication is a key component in education and the ability to electronically connect with professionals actively engaged within the content area of study has important ramifications.
>
> Several institutions responded to my proposal, and engaged my students in ways that allowed for collaborations both within and outside the school setting (Table 2). As part of the outreach within the school setting, students targeted in my proposal listened to a presentation and interacted with a chemist from a translational laboratory. As part of the out-of-school experience, students visited a biomedical research university (The Urban biomedical research university). Via personal testimonial, research presentation, science content demonstrations, interactive panel discussions, campus tours, and meet-and-greet with a variety of researchers, students, and professionals, students experienced the possibilities, activities, and interactions which occur within a science educational research organization. Their knowledge base of the opportunities inherent within the scientific field, and the connections between their understanding that what is learned in the classroom as an initiation to higher education settings and real-world application, broadened immensely.
>
> The benefits and opportunities which resulted from the relationships formed during this E-matching process (including acceptance of four students to the longer duration summer program) enhanced the awareness of the Bronx high school students to the scientific community. These connections were made possible due to the establishment of a venue in which partnerships could be initiated electronically. The fact that there were individual STEM professionals and their respective scientific organizations who were willing and able to connect with urban youth and offer these students a window into the STEM community was made possible through the E-matching initiative. As the teacher, I also received stimulation from these opportunities to connect with scientific and educational professionals engaged in the process of academic and medical research. Such interactions will serve to enhance the educational experiences of the students, teachers, and the scientific community.

Students must work in a rich, responsive environment and have contact with knowledgeable people in the community if they are to make the habits of mind their own (Costa & Kallick, 2000).

Social Capital and E-matching

In this section, E-matching in the context of social capital is described and related specifically to the case of the teacher, beginning with a general review of the literature and definition of major terms.

Social capital is enhanced through interactions which facilitate networking and relationship building. The interactions and networking may not have occurred without intervention. The intervention highlighted in this study is E-matching. With social capital, relationships change between people toward action and resource generation. Bourdieu (1986) viewed social capital as a resource which stems from group membership. Thus, social capital is a form of power that is available based on the quality of one's social networks.

This review of the literature suggests that students from underrepresented populations are reliant on institutional agents for knowledge, support, and information about pursuing higher education. Gaps in the literature left questions about the development of social capital for underrepresented students, particularly the role of social capital in helping students navigate the science pipeline.

Partnerships between institutions of higher education and K-12 systems have become increasingly critical in remedying these disparities in the STEM disciplines. As mentioned previously, the U.S. Department of Education's NCES 2008 report on K-12 intervention strategies identified six common elements of intervention programs that have been most successful in doubling the college attendance rates of program participants: 1) providing a key person such as a mentor, director or guidance counselor to monitor and guide a student over a long period of time; 2) providing instruction through access to the most challenging courses offered by the school, through special coursework that supports the regular curricular offerings or by revamping the curriculum to better address the learning needs of students; 3) making long-term investments in students; 4) recognizing the cultural background of students; 5) providing a peer group to provide social and emotional support; and 6) providing financial assistance and incentives such as college visits, standardized preparation courses, and scholarship support.

Application of Social Capital to the Case of L.E.'s School and E-matching

Institutional agents and community partners serving as equal stakeholders in the partnership can play an instrumental role in facilitating CBPA and social capital. For the E-matching initiative, a K-12 teacher at an urban school serving predominantly URMs and disadvantaged students, who was also a stakeholder in the science outreach, states the following thoughts about the program: "As the teacher, I also received stimulation from these opportunities to connect with scientific and educational professionals engaged in the process of academic and medical research. Such interactions will serve to enhance the educational experiences of the students, teachers and the scientific community." Hence, the CBPA and science outreach increased this K-12 teacher's social capital, resulting in connections with the scientific community. The CBPA to science outreach may play a role in enhancing URM participation in the STEM educational pipeline, thereby potentially increasing social capital for both K-12 teachers and students.

In L.E.'s case she utilized weak ties with institutional agents to enhance social capital. Weak ties are explained as relationships with acquaintances or friends. Granovetter (1983) further explained that these weak ties form a network of heterogeneous members through which valuable social connections are created and upward mobility can be obtained. Granovetter defined tie strength as a composite of several correlated factors, including time, closeness, and intimacy involved in the relationship. Therefore, frequency of contact and duration can have an impact on strength of social capital.

Table 2 outlines the various forms of social capital obtained through the E-matching initiative. Social capital was obtained from institutional agents in the form of graduate students, scientists, and administrators from the urban biomedical research university. Social capital was imparted to both the teacher and students in the form of knowledge, information, networking with institutional agents, resources, and access, which otherwise would not have occurred without the exposure. The teacher (L.E.) stated that "The chances of my urban high school students interacting with science professionals increased dramatically with E-matching." She further explained the benefits of the panels and hands-on experience in the science environments in making science real and exciting for her students. She also explained that this experience not only benefited her students but also increased her professional development. Therefore, social capital was experienced at both the teacher and student levels.

Table 2

Science Outreach Needs and Tailored Agenda for National Lab Day

School Needs	National Lab Day Agenda	Volunteers	Forms of Social Capital
Need for exposure to racially and ethnically diverse scientists	Mentoring advice, diverse science training, and careers panel consisting of racial/ethnic and gender-diverse scientists/ scientists in training	Ph.D., M.D./Ph.D., and M.D. students	Knowledge/Information
Exposure to diverse career options in the sciences	Mentoring advice, science training and careers panel, mentoring and mingling session, campus/lab tours, interactive science demonstration, and science research presentation	Science outreach staff, research scientists and various members of the health professional and research team	Knowledge/Information, Access, Network with Institutional Agents, Resources
Seeing "real-life science" at work	Science research presentation, interactive science demonstration, lab tours	Science outreach staff, health professional and research team, Ph.D., M.D./Ph.D., and M.D. students	Access, Network with Institutional Agents

Limitations

The E-matching initiative has inherent limitations in that it is limited to those who know about the resource to be able to utilize it. Despite the accessibility of numerous initiatives via the Internet, one still needs to be informed about these resources in order to utilize them. Efforts were made to advertise the website through a wide variety of channels. The author also made efforts to advertise the website through minority serving institutions to increase access within these populations. Moreover, the need for more science outreach far exceeds the resources that are available. For example, because numerous advertisements on the website were waiting to be matched, selection of a school by a STEM professional is dependent on there being a match in

STEM interest and school needs. Finally, this is a conceptual study which will be further strengthened with both short-term impact and longitudinal quantitative data.

Preliminary Benefits

There were several benefits to the outreach via E-matching. This endeavor served as an information pipeline for underrepresented minority and disadvantaged students to consider science careers as a viable option. An unexpected benefit was the social capital experienced by the teacher (L.E.) in that she was able to connect with researchers for her own professional development. This same teacher was invited to be a participant of the achieving Successful and Productive Academic Research Careers (SPARC) initiative reported in the second manuscript (Chapter IV). As a result of the E-matching exposure, 19% (n = 7) of the 36 student participants who previously did not have exposure to science/real-world scientists went on to apply to the urban biomedical research university Summer Neuroscience Program and 57% (n = 4) were accepted. This outcome of increasing social capital via access would not have happened without such a connection.

Policy

As a result of the author's proposed tailored program, some of the selection criteria for the science outreach program were changed, allowing for a more holistic view of the applicants coming from disadvantaged and URM backgrounds. This micro-cultural change in institutional policies has made a significant difference in URMs' and disadvantaged students' entry into the competitive program. Taking into account micro and macro institutional policy changes to help increase social capital for underrepresented populations can play an important role for successful and sustainable outcomes.

Conclusion

Utilizing E-matching and a Community-Based Participatory Approach to tailor science outreach allows for highly specific, targeted, and collaborative coordination of science outreach endeavors to meet the needs of all stakeholders. Reflecting back on the high school student's statement in the beginning about inequities in science access, E-matching can address some of the science exposure disparities seen in many urban classroom settings to increase social capital. This approach may also serve as a pipeline to increase diversity in the STEM fields. We do not deny that for some science outreach programs, a traditional pre-structured outreach may work better. Perhaps a hybrid approach to science outreach utilizing both the traditional and tailored approaches would best meet the science outreach needs to increase URMs' access to the pipeline.

Chapter IV

APPLICATION OF SOCIAL CAPITAL THEORY TO BUILD INDIVIDUAL CAPACITY FOR DIVERSITY IN BIOMEDICAL RESEARCH: THE SPARC

Abstract

Introduction

Social capital theory states that resources, both actual and prospective, are inherently linked to networks. Therefore, a basic tenet of social capital theory is that “relationships matter.” In the academic research realm, social capital, such as strong mentorship relationships and collaborative research networks, are critical elements for developing an individual’s capacity for a strong research career. However, racial and underrepresented minorities (URMs) are often bereft of basic social capital because they lack proper mentorships and/or are not part of “inner” circles of biomedical research. Therefore, academic institutions which share a common vision of diversity in biomedical research must leverage resources and form strategic partnerships in order to build their own capacity and social capital to support initiatives that provide mentoring, networks, information, knowledge, and opportunities for advancement. Using a social capital theoretical framework, this paper describes the development, implementation, and evaluation of achieving Successful and Productive Academic Research Careers (SPARC), a novel initiative undertaken by three urban biomedical centers to build individual capacity for biomedical research careers. Achieving Successful and Productive Academic Research Careers is a tri-institutional partnership between an academic medical center (Weill Cornell Medical College), a translational research center (The Rockefeller University Center for Clinical and Translational

Science), and a cancer center (Memorial Sloan-Kettering Cancer Center). The mission of SPARC was to create an infrastructure to increase capacity for research career development of URM trainees and faculty who are in different stages of their science career paths by facilitating networking opportunities. A second objective was to leverage resources and build partnerships that could sustain future initiatives. This paper focuses on increasing translational science knowledge for individuals earlier in the pipeline: high school, college, and post-baccalaureate students.

Methods

An 18-item survey was designed to assess the impact of the SPARC initiative on social capital constructs including mentoring, professional development, knowledge about translational science, view of science, and exposure to diverse scientists. The survey was distributed to a convenience sample of 93 high school students, undergraduate students, post-baccalaureate students, parents, and teachers who participated in the SPARC initiative. The data were analyzed using SAS V9.3 (SAS Institute Inc.). The survey addressed the social capital indicators of mentoring, networking, knowledge, and information. Due to logistical reasons, the initiative was assessed using a post-survey only.

Results

There was a 67% survey completion rate (n = 63). Respondents represented the broad range of individuals who attended the SPARC conference. The following aspects of the SPARC initiative were reported as having a strong influence on increasing individual capacity in the pre-college, college, and post-baccalaureate students: 1) mentoring and networking, and

2) increasing knowledge and interests in translational science careers. The results also provide lessons learned and identify opportunities to improve future initiatives.

Conclusion

Since its inception, the SPARC initiative has reached over 200 pre-college students, undergraduates, and junior faculty from URM backgrounds. Additionally, this initiative provides a framework for other biomedical institutions to enhance individual capacity to support diversity.

Introduction

Achieving Successful Productive Academic Research Careers was launched in 2010 as a collaboration between Weill Cornell Medical College, Memorial Sloan-Kettering Cancer Center, and The Rockefeller University, referred to as the tri-institution. This initiative was conceived in direct response to the NIH’s call for expedient actions to address the underrepresentation of racial/ethnic minorities and women in biomedical research. In 2010, representatives from each institution met and discussed existing diversity programs and existing gaps. Identified gaps fell into several areas: 1) recruitment: low numbers of trainees in the pipeline to pursue academic research careers; 2) retention: lack of support for underrepresented minority faculty to advance within academia; and 3) resources and infrastructure: lack of resources within the institutional infrastructure to support broad diversity programming. The group discussed ways to leverage resources to create a diversity partnership through the tri-institution; hence, the SPARC initiative was created with co-chairs appointed from each institution as a first step to partner and discuss strategic planning for next steps. The group decided to target the needs of existing underrepresented minority junior faculty members. Therefore, a conference targeting junior faculty members was held in April 2011. This conference was highly successful and attended by over 100 investigators throughout New York City. Results from this conference are reported as a separate manuscript. Because of the high success of the first conference, a follow-up conference focusing on translational science was held a few months later targeting individuals earlier in the pipeline. These individuals were high school students, undergraduate students, post-baccalaureate students, parents, and teachers. This was the first tri-institutional translational science and health disparities conference focused on individuals earlier in the pipeline. This second conference is the focus of this manuscript.

Literature Review

Social Capital Theory

Restating the definition from Chapter I that was used in this study, social capital is: resources and benefits that result from group membership, relationships, social interactions, and networks. While these relationships are first provided to students typically through parents, they can also be provided through mentors and can manifest through the possession and acquisition of specific, highly-sought-after bodies of knowledge.

Bourdieu (1986) states that the three forms of capital are economic capital, cultural capital, and social capital. Social capital results from social connections. Bourdieu’s link between capital and education stands to provide an economic and social explanation for the outcomes of an applied social learning theory. He sees successes and failures of students as inherently linked to social capital or the lack thereof in their immediate environment.

Social capital and the pipeline. Bourdieu (1973) was the first to relate social capital to individual achievement and access to resources which occur through group membership. He viewed social capital as a resource that stems from group membership or connections with others. Thus, social capital is a form of power that is available based on the quality of one's social networks. The SPARC initiative provides an environmental context of like-minded individuals at various career stages who can serve as mentors and informational resources to those more junior in the pipeline.

The explanation of social capital as access to institutional resources has its roots in the work of Bourdieu, who was the first sociologist to systematically analyze the concept of social capital. Bourdieu (1977) states that while individuals occupy various dimensions within their social environments, it is not necessarily their original or inherent positions which define them, but rather the amount of social capital they are able to amass through social exchanges or networking. These beneficial relationships and connections enhance social capital. Coleman (1988) and Lin (2000) also played an instrumental role in defining social capital. Coleman built upon Bourdieu's framework of social capital, defining it as a public resource enforcing the desired social norms and sanctions within families and communities. Lin states that one of the greatest challenges confronting minority students is their lack of awareness of and lack of access to social networks rich in potential sources of social capital. Stanton-Salazar (1997) built on this work by looking at the role of institutional agents in conferring social capital. Institutional agents such as scientists, administrators, teachers, and counselors can play a role in building social capital for students in the pipeline via mentorship and support networks.

Logic Model and Conceptual Framework

Figure 1 outlines the logic model and conceptual framework used for the SPARC diversity in translational science conference. This logic model provides a replicable framework for process and outcome evaluation of both short and long duration initiatives. The input represents the programmatic aspect of the SPARC initiative. The output, short-term and long-term outcomes, indicates the various forms of social capital and capacity building that are expected (i.e., increase knowledge of translational science, increase mentoring and networking, build capacity to pursue research careers). In the context of this study, building capacity is defined as information, resources, and tools needed to navigate the science, medicine, and research pipeline; hence, building capacity is also a social capital indicator.

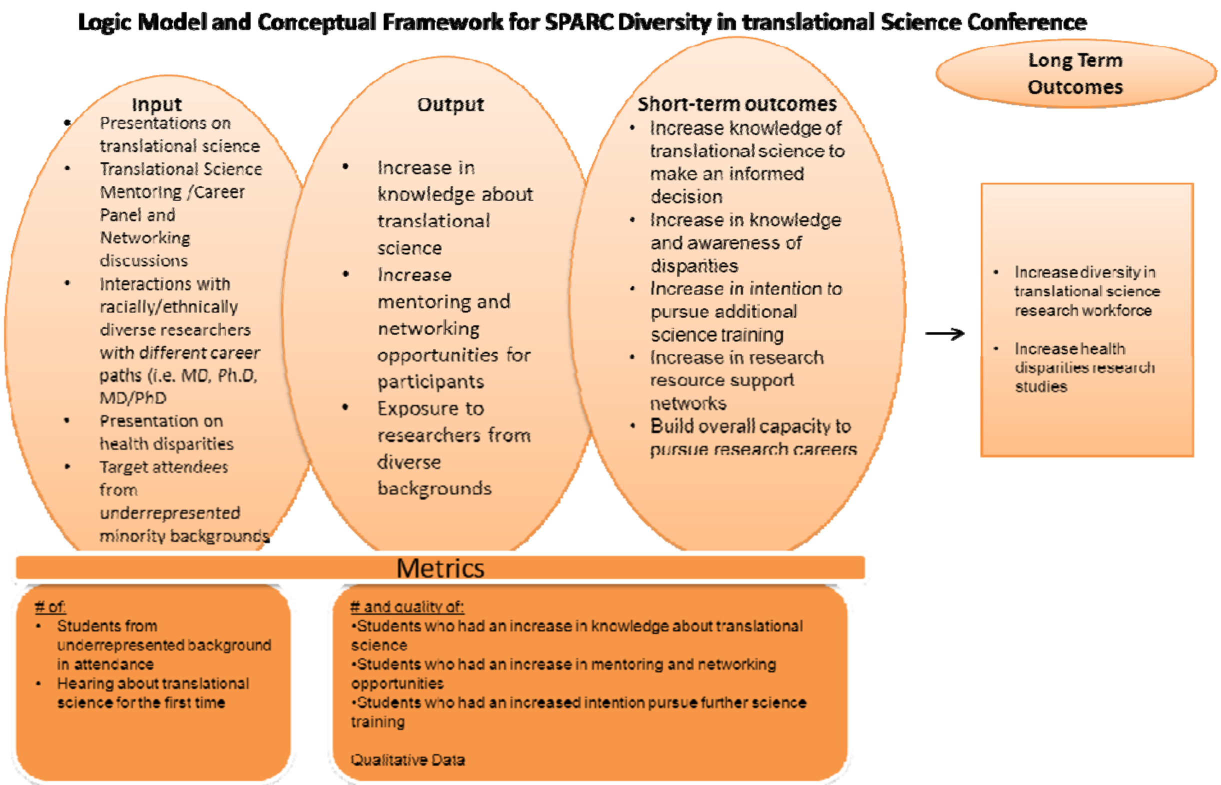


Figure 1. SPARC Logic Model

SPARC Conference Program

The SPARC program consisted of a half-day workshop which included talks on health disparities, translational science, and panelists for the mentoring and career session. A concerted effort was made to have diverse representation in speakers and panelists in terms of race, field, and training level. A specific effort was made to have a good representation of speakers and panelists from URM backgrounds. Panelists included M.D./Ph.D. students, a surgeon, a physician, a public health researcher, and translational scientists. In an effort to foster additional networking and mentoring in small groups (6 students per table), 13 roundtables featuring 7 different topic areas were held. A roundtable leader specializing in the topic served as the information source for questions the students posed. Roundtable topics included: 1) careers in science and medicine; 2) a closer look at translational science research careers; 3) the life of a medical student; 4) careers as a physician scientist; 5) public health and health profession careers; 6) mentoring and networking tips for advancement in science and medicine; and 7) science enrichment and the process of applying to medical school. The full program is shown in Appendix B.

The SPARC program is meant to serve as both a professional development umbrella for existing pipeline programs within and outside the tri-institution. Figure 2 shows the relationship between the SPARC program and other institutional pipeline programs ranging from high school to professional level programs. The SPARC program is meant to serve as an umbrella infrastructure to build capacity and support diversity in both existing tri-institutional pipeline programs and also support URM individuals who are external to the tri-institution.

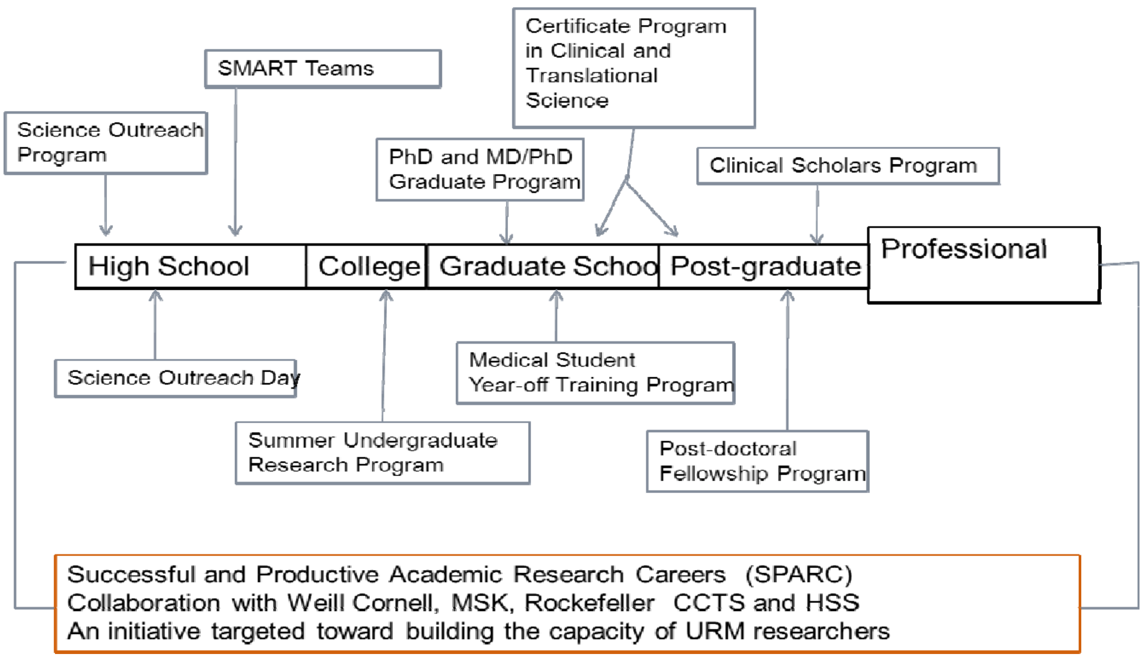


Figure 2. SPARC program and relation to pipeline programs

Research Objectives

The main purpose of the study was to assess the impact of the SPARC initiative on social capital constructs such as mentoring, professional development, knowledge about translational science, view of science, and exposure to diverse scientists. The study utilized quantitative data collected through a survey to address the following questions:

- Does this initiative build capacity through a) expanding mentoring, b) expanding networks or c) expanding professional development opportunities?
- Does this initiative increase knowledge about translational science and the path to translational science careers?

- What role did this initiative play in participants' views of science/translational science careers?
- What type of impact did this initiative have on participants?
- Did this initiative provide additional exposure to scientists from diverse racial/ethnic groups?
- Do respondents hold different views based on their demographic characteristics (e.g., gender, education, and race/ethnicity)?

Research Method

Surveys were distributed to 93 participants; 64 participants completed the survey. Respondents represented the broad range of conference participants targeted for this initiative. The objectives of the survey were to assess the impact of the initiative on social capital constructs such as mentoring, professional development, knowledge about translational science, view of science, and exposure to diverse scientists. Questions in the survey were developed in consultation with a panel of education experts. The final version of the survey is provided in the Appendix A.

Participant Selection

This conference targeted participants who were underrepresented in science and medicine. Participants of the SPARC conference were originally recruited from summer research programs within the tri-institution (Weill Cornell Medical College, The Rockefeller University, and Memorial Sloan-Kettering Cancer Center); however, because of increased external interest, invitations were extended to underrepresented groups outside of the tri-institution to learn about translational science and health disparities. The invitation was distributed to institutions within the New York City area, minority-serving email lists such as the Minority Graduate Student Network of New York, and investigators who participated in the first SPARC initiative for junior and senior investigators. Non-URMs were also welcome to participate if they expressed interest.

Data Collection

This study involved conducting a survey of high school students, undergraduate students, post-baccalaureate students, parents, and teachers who participated in the SPARC initiative. The survey was distributed to 93 participants. Surveys were completed by participants after the initiative. The participants were given sufficient time to fill out the survey. Upon completion of the survey, all paperwork was given back to a member of the diversity office. All information given was anonymous and only accessible to research staff.

Survey Instrument

The author developed a survey based on the available literature and in consultation with science education experts to assess the impact of the SPARC Diversity in Translational Science Conference on participants. The survey was converted to electronic form using the online survey tool http://www.surveymonkey.com and distributed as a hard copy to participants. The survey was vetted with science education survey experts. The instrument was an 18-item survey composed of both multiple-choice with sub-questions and open-ended questions. The survey consisted of questions on participants' demographics, impacts of initiative on professional development, knowledge and views regarding science careers, and so on (see Appendix A).

Data Analysis

The multiple-choice responses of the participants were entered into Microsoft Office Excel and checked for accuracy. Missing values were excluded from the analysis. The data were analyzed with SAS V9.3 (SAS Institute Inc.). Descriptive statistics were computed to summarize the data, which includes a frequency table (count and percentage) for each multiple-choice question, and mean and range for age. Themes for open-ended questions were summarized.

For Likert-scale-based questions (Q8-Q14), the proportion of total positive responses and proportion of total negative or neutral responses were computed. In order to determine whether the participants responded to each question positively or not, the exact one-sided binomial test was performed. The exact binomial test was used to determine whether two categories were equally likely to occur (i.e., the positive opinion vs. negative or neutral opinion) in one sample. In this study, the one-sided test was used to determine whether the proportion of positive responses was significantly higher than the proportion of negative or neutral responses. The null hypothesis stated that the proportion of positive responses would be equal to or lower than the proportion of negative or neutral responses, and the alternative hypothesis was that the proportion of positive responses would be higher than the proportion of negative or neutral responses. Chi-square test of independence was used to determine whether participants' demographics (gender, education level, and ethnicity/race) were associated with participants' responses to each Likert-scale-based question (positive vs. negative/neutral). This test was used to determine the association between two categorical variables. The chi-square test of statistical significance is a series of mathematical formulas that compare the actual observed frequencies of the two variables measured in a sample with the frequencies one would expect if there were no relationship at all between those variables. That is, chi-square assesses whether the actual results are different enough from the null hypothesis to overcome a certain probability that they are due to sampling error, randomness or a combination of the two. The null hypothesis states there is no association between the two variables, while the alternative hypothesis concludes there is an association between the two variables. Various self-reported race/ethnicity categories were grouped into the following two categories for comparison purposes: 1) Underrepresented Minorities (i.e., Black/African American, Hispanic/Latino, West Indian, Cuban, Egyptian, Dominican), and 2) Non-Underrepresented Minorities (i.e., White/Caucasian, Asian, Pakistani, White/Asian). In addition, chi-square test of independence was also performed to test the independence between Questions 6A, 6B, Questions 8-10, and between 6A and 11A.

In order to assess the overall trend of participant perception in each section, the Likert-scale-based question responses were recorded with a numerical scale from most negative to most positive response. The Mann-Whitney test was used to compare the overall perceptions among groups with different demographic characteristics (gender, education level, and ethnicity/race). The Mann-Whitney test is a nonparametric test that compares two independent groups. Here, the two groups were divided by respondents' demographic characteristics (gender, education level, and ethnicity/race). Statistical significance was declared at $\alpha = 0.05$ level. Open-ended questions were summarized by identifying themes or patterns and organizing them into coherent categories.

Results

Response Rate and Characteristics of the Study Population

A total of 93 surveys were distributed to participants of the initiative. With 63 surveys returned, the response rate was 67.7%. The respondents' ages ranged from 14-58 years, with a mean age of 19. Demographic characteristics (i.e., gender, race, ethnicity, education level) of the population are presented in Table 1. The majority of the participants were female (65.1%). Regarding race, 14.5% of the participants were Hispanic or Latino. Regarding race, 57.4% were Black/African American, 16.4% were Caucasian, 11.5% were Asian, and the remaining participants self-identified as Cuban, Egyptian, Dominican, Pakistani, West Indian, and so on or mixed race. In terms of education, 34.9% of the participants were high school students and 57.1% were undergraduates. In addition, 4 participants were post-baccalaureate and 1 participant had an M.A. degree.

The background information regarding whether participants had ever participated in a workshop on translational science, whether they had a science mentor, and whether they were currently enrolled in a summer program was also collected. The frequency distribution for this background information is presented in Table 2. The results show that most (80.7%) of the respondents were first-timers to attend a workshop on translational science. About half (52.5%) of them had a science mentor and the vast majority (83.9%) of them were currently in a summer program.

Table 1

Demographic Characteristics of the Study Population (N = 63)

Characteristic	Count (%)
Gender	
Female	41 (65.1%)
Male	22 (34.9%)
Race	
Black/African American	35 (57.4%)
White/Caucasian	10 (16.4%)
Asian	7 (11.5%)
Cuban	1 (1.6%)
Egyptian	1 (1.6%)
H/Dominican	1 (1.6%)
Half Trinidadian, half Filipino	1 (1.6%)
Hispanic	1 (1.6%)
NH/P	1 (1.6%)
Pakistani	1 (1.6%)
West Indian (Trinidadian)	1 (1.6%)
White/Asian	1 (1.6%)
Ethnicity	
Hispanic or Latino	9 (14.5%)
Not Hispanic or Latino	53 (85.5%)
Education Level	
High School	22 (34.9%)
Undergraduate	36 (57.1%)
Post Baccalaureate	4 (6.4%)
Master of Arts	1 (1.6%)

Table 2

Background Information of Respondents (N = 63)

Question	Count (%)
Is this your first time attending a workshop on translational science?	
Yes	50 (80.7%)
No	12 (19.4%)
Do you have a science mentor?	
Yes	31 (52.5%)
No	28 (47.5%)
Are you currently in a summer program?	
Yes	52 (83.9%)
No	10 (16.1%)

Impact of Initiative on Building Capacity

Six questions were asked to evaluate the participants' perceptions on the impact of this initiative on building capacity through expanding mentoring, expanding networks, and expanding professional development opportunities. Total positive responses were computed as the percentage of participants who chose strongly agree or agree, and total negative/neutral responses were computed as percentage of participants who chose strongly disagree, disagree, and neutral. The exact one-sided binomial test was used to determine whether the proportion of respondents who chose positive responses was significantly higher than the proportion of respondents who chose negative or neutral responses. The results (Table 3) demonstrated that a significantly higher proportion of respondents agreed that, as a result of participating in this conference, they were able to build capacity through expanding mentoring, expanding networks, and expanding professional development opportunities. In particular, over two-thirds of the respondents agreed that the conference had helped them by better identifying, changing or expanding possible research networks (78.3%, $p < 0.0001$). Respondents also agreed that this initiative assisted in expanding professional development opportunities by having a better understanding of the process for developing an academic research career (80.0%, $p < 0.0001$). Furthermore, the respondents agreed that the initiative helped in terms of providing information to develop and enhance the participants' academic research careers (75.0%, $p < 0.0001$).

Table 3

Binomial Test Results for Questions Regarding Impact of Initiative on Building Capacity

(N = 63) (Question 8)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
8a. I am better able to identify, change or expand possible research networks	78.3%	21.7%	**<0.0001**
8b. I am better prepared to identify, change or expand possible mentoring relationships	81.7%	18.3%	**<0.0001**
8c. I have a role model in science	39.0%	61.0%	0.9413
8d. I have someone to discuss my career interests with	62.1%	37.9%	**0.0435**
8e. I now have a better understanding of the process of developing an academic research career	80.0%	20.0%	**<0.0001**
8f. I will seek further information to develop and enhance my academic research career	75.0%	25.0%	**<0.0001**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

The majority of the respondents also agreed that the conference helped them to expand mentoring, such as having someone to discuss career interests (62.1%, $p = 0.0435$), and they were better prepared to identify, change or expand possible mentoring relationships (81.7%, $p < 0.0001$). However, only 39.0% of respondents agreed that they had a role model in science as a result of the participation in this conference. The non-significant result ($p = 0.9413$) suggests that the proportion of respondents who agreed that they had a role model in science as a result of the participation in this conference was not significantly higher than the proportion of respondents who disagreed or had no opinion on the same statement. Therefore, this initiative appears not to have affected the respondents positively in terms of establishing a role model in science. In an attempt to further investigate this finding, a stacked bar chart was constructed (Figure 3) to illustrate the difference in the effect of expanding mentoring for participants who were in a summer program and had a mentor and those who did not. The results demonstrate that the initiative had the highest impact on participants who were in a summer program and had a mentor; 56% of the participants agreed that as a result of participating in this conference, they had a role model in science, and about half of the participants who were not in a summer program but had a mentor agreed to the same statement. Furthermore, it is worth mentioning that 30% of the participants who were in a summer program without a science mentor were able to identify a role model in science as a result of participating in the program. In addition, participants who were not in a summer program and were without science mentors were not able to identify a role model.

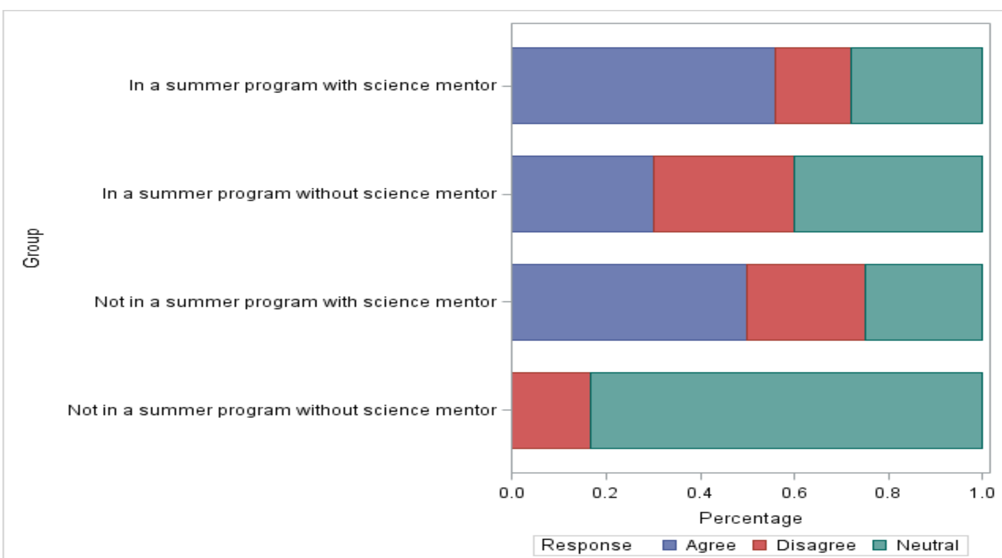


Figure 3. Expanding mentoring for participants by summer program and with/without a science mentor

Furthermore, chi-square test was used to determine whether there was a difference in proportion of positive vs. negative/neutral responses among males and females (Table 4), education level (Table 5), and race/ethnicity (Table 6). The results reveal that the female and male respondents' perceptions of the impact of the initiative on building capacity were not significantly different. While the respondents with different education levels (high school vs. above high school [undergraduate, post-baccalaureate, and M.A.]) showed significant differences in their perceptions of the initiative on building capacity through expending network and expanding mentoring. Specifically, a significantly higher proportion of respondents with education beyond high school responded positively to the following two statements: "I am better able to identify, change, or expand possible research networks" ($p = 0.0148$), and "I have a role model in science" ($p = 0.0068$), than those respondents with only a high school education. This suggests that a significantly higher positive impact of the initiative on building capacity through expanding network and mentoring was found among respondents with a higher education level. The results further confirmed that the difference in perception on the impact of initiative on building capacity between underrepresented minorities and non-underrepresented minorities was not significant, which indicated that ethnicity and race did not affect the respondents' opinions on the impact of the initiative on building capacity.

Table 4

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males (N = 63) (Question 8)

Question	Percentage of positive responses		
	Female	Male	p-value*
8a. I am better able to identify, change or expand possible research networks.	85.0%	65.0%	0.0763
8b. I am better prepared to identify, change or expand possible mentoring relationships.	82.5%	80.0%	0.8135
8c. I have a role model in science.	43.6%	30.0%	0.3110
8d. I have someone to discuss my career interests with.	63.2%	60.0%	0.8138
8e. I now have a better understanding of the process of developing an academic research career.	79.5%	81.0%	0.8923
8f. I will seek further information to develop and enhance my academic research career.	69.2%	85.7%	0.1596

Note. *Two-sided chi-square test

Table 5

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with High School vs. Above High School Education (N = 63) (Question 8)

Question	Percentage of positive responses		p-value*
	High school	Above high school	
8a. I am better able to identify, change or expand possible research networks.	60.0%	87.5%	**0.0148**
8b. I am better prepared to identify, change or expand possible mentoring relationships.	80.0%	82.5%	0.8135
8c. I have a role model in science.	15.0%	51.3%	**0.0068**
8d. I have someone to discuss my career interests with.	45.0%	71.1%	0.0519
8e. I now have a better understanding of the process of developing an academic research career.	81.0%	79.5%	0.8923
8f. I will seek further information to develop and enhance my academic research career.	76.2%	74.4%	0.8758

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 6

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with Different Race/Ethnicity (N = 63) (Question 8)

Question	Percentage of positive responses		
	Under-represented Minorities	Non-Under-represented Minorities	p-value*
8a. I am better able to identify, change or expand possible research networks.	78.9%	75.0%	0.7319
8b. I am better prepared to identify, change or expand possible mentoring relationships.	78.9%	85.0%	0.5762
8c. I have a role model in science.	41.0%	30.0%	0.3270
8d. I have someone to discuss my career interests with.	64.9%	52.6%	0.3748
8e. I now have a better understanding of the process of developing an academic research career.	78.9%	80.0%	0.9251
8f. I will seek further information to develop and enhance my academic research career.	73.7%	80.0%	0.5932

The results revealed that the initiative had a higher positive impact on building capacity for those whose education extended beyond high school. In order to assess whether the initiative had a positive impact on participants with only a high school education, the exact one-sided binomial test was used to determine whether the proportion of respondents who chose positive responses was significantly higher than the proportion of respondents who chose negative or neutral responses for participants with high school education only. The results (Table 7) demonstrate that a significantly higher proportion of respondents agreed that as a result of participating in this conference, they were able to build capacity through expanding mentoring as they were better prepared to identify, change or expand possible mentoring relationships (80.0%, p = 0.0059) and through expanding professional development opportunities by having a better understanding of the process of developing an academic research career (81.0%, p = 0.0036) and seeking further information to develop and enhance participants' academic research careers (76.2%, p = 0.0133).

Table 7

Binomial Test Results for Questions Regarding Impact of Initiative on Building Capacity for Participants with High School Education Only (N = 22) (Question 8)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
8a. I am better able to identify, change or expand possible research networks.	60.0%	40.0%	0.2517
8b. I am better prepared to identify, change or expand possible mentoring relationships.	80.0%	20.0%	**0.0059**
8c. I have a role model in science.	15.0%	85.0%	0.9987
8d. I have someone to discuss my career interests with.	45.0%	55.0%	0.4119
8e. I now have a better understanding of the process of developing an academic research career.	81.0%	19.1%	**0.0036**
8f. I will seek further information to develop and enhance my academic research career.	76.2%	23.8%	**0.0133**

Impact of Initiative on Knowledge and View about Translational Science and Career Path

The impact of the initiative on knowledge and view about translational science and career path were examined with two questions, which included multiple sub-questions. The first question (Q9) asked the participants about their perceptions on change of knowledge, interest, and motivation after attending this initiative, while the second question (Q10) asked about the likelihood of pursuing science as a result of this program. Total positive and negative/neutral responses were computed. The exact one-sided binomial test was used to determine whether the proportion of respondents who chose positive responses was significantly higher than the proportion of respondents who chose negative or neutral responses. The results (Table 8) demonstrated that a significantly higher proportion of participants responded positively to all questions, which suggested that this outreach increased their knowledge about translational science and had a positive impact on participants' views of science and/or translational science. In particular, over 90% of the participants thought that this outreach increased their knowledge about translational science, increased their interest in science, did not make them feel science was boring, and did not decrease their motivation to study science. In addition, the majority of the participants agreed that this outreach had increased their interest in science and translational science and increased their motivation to study science. It is also worth noting that out of the 18 high school participants without any prior knowledge of translational science, 17 (94.4%) had increased knowledge of translational science, as shown in Figure 4.

Table 8

Binomial Test Results for Questions Regarding Impact of Initiative on Knowledge and View about Translational Science and Career Path (N = 63) (Section A) (Question 9)

Question	Percentage of positive responses	Percentage of negative/neutral responses	p-value*
Increased my knowledge about translational science.	91.9%	8.1%	**<0.0001**
*Decreased my interest in science.	95.2%	4.8%	**<0.0001**
Increased my motivation to study science.	80.0%	20.0%	**<0.0001**
Decreased my interest in translational science.	90.3%	9.7%	**<0.0001**
Made me realize science is boring.	98.4%	1.6%	**<0.0001**
Increased my interested in science.	78.3%	21.7%	**<0.0001**
Increased my interest in translational science.	61.3%	38.7%	**0.0490**
Decreased my motivation to study science.	95.2%	4.8%	**<0.0001**
Increased my interest in participating in more science programs.	82.0%	18.0%	**<0.0001**

*Note: Percentage of positive responses for increase and decrease items indicates those who responded positively to items. For example, a positive response for decreased interest in science would be disagree or strongly disagree.

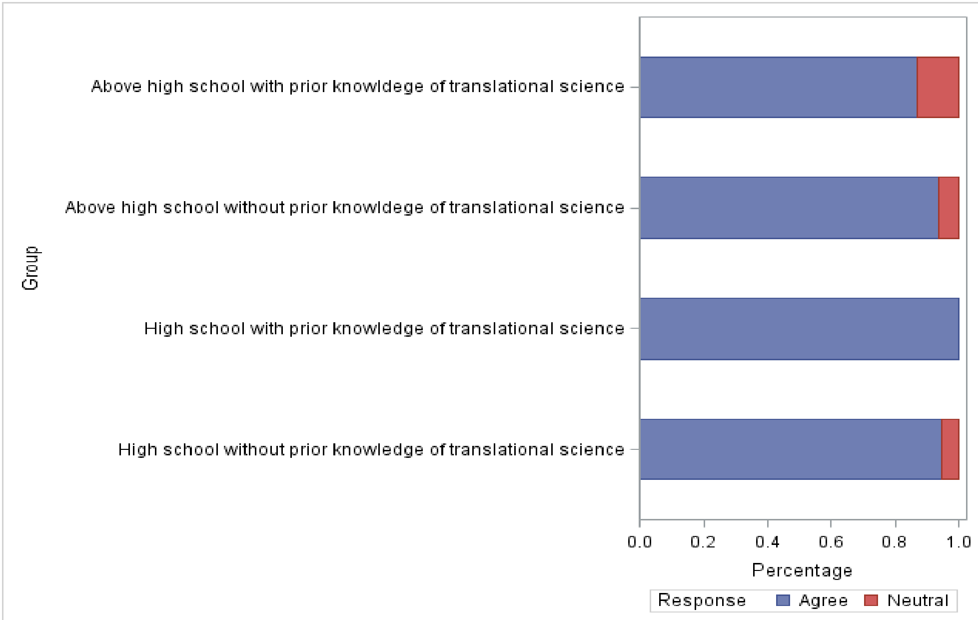


Figure 4. Increasing knowledge about translational science for participants who had high school or above education and with or without prior knowledge of translational science

Furthermore, chi-square test results (Table 9) demonstrated that the majority of the female and male participants responded to all questions positively. The results further indicated that a significantly higher proportion of male participants responded positively in terms of increasing their motivation to study science than females ($p = 0.0032$). In particular, all male respondents agreed that the outreach increased their motivation to study science, while 68.4% of female respondents felt the same way. The respondents with different education levels responded to all questions similarly and no significant difference was observed in the proportion of positive responses between the two groups (high school vs. above high school [undergraduate, post-baccalaureate, and M.A.]). Similarly, the respondents in different racial categories also responded to all questions similarly and no significant difference was observed.

Table 9

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males (N = 63) (Section A) (Question 9)

Question	Percentage of positive responses		
	Female	Male	p-value*
Increased my knowledge about translational science.	87.5%	100.0%	0.0837
Decreased my interest in science.	92.5%	100.0%	0.1879
Increased my motivation to study science.	68.4%	100.0%	**0.0032**
Decreased my interest in translational science.	90.0%	90.9%	0.9078
Made me realize science is boring.	100.0%	95.5%	0.1740
Increased my interested in science.	71.8%	90.5%	0.0939
Increased my interest in translational science.	55.0%	72.7%	0.1703
Decreased my motivation to study science.	97.5%	90.9%	0.2472
Increased my interest in participating in more science programs.	79.5%	86.4%	0.5024

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 10

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with High School vs. Above High School Education (Section A) (Question 9)

Question	Percentage of positive responses		p-value*
	High school	Above high school	
Increased my knowledge about translational science.	95.2%	90.2%	0.4943
Decreased my interest in science.	90.5%	97.6%	0.2186
Increased my motivation to study science.	76.2%	82.1%	0.5883
Decreased my interest in translational science.	95.2%	87.8%	0.3488
Made me realize science is boring.	100.0%	97.6%	0.4706
Increased my interested in science.	81.0%	76.9%	0.7178
Increased my interest in translational science.	47.6%	68.3%	0.1137
Decreased my motivation to study science.	95.2%	95.1%	0.9839
Increased my interest in participating in more science programs.	76.2%	85.0%	0.3952

Note. *Two-sided chi-square test

Table 11

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with Different Race/Ethnicity (N = 63) (Section A) (Question 9)

Question	Percentage of positive responses		
	Under-represented Minorities	Non-Under-represented Minorities	p-value*
Increased my knowledge about translational science.	90.0%	95.0%	0.5089
Decreased my interest in science.	92.5%	100.0%	0.2089
Increased my motivation to study science.	81.6%	75.0%	0.5566
Decreased my interest in translational science.	90.0%	90.0%	1.0000
Made me realize science is boring.	97.5%	100.0%	0.4758
Increased my interested in science.	73.7%	85.0%	0.3260
Increased my interest in translational science.	57.5%	65.0%	0.5762
Decreased my motivation to study science.	97.5%	95.0%	0.6111
Increased my interest in participating in more science programs.	76.9%	90.0%	0.2221

Note. *Two-sided chi-square test

Question 10 addressed respondents' likelihood of pursuing science as a result of the program. The results (Table 12) demonstrated that a significantly higher proportion of participants responded positively that as a result of the program, they were likely to: "Pursue a science major," "Apply to more science enrichment programs," "Read more science literature," "Participate in science discussions," and "Tell others about science." However, the proportion of respondents who thought they were likely to pursue a career in translational science (55.7%) was not significantly higher than the proportion of respondents who chose negative or neutral responses, which suggested that the initiative did not significantly increase the respondents' likelihood of pursuing a career in translational science.

Table 12

Binomial Test Results for Questions Regarding Impact of Initiative on Knowledge and View about Translational Science and Career Path (N = 63) (Section B) (Question 10)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
Pursue a science major	62.3%	37.7%	**0.0361**
Apply to more science enrichment programs	83.6%	16.4%	**<0.0001**
Read more science literature	82.0%	18.0%	**<0.0001**
Participate in science discussions	90.2%	9.8%	**<0.0001**
Tell others about science	90.2%	9.8%	**<0.0001**
Pursue a career in translational science	55.7%	44.3%	0.2213

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

Furthermore, chi-square test results (Table 13) demonstrated that the majority of the female and male participants responded to all questions positively. The proportions of participants who chose positive responses were slightly higher for males than females for all questions; however, no significant difference was observed. The proportion of participants who chose positive responses was not significantly different between the URMs versus non URMs either (Table 15). Moreover, the results (Table 14) showed that the likelihood of pursuing a science major as a result of this conference was significantly higher for high school students than for respondents with above high school education, which suggested that the conference had a more positive impact for respondents in their earlier stage of education.

Table 13

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males (N = 63) (Section B) (Question 10)

Question	Percentage of positive responses		
	Female	Male	p-value*
Pursue a science major	60.0%	66.7%	0.6097
Apply to more science enrichment programs	77.5%	95.2%	0.0754
Read more science literature	80.0%	85.7%	0.5813
Participate in science discussions	87.5%	95.2%	0.3349
Tell others about science	87.5%	95.2%	0.3349
Pursue a career in translational science	50.0%	66.7%	0.2131

Note. *Two-sided chi-square test

Table 14

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with High School vs. Above High School Education (N = 63) (Section B) (Question 10)

Question	Percentage of positive responses		p-value*
	High school	Above high school	
Pursue a science major	81.0%	52.5%	**0.0294**
Apply to more science enrichment programs	90.5%	80.0%	0.2937
Read more science literature	71.4%	87.5%	0.1209
Participate in science discussions	81.0%	95.0%	0.0800
Tell others about science	85.7%	92.5%	0.3978
Pursue a career in translational science	47.6%	60.0%	0.3550

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 15

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with Different Race/Ethnicity (N = 63) (Section B) (Question 10)

Question	Percentage of positive responses		p-value*
	Under-represented Minorities	Non-Under-represented Minorities	
Pursue a science major	53.8%	75.0%	0.1148
Apply to more science enrichment programs	79.5%	90.0%	0.3083
Read more science literature	84.6%	75.0%	0.3694
Participate in science discussions	87.2%	95.0%	0.3468
Tell others about science	87.2%	95.0%	0.3468
Pursue a career in translational science	56.4%	55.0%	0.9177

Note. *Two-sided chi-square test

Participants' Exposure to Scientists and Physicians from Diverse Racial/Ethnic Groups

Question 11 examined the participants' exposure to scientists and physicians from different genders and diverse racial/ethnic groups prior to the initiative, and Question 12 asked the participants' opinion on whether it is important to increase racial/ethnic diversity in the science field. The results (Table 16) demonstrated that a significantly higher proportion of respondents had met at least one male or female scientist and at least one underrepresented minority (African American/Black, Hispanic/Native American) scientist prior to the initiative. It was also shown that a significantly higher proportion of respondents agreed that it was important to increase racial/ethnic diversity in the science field. However, only 44.3% of the respondents had knowledge of translational science, which did not demonstrate statistical significance (p = 0.2213). When stratified by URM status, a significantly higher proportion of URMs had met at least one male or female scientist and at least one underrepresented minority scientist prior to the initiative. Also, a high proportion of respondents agreed that it was important to increase racial/ethnic diversity in the science field. Prior knowledge of translational science did not yield significant results for the URM population (Table 17).

Table 16

Binomial Test Results for Questions Regarding Exposure to Scientists and Physicians from Diverse Racial/Ethnic Groups (N = 63) (Questions 11, 12)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
Q11a. Prior to today, I had knowledge of translational science.	44.3%	55.7%	0.2213
Q11b. Prior to today, I had met at least one female science.	88.5%	11.5%	**<0.0001**
Q11c. Prior to today, I had met at least one male science.	91.8%	8.2%	**<0.0001**
Q11d. Prior to today, I had met at least one African American/Black, Hispanic/Native American scientist.	77.1%	23.0%	**<0.0001**
Q12. It is important to increase racial/ethnic diversity in the science field.	87.1%	12.9%	**<0.0001**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

Table 17

Binomial Test Results for Questions Regarding Exposure to Scientists and Physicians from Diverse Racial/Ethnic Groups for URMs Only (N = 41) (Questions 11, 12)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
Q11a. Prior to today, I had knowledge of translational science.	48.72%	51.28%	0.5000
Q11b. Prior to today, I had met at least one female science.	94.87%	5.13%	**<0.0001**
Q11c. Prior to today, I had met at least one male science.	92.31%	7.69%	**<0.0001**
Q11d. Prior to today, I had met at least one African American/Black, Hispanic/Native American scientist.	79.49%	20.51%	**<0.0001**
Q12. It is important to increase racial/ethnic diversity in the science field.	82.50%	17.50%	**<0.0001**

Note. *one-sided exact binomial test, boldness indicates significance at 0.05 level.

Furthermore, chi-square test results (Table 19) demonstrated that the only significant difference in proportions choosing positive vs. negative/neutral responses was found between respondents with high school and above high school education in terms of knowledge of translational science prior to the initiative (p = 0.0021). Specifically, the majority of respondents with above high school education (59.0%) had knowledge of translational science prior to the initiative, while only 18.2% of respondents with high school education had knowledge of translational science prior to the initiative. There were no significant differences observed among groups for other questions (Tables 18 and 20).

Table 18

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males (N = 63) (Questions 11, 12)

Question	Percentage of positive responses		
	Female	Male	p-value*
Q11a. Prior to today, I had knowledge of translational science.	47.5%	38.1%	0.4823
Q11b. Prior to today, I had met at least one female science.	90.0%	85.7%	0.6178
Q11c. Prior to today, I had met at least one male science.	90.0%	95.2%	0.4786
Q11d. Prior to today, I had met at least one African American/Black, Hispanic/Native American scientist.	80.0%	71.4%	0.4494
Q12. It is important to increase racial/ethnic diversity in the science field.	92.7%	76.2%	0.0668

Note. *Two-sided chi-square test

Table 19

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with High School vs. Above High School Education (N = 63) (Questions 11, 12)

Question	Percentage of positive responses		
	High school	Above high school	p-value*
Q11a. Prior to today, I had knowledge of translational science.	18.2%	59.0%	**0.0021**
Q11b. Prior to today, I had met at least one female science.	90.5%	87.5%	0.7290
Q11c. Prior to today, I had met at least one male science.	85.7%	95.0%	0.2091
Q11d. Prior to today, I had met at least one African American/Black, Hispanic/Native American scientist.	61.9%	85.0%	0.0416
Q12. It is important to increase racial/ethnic diversity in the science field.	81.8%	90.0%	0.3578

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 20

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with Different Race/Ethnicity (N = 63) (Questions 11, 12)

Question	Percentage of positive responses		p-value*
	Under-represented Minorities	Non-Under-represented Minorities	
Q11a. Prior to today, I had knowledge of translational science.	48.7%	40.0%	0.5246
Q11b. Prior to today, I had met at least one female science.	94.9%	80.0%	0.0736
Q11c. Prior to today, I had met at least one male science.	92.3%	95.0%	0.6970
Q11d. Prior to today, I had met at least one African American/Black, Hispanic/Native American scientist.	79.5%	75.0%	0.6939
Q12. It is important to increase racial/ethnic diversity in the science field.	82.5%	95.0%	0.1794

Note. *Two-sided chi-square test

Rating of the Initiative

Two questions were designed to assess the respondents' perceptions on overall rating of the initiative (Q13) and rating of the networking/roundtable discussion (Q14). The results demonstrated that a significantly higher proportion of respondents gave positive ratings for all questions (Tables 21 and 22).

Table 21

Binomial Test Results for Questions Regarding Rating of the Initiative (N = 63)

(Questions 13, 14)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
Q13a. Rating of initiative: Introduction and Overview	87.1%	12.9%	**<0.0001**
Q13b. Rating of initiative: Role of academic research in health disparities	95.2%	4.8%	**<0.0001**
Q13c. Rating of initiative: What is translational science	88.7%	11.3%	**<0.0001**
Q13d. Rating of initiative: Mentoring/Career panel	93.3%	6.7%	**<0.0001**
Q13e. Rating of initiative: Networking	90.0%	10.0%	**<0.0001**
Q14a. Rating of discussion: A closer look at translational science careers	94.7%	5.3%	**<0.0001**
Q14b. Rating of discussion: Careers in medicine	94.7%	5.3%	**<0.0001**
Q14c. Rating of discussion: Life of a medical student	78.4%	21.6%	**<0.0001**
Q14d. Rating of discussion: Careers as a Physician scientist	87.2%	12.8%	**<0.0001**
Q14e. Rating of discussion: Networking tips for advancement in science and medicine	91.9%	8.1%	**<0.0001**
Q14f.	85.7%	14.3%	**<0.0001**
Q14g.	78.4%	21.6%	**<0.0001**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

Table 22

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males (N = 63) (Questions 13, 14)

Question	Percentage of positive responses		
	Female	Male	p-value*
Q13a. Rating of initiative: Introduction and Overview	87.5%	86.4%	0.8984
Q13b. Rating of initiative: Role of academic research in health disparities	92.7%	100.0%	0.1936
Q13c. Rating of initiative: What is translational science	90.0%	86.4%	0.6651
Q13d. Rating of initiative: Mentoring/Career panel	92.1%	95.5%	0.6162
Q13e. Rating of initiative: Networking	94.1%	81.3%	0.1571
Q14a. Rating of discussion: A closer look at translational science careers	92.3%	100.0%	0.3236
Q14b. Rating of discussion: Careers in medicine	92.0%	100.0%	0.2948
Q14c. Rating of discussion: Life of a medical student	72.0%	91.7%	0.1737
Q14d. Rating of discussion: Careers as a Physician scientist	85.7%	90.9%	0.6624
Q14e. Rating of discussion: Networking tips for advancement in science and medicine	88.9%	100.0%	0.2715
Q14f.	79.2%	100.0%	0.1020
Q14g.	74.1%	90.0%	0.2960

Note. *Two-sided chi-square test

Furthermore, chi-square test results (Table 24) demonstrated that the only significant differences in proportions choosing positive vs. negative/neutral responses existed between underrepresented minorities and non-underrepresented minorities in terms of rating of discussion: a closer look at translational science careers (p = 0.0117). Specifically, the proportion of underrepresented minority respondents who responded positively (100.0%) to this question was significantly higher than the proportion of non-underrepresented minority respondents who responded positively (77.8%). There were no statistically significant differences based on education level (Table 23).

Table 23

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with High School vs. Above High School Education (N = 63) (Questions 13, 14)

Question	Percentage of positive responses		p-value*
	High school	Above high school	
Q13a. Rating of initiative: Introduction and Overview	81.8%	90.0%	0.3578
Q13b. Rating of initiative: Role of academic research in health disparities	95.5%	95.1%	0.9529
Q13c. Rating of initiative: What is translational science	85.7%	90.2%	0.5938
Q13d. Rating of initiative: Mentoring/Career panel	90.0%	95.0%	0.4642
Q13e. Rating of initiative: Networking	81.3%	94.1%	0.1571
Q14a. Rating of discussion: A closer look at translational science careers	91.7%	96.2%	0.5648
Q14b. Rating of discussion: Careers in medicine	91.7%	96.2%	0.5648
Q14c. Rating of discussion: Life of a medical student	83.3%	76.0%	0.6120
Q14d. Rating of discussion: Careers as a physician/scientist	75.0%	92.6%	0.1293
Q14e. Rating of discussion: Networking tips for advancement in science and medicine	90.9%	92.3%	0.8867

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 24

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with Different Race/Ethnicity (N = 63) (Questions 13, 14)

Question	Percentage of positive responses		
	Under-represented Minorities	Non-Under-represented Minorities	p-value*
Q13a. Rating of initiative: Introduction and Overview	85.0%	90.0%	0.5912
Q13b. Rating of initiative: Role of academic research in health disparities	97.6%	90.0%	0.1999
Q13c. Rating of initiative: What is translational science	87.5%	90.0%	0.7761
Q13d. Rating of initiative: Mentoring/Career panel	89.5%	100.0%	0.1327
Q13e. Rating of initiative: Networking	85.3%	100.0%	0.1295
Q14a. Rating of discussion: A closer look at translational science careers	100.0%	77.8%	**0.0117**
Q14b. Rating of discussion: Careers in medicine	91.7%	100.0%	0.3035
Q14c. Rating of discussion: Life of a medical student	73.9%	83.3%	0.5287
Q14d. Rating of discussion: Careers as a Physician scientist	84.0%	91.7%	0.5231
Q14e. Rating of discussion: Networking tips for advancement in science and medicine	91.7%	90.9%	0.9408

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Test of Independence between Questions 6A-6B, and Questions 8-10 and Between 6A and 11A

A Chi-square test was used to test the independence between questions 6A-6B, questions 8-10, and between 6A and 11A (Table 25). Question 6A asked the participants whether this was the first time they attended a workshop or conference on translational science. The analysis intended to see whether the impact of the initiative varied between first-timers and not first-timers. The results demonstrated that the only significant difference was observed for the question, "I am better prepared to identify, change or expand possible mentoring relationships." In particular, a significantly higher proportion of the first-timers chose positive responses for this question than not first-timers, which suggests that a more positive impact on building capacity through expanding mentoring was yielded among first-time-respondents than non-first-time respondents.

Question 6B asked the participants whether they had a science mentor. The analysis intended to see whether the impact of the initiative varied between respondents with and without science mentors. The results (Table 26) demonstrated that the only significant difference in the proportion of respondents who chose positive responses was observed between respondents with and without a science mentor in the question, "As a result of participation in this conference, I have a role model in science." In particular, more than half the respondents (55.2%) with a science mentor responded to this question positively, which was significantly higher than the proportion of respondents without a science mentor who responded positively (23.1%). This suggested that a more positive impact in terms of having a role model in science was yielded for respondents who had a science mentor as a result of participation this initiative.

Table 25

Chi-square Test Results for Comparing Proportion of Positive Responses between First-Time and Non-First-Time Respondents (N = 63)

Question	Percentage of positive responses		
	First-timer	Not First-timer	p-value*
8a. I am better able to identify, change or expand possible research networks	81.3%	63.6%	0.2036
8b. I am better prepared to identify, change or expand possible mentoring relationships	87.5%	54.5%	**0.0114**
8c. I have a role model in science	36.2%	45.5%	0.5678
8d. I have someone to discuss my career interests with	58.7%	72.7%	0.3905
8e. I now have a better understanding of the process of developing an academic research career	83.3%	63.6%	0.1432
8f. I will seek further information to develop and enhance my academic research career	73.5%	80.0%	0.6656
9a. Increased my knowledge about translational science	92.0%	100.0%	0.3318
9b.Decreased my interest in science	94.0%	100.0%	0.4048
9c. Increased my motivation to study science	79.2%	90.9%	0.3671
9d. Decreased my interest in translational science	90.0%	90.9%	0.9270
9e. Made me realize science is boring	100.0%	90.9%	0.0316
9f. Increased my interested in science	79.2%	81.8%	0.8438
9g. Increased my interest in translational science	60.0%	72.7%	0.4304
9h. Decreased my motivation to study science	96.0%	90.9%	0.4796
9i. Increased my interest in participating in more science programs	96.0%	90.9%	0.4796
10a. Pursue a science major	62.0%	60.0%	0.9055
10b. Apply to more science enrichment programs	82.0%	90.0%	0.5355
10c. Read more science literature	80.0%	90.0%	0.4556
10d. Participate in science discussions	90.0%	90.0%	1.0000
10e. Tell others about science	90.0%	90.0%	1.0000
10f. Pursue a career in translational science	52.0%	70.0%	0.2963
Q11a. Prior to today, I had knowledge of translational science	40.8%	54.5%	0.4063

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Table 26

Chi-square Test Results for Comparing Proportion of Positive Responses between Respondents with and without a Science Mentor (N = 63)

Question	Percentage of positive responses		p-value*
	No science mentor	Has science mentor	
8a. I am better able to identify, change or expand possible research networks	77.8%	82.8%	0.63/ 92
8b. I am better prepared to identify, change or expand possible mentoring relationships	81.5%	82.8%	0.9008
8c. I have a role model in science	23.1%	55.2%	**0.0153**
8d. I have someone to discuss my career interests with	52.0%	72.4%	0.1214
8e. I now have a better understanding of the process of developing an academic research career	76.9%	83.3%	0.5471
8f. I will seek further information to develop and enhance my academic research career	70.4%	83.3%	0.2442
9a. Increased my knowledge about translational science	89.3%	96.7%	0.2676
9b.Decreased my interest in science	100.0%	93.3%	0.1644
9c. Increased my motivation to study science	81.5%	79.3%	0.8381
9d. Decreased my interest in translational science	89.3%	90.0%	0.9289
9e. Made me realize science is boring	100.0%	96.7%	0.3298
9f. Increased my interested in science	74.1%	82.8%	0.4287
9g. Increased my interest in translational science	60.7%	66.7%	0.6374
9h. Decreased my motivation to study science	96.4%	93.3%	0.5948
9i. Increased my interest in participating in more science programs	96.4%	93.3%	0.5948
10a. Pursue a science major	60.7%	65.5%	0.7071
10b. Apply to more science enrichment programs	82.1%	86.2%	0.6740
10c. Read more science literature	82.1%	89.7%	0.4143
10d. Participate in science discussions	92.9%	89.7%	0.6692
10e. Tell others about science	92.9%	89.7%	0.6692
10f. Pursue a career in translational science	57.1%	62.1%	0.7047

Note. *Two-sided chi-square test, boldness indicates significance at 0.05 level

Overall Trend of Perceptions

In order to assess the overall trend of participants' perceptions to each section, the responses were recorded with a numerical scale from most negative to most positive responses. The descriptive statistics are shown in Table 27. An overall positive attitude or belief was observed in response to all questions. In particular, females had significantly more positive attitudes toward the importance of racial/ethnic diversity in the science field than males ($p = 0.0307$; Table 28). Respondents with above high school education had significantly more positive attitudes toward the impact of the initiative in terms of building capacity through expending mentoring, networking, professional opportunities ($p = 0.0084$), and the likelihood of pursuing science than respondents with only a high school education ($p = 0.0017$; Table 29). They also had a significantly higher exposure to scientists and physicians from diverse racial/ethnic groups prior to this initiative than respondents with only high school education ($p = 0.0041$; Table 29). No significant difference in overall evaluation of these questions existed between the two ethnic groups (Table 30).

Table 27

Overall Evaluation of All Likert-Scale-Based Questions (N = 63)

Question	Mean	Median	Standard deviation	Minimum	Maximum
Q8. Does this initiative build capacity through expending mentoring, network, professional developmental opportunities? *	3.9	3.8	0.5	2.2	5.0
Q9. Impact of initiative on knowledge and view about translational science and career path*	4.2	4.3	0.6	2.9	5.0
Q10. Likelihood of pursuing science**	3.4	3.5	0.6	2.0	4.0
Q11. Participant's exposure to scientists and physicians from diverse racial/ethnic groups prior to this initiative***	1.8	1.8	0.3	1.0	2.0
Q12 Opinion on importance to increase racial/ethnic diversity in the science field*	4.4	5.0	1.2	1.0	5.0
Q13. Overall rating of this initiative****	3.4	3.4	0.5	2.2	4.0
Q14. Rating of the network/roundtable discussion****	3.2	3.1	0.5	2.3	4.0

Note. *Scale 1-5 from most negative to most positive responses with 'Strongly disagree/agree'=1 or 5, 'Disagree/agree'=2 or 4, and 'Neutral'=3 depending on whether agree or disagree is considered as positive or negative response
**Scale 1-4 from most negative to most positive responses with 'Unlikely'=1, 'Not sure'=2, 'Somewhat likely'=3, 'Very likely'=4
***Scale 1-2 from most negative to most positive responses with 'No'=1 and 'Yes'=2
****Scale 1-3 from most negative to most positive responses with 'Poor'=1, 'Fair'=2, 'Good'=3, and 'Excellent'=4

Table 28

Comparison of Overall Evaluation of All Likert-Scale-Based Questions between Females and Males (N = 63)

Question	Mean		Standard deviation		p-value+
	Female	Male	Female	Male	
Q8. Does this initiative build capacity through expending mentoring, network, professional developmental opportunities?*	3.8	3.9	0.5	0.6	0.8859
Q9. Impact of initiative on knowledge and view about translational science and career path*	4.1	4.4	0.6	0.5	0.1460
Q10. Likelihood of pursuing science**	3.4	3.5	0.5	0.6	0.2172
Q11. Participant's exposure to scientists and physicians from diverse racial/ethnic groups prior to this initiative***	1.8	1.7	0.3	0.3	0.5103
Q12 Opinion on importance to increase racial/ethnic diversity in the science field*	4.6	4.0	1.1	1.4	**0.0307**
Q13. Overall rating of this initiative****	3.4	3.4	0.5	0.5	0.9305
Q14. Rating of the network/roundtable discussion****	3.1	3.4	0.5	0.5	0.1094

Note. *Scale 1-5 from most negative to most positive responses with 'Strongly disagree/agree'=1 or 5, 'Disagree/agree'=2 or 4, and 'Neutral'=3 depending on whether agree or disagree is considered as positive or negative response
**Scale 1-4 from most negative to most positive responses with 'Unlikely'=1, 'Not sure'=2, 'Somewhat likely'=3, 'Very likely'=4
***Scale 1-2 from most negative to most positive responses with 'No'=1 and 'Yes'=2
****Scale 1-3 from most negative to most positive responses with 'Poor'=1, 'Fair'=2, 'Good'=3, and 'Excellent'=4
+ Two-sided Mann-Whitney test, boldness indicates significance at 0.05 level

Table 29

Comparison of Overall Evaluation of All Likert-Scale-Based Questions between Respondents with High School vs. Above High School Education (N = 63)

Question	Mean		Standard deviation		p-value+
	High school	Above high school	High school	Above high school	
Q8. Does this initiative build capacity through expending mentoring, network, professional developmental opportunities?*	3.7	4.0	0.4	0.6	**0.0084**
Q9. Impact of initiative on knowledge and view about translational science and career path*	4.1	4.3	0.6	0.5	0.4457
Q10. Likelihood of pursuing science**	3.2	3.7	0.6	0.4	**0.0017**
Q11. Participant's exposure to scientists and physicians from diverse racial/ethnic groups prior to this initiative***	1.6	1.8	0.3	0.2	**0.0041**
Q12 Opinion on importance to increase racial/ethnic diversity in the science field*	4.1	4.6	1.4	1.1	0.0589
Q13. Overall rating of this initiative****	3.3	3.5	0.5	0.4	0.1430
Q14. Rating of the network/roundtable discussion****	3.3	3.1	0.7	0.5	0.6941

Note. *Scale 1-5 from most negative to most positive responses with 'Strongly disagree/agree'=1 or 5, 'Disagree/agree'=2 or 4, and 'Neutral'=3 depending on whether agree or disagree is considered as positive or negative response
**Scale 1-4 from most negative to most positive responses with 'Unlikely'=1, 'Not sure'=2, 'Somewhat likely'=3, 'Very likely'=4
***Scale 1-2 from most negative to most positive responses with 'No'=1 and 'Yes'=2
****Scale 1-3 from most negative to most positive responses with 'Poor'=1, 'Fair'=2, 'Good'=3, and 'Excellent'=4
+ Two-sided Mann-Whitney test, boldness indicates significance at 0.05 level

Table 30

Comparison of Overall Evaluation of All Likert-Scale-Based Questions between Respondents with Different Race/Ethnicity (N = 63)

Question	Mean		Standard deviation		p-value+
	Under-represented Minorities	Non-Under-represented Minorities	Under-represented Minorities	Non-Under-represented Minorities	
Q8. Does this initiative build capacity through expending mentoring, network, professional developmental opportunities? *	3.8	3.9	0.6	0.5	0.9005
Q9. Impact of initiative on knowledge and view about translational science and career path*	4.2	4.3	0.6	0.6	0.6031
Q10. Likelihood of pursuing science**	3.3	3.5	0.6	0.3	0.6154
Q11. Participant's exposure to scientists and physicians from diverse racial/ethnic groups prior to this initiative***	1.8	1.7	0.3	0.2	0.1558
Q12 Opinion on importance to increase racial/ethnic diversity in the science field*	4.3	4.6	1.4	0.9	0.6787
Q13. Overall rating of this initiative****	3.3	3.6	0.5	0.5	0.0540
Q14. Rating of the network/roundtable discussion****	3.2	3.0	0.5	0.4	0.4891

Note. *Scale 1-5 from most negative to most positive responses with 'Strongly disagree/agree'=1 or 5, 'Disagree/agree'=2 or 4, and 'Neutral'=3 depending on whether agree or disagree is considered as positive or negative response
**Scale 1-4 from most negative to most positive responses with 'Unlikely'=1, 'Not sure'=2, 'Somewhat likely'=3, 'Very likely'=4
***Scale 1-2 from most negative to most positive responses with 'No'=1 and 'Yes'=2
****Scale 1-3 from most negative to most positive responses with 'Poor'=1, 'Fair'=2, 'Good'=3, and 'Excellent'=4
+ Two-sided Mann-Whitney test

Analysis of Open-ended Questions

The open-ended questions provided additional information on feedback received from the participants. The responses are summarized in Tables 31 and 32. The results revealed that the aspects the respondents liked the most were the conference's mentoring and career panel, networking, information, the presentations, Q/A session, information on translational science, the friendly and easy environment, interactions with speakers and others. Only about 30% of the respondents actually left their feedback on what they liked the least, while others either responded that they liked everything or did not leave any comment. The following aspects were identified as liked least by the respondents: did not start on time, presentation about summer programs ran a little long. In terms of change they recommended for future conferences, most of the responses fell into the time management category. The respondents thought there should be more time for questions, for panelists, at roundtables, more time for breaks, and so on. In addition, they reported that future conferences should be more interactive, have separate sections for high school and college students, offer more information about medical school, and so on. In terms of additional topics they would like to see presented at future conferences, a range of diverse opinions were given, with more clinical, medical or M.D.-related topics as the most frequently mentioned.

Table 31

Results of Open-ended Questions 15 and 16

Category	Count	Category	Count
Q15. What did you like the most about the conference and workshop?		Q16. What did you like least about the conference and workshop?	
Panel discussion	18	Didn't start on time	4
Networking	9	Talk about summer programs	2
Informative	5	Could be a bit more prompt	1
Presentations	3	It was a bit long	1
Q/A	3	Lack of MD/PhD with active practice	1
Translational science	3	Like to be apart of more than just round table	1
Environment	2	Liked the networking event the least	1
The interaction	2	Mentoring/career panel	1
The talk on health disparities	2	Moved too slowly	1
Motivating	1	Registration and sign-in	1
Free Food	1	Short period of time	1
		Slides	1
		The fact that we only got to sit at a single table	1
		The rain	1
		The roundtable dinner got a little off topic	1
		Translational science section was too briefly focused on lung cancer	1
		Wish panelists moved around during dinner	1

Table 32

Results of Open-ended Questions 17 and 18

Category	Count	Category	Count
Q17. What would you change about future conferences?		Q18 What additional topics would you like to see presented at future conferences?	
Time management	9	More Clinical/medical/MD-related	5
More interactive	2	Anything you find help	1
Separate sections for HS vs. college students	2	Basic Research	1
More about applying to/ being in medical school	2	Careers in medicine	1
Discuss other topics related to the sciences other than health and medicine	1	Go in depth when it comes to careers in medicine and certain specialties	1
Have a chance to rotate tables	1	How does one go about pursuing an MD or MD/PhD (for H.S. students)	1
Having a chance to move around at dinner	1	How to feel comfortable strategizing—especially in non-traditional paths, like what to do during a gap year…where to look, etc.	1
Introduction and overview	1	How to search for research positions one can eventually apply to	1
More discussions with medical students/hearing their experiences	1	Interview & networking tips	1
More diversity, aka mixing of professional levels at tables	1	A psychologist in related health professional fields was represented on the panel	1

Table 32 (continued)

Category	Count	Category	Count
More mentoring opportunities	1	Mechanisms for studying	1
People who have only PhDs (not MDs), but that do more than just exclusively basic science	1	More current medical students on the panel	1
Schedule the benefits of summer programs discussion before the question and answer	1	More high school-based topics	1
Should be hosted to the general public	1	More on finding a mentor/guidance	1
		More on public health in terms of public policy	1
		More topics in researching	1
		MPH/DO/PA/NP research	1
		Place of women balancing family and money- work/life (social, family) , careers in trans. Science/motherhood	1
		Research in physics and chemistry related fields	1
		Research options within certain specialties	1
		Research w/ just a MD	1
		Scholarship opportunities for college and graduate school	1
		Slightly prolonged sessions	1
		Summer science research programs	1
		Things to do or avenues to pursue before med school	1
		Use of technology in science	1

Discussion

Social Capital Impact of the SPARC Initiative: Mentoring, Networks, and Professional Development

The majority of attendees were underrepresented minority and female; therefore, the SPARC initiative was successful in reaching the target population of individuals underrepresented in science. Additionally, more than 80% of the attendees were participants in a summer program, which is expected given that initial recruitment efforts focused on participants of the tri-institutional program. Given that the majority of participants were in a summer program, it is striking that over half reported they did not have a mentor. This result highlights the need for existing pipeline programs to build the social capital of participants by expanding beneficial mentorship networks. For example, an assigned mentor for a summer program may not have the actual qualities of mentoring that a participant needs to build social capital. Overall, the SPARC initiative presents one way of bridging this deficiency. The SPARC results highlight the importance of group membership in building capacity and hence social capital through networks. For example, one-third of participants who were in a summer program without a mentor were able to identify a role model in science as a result of participating in the conference

Also the results corresponded with the author's hypothesis of the SPARC initiative playing a role in enhancing social capital indicators of mentoring, networks and knowledge. A majority of the attendees were able to build capacity through expanding networks, expanding mentoring, expanding professional development opportunities by having a better understanding of the process of developing a research career, and expanding informational resources to enhance an academic research career. Also, a significant number had an increase in knowledge and interest for translational science careers. This social capital experienced by simple short duration interactions with experts can add to the cumulative social capital which participants receive as mentorship and networks are expanded. For Coleman (1988), a crucial component of social capital is the potential for information exchange. Information is a key element in "providing a basis for action." While Bourdieu (1986) sees social capital as the development of capital beyond that of one's own labor, Stanton-Salazar (1997) sees it as the networks and "ladders" that permit upward mobility through the acquisition of a new skill set. This initiative shows the importance of short duration interaction, an oftentimes undervalued measure, in increasing a participant's network which can be activated for social capital and further opportunities and advancement.

Bourdieu (1973) and Stanton-Salazar (1997) reference the role of institutional agents in activating social capital. The general concept of social capital is viewed as the social networks or relationships with individuals or institutions that provide sources of value (Bourdieu, 1986; Coleman, 1988). Initiatives such as SPARC provide sources of value to participants who otherwise may not have received the information and expanded networks without such an encounter. Furthermore, Bourdieu discusses the role of networks in producing actual or potential resources from institutionalized relationships by mutual acquaintance or recognition, which in essence gives those who are members of the group collective capital; that is, these members have been vetted and will have access to other networks. For example, participants of the SPARC initiative were vetted by this group membership and were able to follow up with potential mentors and expand their network by being members of that group. In some cases, these networks extended beyond the initiative and resulted in year-round interactions to increase social capital. Additionally, although not captured in the data, I was informed of social capital that was facilitated between institutional agents; for example, one member of the SPARC research panel, an M.D./Ph.D. student, was able to receive mentorship from another participant on the panel, a translational scientist.

Looking within the high school-only population, the majority were able to increase social capital by expanding mentoring relationships, identifying role models in science, and identifying changing or expanding possible research networks. However, differences were reported when comparing different educational levels (high school vs. above high school). The above high school populations were able to identify, change or expand possible research networks and also identify a role model in science. This is likely due to limited exposure, experience, and lack of knowledge on how to best utilize this form of social capital. Bourdieu (1986) and Stanton-Salazar (1997) state that the presence of social capital is not sufficient; it must be activated by institutional agents and be generated by opportunities. This suggests that pre-conference workshops, tailored to the needs of this group, might be beneficial in providing professional development to activate this form of social capital. Responses to the open-ended questions also generated comments about separating the high school students from the college and post-baccalaureate students. The specific rationale for grouping everyone together was to increase interaction and networking between participants at different education levels.

Increasing Translational Science Knowledge as Social Capital

As mentioned previously, more than 80% of the attendees were current participants of a summer program and attending a workshop on translational science for the first time. An overwhelming majority of the participants thought that this initiative increased their knowledge of translational science, increased their interest in science, and increased their motivation to study science. In particular, within the high school-only participant population without prior knowledge of translational science, 94.4% had an increased knowledge. Although not statistically significant, when asked as a result of the initiative if they were likely to pursue a career in translational science, more than half of the respondents agreed. It is likely that longer duration exposure would increase their intent to pursue a career in translational science. However, a majority of the high school students stated that as a result of the initiative, they were more likely to pursue a science major. Overall, the results suggested that the SPARC initiative was effective in building social capital in terms of increasing knowledge and interest in transitional science and may be useful for replicating on larger scale for a longer duration to build diversity in the pipeline.

Exposure to Diverse Scientists and Importance of Diversity

The majority of the participants had been exposed to at least one underrepresented minority scientist and the majority also believed that it was important to increase racial/ethnic diversity in the science field.

The SPARC initiative brought together not only institutional agents but also experts in various fields who had access to networks, which could be transferred to the attendees, thereby increasing social capital and resources. The volume of the social capital possessed by a given agent thus depends on the size of the network of connections that can be effectively mobilized and on the volume of the capital possessed in his or her own right by each of those to whom the agent is connected (Bourdieu, 1986). Hence, social capital is a form of power that is available based on the quality of one’s social networks.

For Bourdieu, social capital is an attribute of elites that is consistent with social reproduction. Higher socioeconomic families are more likely to introduce their children to environments and opportunities that develop strong social networks (Lareau, 2003). Hence, initiatives such as SPARC provide an environment for enhancing social capital. This social capital came in the form of increased mentorship, networks, and knowledge of translational science. Bourdieu suggests that people are limited in social capital and beneficial opportunities if they do not have access to appropriate networks of support.

Social capital is defined by its function. It is not a single entity but a variety of different entities with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors—whether persons or corporate actors—within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that would not be possible in its absence (Coleman, 1988). The functional definition of social capital was displayed in the SPARC initiative through small group mentoring roundtables which facilitated bonding and networking. One student participant on a pre-med track met with one of the panelists, a neuroscientist, and has been receiving mentorship and laboratory experience from her throughout the year; hence, this relationship was converted into a resource for mentorship, hands-on laboratory experience, letters of recommendation, and also referral within the neuroscientist mentor's network for more opportunities.

Coleman suggests that social capital is a positive form of social control and that its function is to offer the structure necessary to manage individual pursuits. Thus, social structure provides the resources that assist individuals to achieve their goals and pursue their interests. The participants of the SPARC initiative were able to expand their networks through mentoring and also increase knowledge about translational science. These relationships provide the social capital to be successful in high school. Coleman analyzed retention and dropout rates in high school and looked at the role of social capital such as information channels, expectations, and social norms and their impact on the persistence of these students. Coleman suggests that students are social agents whose actions are controlled by institutional norms, rules, and obligations. A student's academic persistence is linked to an understanding of expectations and adherence to the norms and rules of the academic institution. Students who dropped out of high school were assumed to not have adhered to the same set of rules, norms, and obligations, and, thus, were deficient in the social capital to be academically successful. Hence, group membership and networks help individuals to understand the rules for successfully navigating the pipeline.

Coleman emphasized the adherence to institutional norms as a way to overcome problems within a community. Adherence to particular expectations can facilitate positive actions while constraining negative actions. In the context of navigating the academic research pipeline, one must have an understanding of institutional expectations and institutional culture to perform successfully. Since the SPARC initiative included speakers and panelists at different training levels, it enabled information exchange on successfully navigating institutional culture from those who are senior and have successfully navigated the same culture. Moreover, this information exchange is critical not only for understanding institutional culture, but also for navigating the pipeline toward science and health profession careers.

Through his research on working class minority youths, Stanton-Salazar (1997) underscored how social ties to institutional agents are crucial to social development and empowerment. Unfortunately, these connections are often problematic for this population to form, especially in consideration of the constraints on their access to institutional resources. For example, he showed in his work that children from high socioeconomic status families were inherently better connected as a result of the network of their families. Individuals from low socioeconomic status backgrounds are not likely to have this benefit. Therefore, initiatives such as SPARC provide a vehicle for rapid connection with institutional agents, potential mentors, and possible expansion of networks.

Institutional agents transmit or directly negotiate transmission of institutional resources and opportunities; therefore, the social capital and types of resources generated from networks have limitless possibilities. Without these networks, they may not understand what is required to navigate the STEM and health professions pipeline; thus, pipeline programs such as SPARC are needed to impart social capital for upward mobility.

With the SPARC initiative, we see that administrators, physicians, scientists, and Ph.D. and M.D./Ph.D. trainees served as institutional agents to facilitate social capital for SPARC attendees. One study explained the important role that pipeline programs can play for minority students' success and connection to information for opportunities (Mehan, Villanueva, Hubbard, & Linta, 1996). Mehan et al. explained the role of institutional agents in this population for building capital. Similarly, the SPARC program played a statistically significant role in increasing students' access to resources and connections.

Applying Social Capital Theory to Urban Educational Settings

Stanton-Salazar (1997) emphasizes how important social capital is for professional advancement. Social capital allows for an increased network for professional references. Stanton-Salazar also states that success within schools is not limited to learning, but also to learning how to decode the system and understand the rules of governing for social advancement. In his work, Stanton-Salazar further underscores the importance of navigating the institutional culture. Mentors can play an important role in this navigation. Unfortunately, URMs may not have access to these resources to increase social capital; therefore, more programs are needed to increase social capital. Stanton-Salazar also recognizes the scarcity of these human resources for underprivileged youth. This scarcity raises a need for a system that can aid in the delivery of social capital on a mass scale. Hence, replication of more initiatives such as SPARC is needed to enhance social capital for URMs and disadvantaged individuals.

Limitations

The main limitation of the convenience sample in this study is that it has systematic bias and is not representative of the entire population. Therefore, it cannot be generalized to a broader population. It is not rare that the results from a study that uses a convenience sample differ significantly from the results from the entire population. Additionally, this study used perceptual, subjective data, which may be considered a limitation. Although the perceptions of the participants were meaningful, they are a soft measure of success. Observable variables allow for additional evidence of the success of the program. Also, a cross-sectional study design has limitations. For example, this study only collected viewpoints at one point in time. Lastly, the definitions for “role model” and “mentor” were not provided on the surveys for this study because the authors of the survey wanted the participants to answer the questions based on the participants’ own world view of who a mentor and/or role model is. Future qualitative data will be useful in fleshing out this subjective construct from the participants’ point of view.

However, despite these limitations, our convenience sample may be an added strength since the majority of the participants were in existing pipeline programs. Considering the disparity of knowledge for participants in the pipeline and not yet in the pipeline, this study points to the need for more targeted efforts within both groups. There is also a need for more targeted efforts to the broader population at an earlier stage in the pipeline since short duration interventions such as conferences can have an impact on building capacity for diversity and hence social capital in academic research and translational science.

Additionally, although a pre and post survey would have been ideal; one survey assessing perception of impact was given after the conference as a result of logistical reasons in which a pre-survey could not be accommodated. A true pre and post survey might strengthen the findings of the study.

Conclusion

In this manuscript, the role of social capital for participants of the SPARC initiative was explored. The SPARC initiative expanded mentoring, resources, and increased knowledge for pursuit of translational science careers. In particular, although more than 80% of participants reported being in a summer program, half reported that they did not have a mentor. Therefore, it is recommended that existing pipeline programs build the social capital of participants by expanding beneficial mentorship networks. This study bridges the current gap in the literature on the role that STEM and health profession programs play in imparting social capital on participants. Also, both short-duration and long-duration programs need to include social capital indicators in the evaluation of both the short-term impact of the initiative and long-term impact through longitudinal data. Given the lack of literature on evaluating social capital, it is recommended that more programs include evaluative components for social capital to add richness to the body of literature in this area.

Chapter V

MENTORING IN MEDICINE INITIATIVE

Increasing underrepresented minority participation in the STEM and health professions through the Mentoring in Medicine Initiative: A closer look through a social capital theoretical framework

Abstract

Purpose

The Mentoring in Medicine initiative was founded in an effort to bridge a pipeline gap in underrepresented minority students who are interested in health professional careers. The initial impetus of the program was to provide year-round support for individuals interested in health professions careers. In other models, participants interested in health careers would seek guidance from a premedical advisor and additionally participate in summer program experiences to enhance readiness for applying to health professional schools. However, despite these efforts, anecdotal evidence points to underrepresented minority undergraduate students who initially expressed an interest but were discouraged from pursuing health professional careers because of underperforming in certain courses and other factors. This is particularly true in the Black/African American male population. Therefore, Mentoring in Medicine was initially founded to provide mentorship and support to this group. Over the years, it has expanded to across different spectra of the pipeline, providing a holistic and comprehensive approach to

pipeline diversity for health professions careers. This paper explores survey and qualitative data through a social capital theoretical framework and provides next steps for how schools can adopt a similar model. Lastly, an aspect of the Mentoring in Medicine program that makes it unique is “the doors are always open for mentorship” framework; that is, there is an entry point into the mentorship pipeline at any stage. To our knowledge, this is the first initiative targeting trainees from earlier stages of the pipeline (i.e., elementary school) through more advanced stages (i.e., graduate and medical school).

Methods

We administered a survey among a convenience sample of 340 attendees at the Mentoring in Medicine conference, which included a broad representation of students at varying academic levels: elementary ($n = 11$), middle school ($n = 39$), high school ($n = 148$), undergraduate ($n = 32$), and above college ($n = 37$). Data were analyzed using SAS v. 9.3. Outcome measures included: 1) impact of the Mentoring in Medicine initiative on perception of the health profession; 2) impact of the Mentoring in Medicine initiative on interest in the health professions; and 3) impact of the Mentoring in Medicine initiative on building capacity to pursue a career in the health professions.

Results

Overall, this initiative showed a statistically significant difference ($p < 0.001$) in increasing support, interest, and capacity to pursue health professions careers across the pipeline.

Conclusions

The Mentoring in Medicine initiative built capacity across all educational levels for health profession careers. Furthermore, we provide recommendations for replication of this initiative to build capacity for health profession careers at earlier stages of training.

Introduction

Mentoring in Medicine (MIM) was founded to serve as a bridge between existing science and medicine pipeline programs. Numerous pipeline summer programs exist in the United States and internationally to get more underrepresented minorities interested in health careers in science, technology, engineering, and mathematics. However, anecdotal evidence suggests that summer program participants lack additional year-round support needed when they are between summer programs. For example, students who have gone through the MIM pipeline program mentioned going to their pre-med advisor or calling on people they came into contact with during their summer program; however, students did not have a “home base” or “safe haven” or “extended academic family” to go to when problems occurred. This home base often serves as a place for like-minded individuals who might not be the norm among peers to network, ask for help, and receive further encouragement.

Mentoring in Medicine

The Early Stages

Mentoring in Medicine initially started at the college level and led to development of a clinical exposure program where students volunteer and shadow health professionals in the emergency room department. However, after four years of the program and tracking career progression outcomes for student participants, Black male participants were not progressing through the pipeline for health profession careers. Semi-structured focus groups were conducted to find out reasons for the attrition and the following themes resulted: 1) lack of proper academic study strategies; 2) discouragement as a result of GPA or MCAT scores; and 3) depression as a result of advisors mentioning that they “could not achieve their health profession goals as a result of a ‘C’ or ‘D’ in a course.” Each of these concerns was addressed through development of the following MIM programmatic infrastructures: A learning specialist and test prep coach were added to the MIM team to address study and test-taking strategies, and a psychiatrist, psychologist, and team of advisors were hired to address depression and discouragement in the students. In addition to college students, support was offered to currently enrolled health profession students (i.e., medical and dental students) because similar issues arose in this population. To support the health professional student population, a quarterly educational series known as “Surviving and Thriving in the Health Professions” was held for students enrolled in medical and dental schools. Focus groups were held during the educational series and over 60 issues arose from students in medical and dental school. As an outgrowth of the issues expressed in the medical and dental student focus groups, a curriculum was developed and experts brought in to address the issues.

Having targeted the college and health professional students with supportive services, there was a necessity to reach back further in the pipeline to the high school, junior high, and elementary student populations. Hence, partnerships were initiated with 9 high schools (5 after-school and 4 in-school programs). Three of the five high schools were male Catholic schools. The goal was to awaken interest, through hands-on science and medicine activities, in those who may not presently have an interest in health professional careers. For example, high school students were involved in watching a video of gall bladder removal and in dissecting a pig.

At the elementary and junior high school levels, students were involved in learning about the structure and function of the heart in a hip hop play called "more than a big biology test." This topic was especially important given that heart disease is the number one killer of Americans and there is a high burden of the disease in minority communities. Medical students were also involved as mentors in the elementary through high school population. In summary, a pipeline was created from elementary through the health professional student level to build social capital through mentoring, networking, and access to informational resources.

Conferences

The goal of the Mentoring in Medicine conference is to expose students from first grade and beyond to diverse science and health professionals. The conference takes place in an urban center and serves as a "pep rally" to inspire attendees to pursue science and health professional careers. Energetic science professors and health professionals are invited to inspire the students. The conference has been held six times in New York City and four times in Oakland, CA. Hands-on workshops on dissection and suturing are held for students. Students are also given health professional attire such as hats, gowns, boots, and a stethoscope. Students learn about the stethoscope and practice listening to hearts and lungs. The focus of this study was the participants for the New York City conference, which has an average participation of 1,800 people per conference in the city.

Theoretical Framework

Social Capital Theoretical Framework and Pipeline Programs

The conceptual framework for this study was guided by Stanton-Salazar's (1997) concept of social network analysis that encompassed the institutional support he believed is inherent in interpersonal networks and transmitted through the structure of relationships with key institutional agents. Stanton-Salazar articulated six key forms of institutional support that he believed play a critical role in the social integration and success of racial and ethnic minority students. They are as follows: 1) provision of various funds of knowledge (i.e., institutional sanctioned discourse, academic task-specific knowledge, organizational/bureaucratic knowledge, network development, technical, knowledge of labor and educational markets, and problem-solving); 2) bridging, or the process of acting as a human bridge to gatekeepers, to social networks and to opportunities for exploring various "mainstream" institutions (e.g., university campuses); 3) advocacy and related forms of personalized intervention; 4) role modeling; 5) provision for emotional and moral support; and 6) provision of regular, personalized, and soundly-based evaluative feedback, advice, and guidance.

The notion is that underrepresented minority students' development of social capital can be garnered from institutional support inherent in students' interpersonal networks with key institutional agents in an out-of-school academic enrichment setting, which can serve as a conduit for buffering students from existing in-school social inequalities that consistently perpetuate their STEM underachievement and/or under participation.

Mentoring as a Means of Creating Social Capital

Social learning theory best captures the ways in which learning occurs within the context of the approaches used in our pipeline program, while social capital theory provides a context in which students can advance. Mentoring is a means by which urban students can become connected with people to build social capital. Mentoring can take many manifestations, but the model of Aubrey and Cohen (1995) is particularly useful in our pipeline strategy. Aubrey and Cohen highlight five parts of mentoring in the book *Working Wisdom*: 1) accompanying—the mentor is connected with the mentee; 2) sowing—the mentor plants a seed, 3) catalyzing—the mentor assists in accelerating performance and advancement; 4) showing—the mentor serves as a role model in modeling desirable behaviors for the mentee; and 5) harvesting—the mentor further facilitates and advances the mentee toward realizing goals. Mentoring in the educational context has a variety of uses. In many instances, it helps to build the students' self-esteem, while in others, it can guide mature students through the transition to a career or college.

The beneficial effect of the mentor-student relationship is based on the principles of social learning theory. Social theory was first developed by Bandura (1977), who posited that behavior is modeled and learned from the environment through observation. In social learning, interactions with the mentor change both mentees' attitudes and behaviors (Linnehan, 2001). Bourdieu (1973) also expounded upon social learning theory by looking at these interactions as a form of social capital. Findings of Linnehan's (2001) study include a positive correlation between students participating in a mentoring program and academic performance. The success of mentoring programs has been reiterated in numerous studies focusing on various aspects of mentoring. Students who had a mentor showed a decrease in four out of five "risk behaviors"

(Beier et al., 2000). Mentoring support has also been shown to be a predictor of success in college (Soucy & Larose, 2000; Summers & Hrabowski, 2006). In a recent study looking at disparities in receipt of RO1 grants, the study found that Black/African Americans were less likely to receive RO1 grants when all other factors were controlled for (Ginther et al., 2011). Francis Collins, National Institutes of Health Director, included mentoring programs as one of the solutions to decreasing this disparity (Tabak & Collins, 2011). Mentoring increases social capital by assisting mentees with navigating the pipeline and connecting mentees with networks and opportunities for advancement.

Methods

Participants

Data were collected from a convenience sample of 340 participants attending the Mentoring in Medicine conference in New York City in 2011. Participants were instructed to complete the surveys after the conference and return to the Mentoring in Medicine team at the conference.

Surveys

The survey was developed by the Mentoring in Medicine Team and was distributed in paper format to attendees of the MIM conference. The instrument contained a 20-item survey composed of Likert-scale-based questions assessing the before-and-after impact of the initiative. The survey consisted of questions on participants' demographics, and social capital indicators such as support system, confidence in becoming a health professional, knowledge about what colleges and health professionals look for in applicants, and learning resources for the health professions. The full survey is in Appendix C.

Data Analysis

Data were entered into Microsoft excel and missing values were excluded from the analysis. SAS version 9.3 (SAS Institute Inc.) was used to analyze the data and descriptive statistics were used to summarize the data as frequency tables for each multiple-choice question. For the demographic data, participants depending on their responses were categorized as African American/Black, Asian, Hispanic, Native American, White or Other. For the purposes of this study, respondents who were categorized in our stratification as underrepresented minority (URM) were identified based on the National Science Foundation and National Institutes of Health criteria definition of URM as African American/Black, Hispanic, and Native American. Respondents who did not answer demographic questions of race/ethnicity, gender or education level were excluded from any analysis which stratified the data by those variables. A Wilcoxon signed rank test was used to compare the responses before and after the initiative in order to assess the impact of the initiative. The analysis was performed for the total population and by demographic characteristics such as gender, race/ethnicity, and education level. The survey included questions on perceptions of before-and-after impact of the initiative. In addition, the Mann-Whitney test or Analysis of variance (ANOVA) were used to compare change in overall perceptions before and after the initiative among groups with different demographic characteristics (gender, education level, and ethnicity/race) in order to determine whether the impact was significantly different among different groups.

For Questions 11-13, on the impact of building capacity, the proportion of total positive responses and proportion of total negative or neutral responses were computed. In order to determine whether the participants responded to each question positively or not, the exact one-sided binomial test was performed for the total population as well as by gender, race/ethnicity, and education level. Chi-square test of independence was used to determine whether participants' demographics (gender, education level, and ethnicity/race) were associated with responses to each Likert-scale question (positive vs. negative/neutral). Statistical significance was set at α = 0.05 level.

Results

Demographic Characteristics of the Study Population

A total of 340 participants completed the survey. Demographic characteristics (i.e., gender, race/ethnicity, education level, and location) of the population are presented in Table 1. The results show that the majority of the participants (70.4%) were female. The vast majority of participants were underrepresented minority (91.3%). About half of the participants were high school students and the other half were students from elementary school, middle school, and beyond high school. The participants also included about 3.6% professionals and 4% parents. Most of the participants were from New York state, mainly from the boroughs of New York City: Brooklyn, Queens, Manhattan, Bronx, and some other areas and less than 6% were from New Jersey and Pennsylvania.

Table 1

Demographic Characteristics of the Study Population (N = 340)

Characteristic	Count (%)
Gender	
Female	224 (70.4%)
Male	94 (29.6%)
Race/Ethnicity	
URM	230 (91.3%)
Non URM	22 (8.7%)
Education Level	
Elementary school	11 (4.0%)
Middle school	39 (14%)
High school	148 (53.2%)
Undergraduate	32 (11.5%)
Beyond College	27 (9.7%)
Professional	10 (3.6%)
Parent	11 (4.0%)
Location	
NY-Bronx	100 (38.5%)
NY-Brooklyn	38 (14.6%)
NY-Manhattan	22 (8.5%)
NY-Queens	34 (13.1%)
NY (Other area)	51 (20.0%)
NJ	7 (2.7%)
PA	7 (2.7%)

Comparison of Perception before and after the Conference

The participants showed significantly more positive belief in the first four questions asked after the conference as compared to before the conference (Table 2). Therefore, as a result of the conference, the participants had a significantly stronger belief in statements like "I am 100% confident I can become a health care professional," "I have the proper social support from school and family," "I am smart enough to become a health care professional," and "I know what colleges and health schools look for in applicants." However, the responses to the statement, "I think it is very difficult for people like me to become health professionals," was not statistically different before and after the conference. The same analysis was performed by gender (Table 3), race/ethnicity (Table 4), and education level (Table 5) in order to assess the impact within each subgroup. Similar to the total population, the impact was found to be significantly positive for both female and male participants for all the statements except "I think it is very difficult for people like me to become health professionals."

Table 2

Comparison of Participants' Perceptions before and after the Conference (N = 340)

Question	Mean		Standard deviation		p-value†
	Before	After	Before	After	
I am 100% confident I can become a health care professional.	3.88	4.47	1.07	0.79	**<0.0001**
I have the proper social support from school and family.	4.11	4.26	0.96	0.90	**<0.0001**
I am smart enough to become a health care professional.	4.24	4.51	0.90	0.71	**<0.0001**
I know what colleges and health schools look for in applicants.	3.64	4.26	1.11	0.88	**<0.0001**
I think it is very difficult for people like me to become health professionals.	2.68	2.54	1.32	1.51	0.1197

*Scale 1-5 from most negative to most positive responses with 'Strongly disagree'=1, 'Disagree'=2, 'Neutral'=3, 'Agree'=4, and 'Strongly agree'=5
†Two-sided Wilcoxon Signed Rank test, boldness indicates significance at 0.05 level

Table 3

Comparison of Participants' Perceptions before and after the Conference by Gender

(Female, N = 224; Male, N = 94)

Question	Gender	Mean		Standard deviation		p-value†
		Before	After	Before	After	
I am 100% confident I can become a health care professional.	Female	3.83	4.49	1.08	0.75	<**0.0001**
	Male	3.98	4.42	1.07	0.82	<**0.0001**
I have the proper social support from school and family.	Female	4.08	4.27	1.00	0.93	**0.0001**
	Male	4.21	4.26	0.83	0.79	**0.1686**
I am smart enough to become a health care professional.	Female	4.20	4.50	0.92	0.71	<**0.0001**
	Male	4.34	4.51	0.84	0.70	**0.0353**
I know what colleges and health schools look for in applicants.	Female	3.69	4.28	1.07	0.90	<**0.0001**
	Male	3.53	4.20	1.15	0.85	<**0.0001**
I think it is very difficult for people like me to become health professionals.	Female	2.70	2.52	1.32	1.50	0.1036
	Male	2.63	2.70	1.28	1.55	0.6956

*Scale 1-5 from most negative to most positive responses with 'Strongly disagree'=1, 'Disagree'=2, 'Neutral'=3, 'Agree'=4, and 'Strongly agree'=5
†Two-sided Wilcoxon Signed Rank test, boldness indicates significance at 0.05 level

Table 4

Comparison of Participants' Perceptions before and after the Conference by Race/Ethnicity

(URM, N = 230; Non-URM, N = 22)

Question	Race	Mean		Standard deviation		p-value†
		Before	After	Before	After	
I am 100% confident I can become a health care professional.	URM	3.89	4.47	1.07	0.81	**<0.0001**
	Non-URM	3.70	4.30	1.08	0.73	**0.0039**
I have the proper social support from school and family.	URM	4.19	4.30	0.96	0.89	**0.0051**
	Non-URM	3.76	3.90	0.94	0.89	0.5000
I am smart enough to become a health care professional.	URM	4.24	4.50	0.92	0.73	**<0.0001**
	Non-URM	4.00	4.25	0.97	0.79	0.2266
I know what colleges and health schools look for in applicants.	URM	3.62	4.22	1.12	0.89	**<0.0001**
	Non-URM	3.60	4.24	1.10	0.94	**0.0039**
I think it is very difficult for people like me to become health professionals.	URM	2.65	2.45	1.30	1.47	0.1125
	Non-URM	2.80	2.70	1.28	1.45	0.6563

*Scale 1-5 from most negative to most positive responses with 'Strongly disagree'=1, 'Disagree'=2, 'Neutral'=3, 'Agree'=4, and 'Strongly agree'=5
†Two-sided Wilcoxon Signed Rank test, boldness indicates significance at 0.05 level

Table 5

Comparison of Participants' Perceptions before and after the Conference by Education Level

Question	Education	Mean		Standard deviation		p-value†
		Before	After	Before	After	
I am 100% confident I can become a health care professional.	Elementary school (N=11)	3.22	4.38	1.48	1.06	0.0625
	Middle school (N=39)	3.65	4.30	1.09	0.97	**0.0028**
	High school (N=148)	3.96	4.48	1.04	0.76	**<0.0001**
	Undergraduate (N=32)	3.97	4.61	0.87	0.67	**0.0001**
	Beyond college (N=27)	3.96	4.60	1.11	0.68	**0.0195**
	Professional (N=10)	3.57	4.40	1.62	0.89	0.5000
	Parent (N=11)	4.25	4.40	0.96	0.89	NA
I have the proper social support from school and family.	Elementary school (N=11)	4.20	4.75	1.14	0.71	0.2500
	Middle school (N=39)	3.95	4.08	1.06	1.05	0.2734
	High school (N=148)	4.20	4.33	0.84	0.80	**0.0059**
	Undergraduate (N=32)	4.00	4.31	1.02	0.93	**0.0107**
	Beyond college (N=27)	3.96	4.10	1.04	0.72	0.2656
	Professional (N=10)	4.86	4.83	0.38	0.41	NA
	Parent (N=11)	4.67	4.60	0.58	0.55	NA
I am smart enough to become a health care professional.	Elementary school (N=11)	4.45	4.67	1.21	0.71	0.7500
	Middle school (N=39)	4.03	4.34	0.93	0.71	**0.0056**
	High school (N=148)	4.16	4.44	0.94	0.80	**<0.0001**
	Undergraduate (N=32)	4.34	4.59	0.60	0.56	**0.0078**
	Beyond college (N=27)	4.36	4.57	0.95	0.51	0.2344
	Professional (N=10)	4.83	5.00	0.41	0.00	1.0000
	Parent (N=11)	4.67	4.57	0.52	0.53	NA
I know what colleges and health schools look for in applicants.	Elementary school (N=11)	3.36	3.56	1.63	1.81	0.9688
	Middle school (N=39)	3.26	4.06	1.40	1.07	**0.0007**
	High school (N=148)	3.53	4.19	1.03	0.85	**<0.0001**
	Under graduate (N=32)	3.74	4.53	0.86	0.57	**<0.0001**
	Beyond College (N=27)	3.96	4.38	0.86	0.50	**0.0156**
	Professional (N=10)	4.67	4.90	0.71	0.32	1.0000
	Parent (N=11)	4.71	4.75	0.49	0.46	1.0000

Table 5 (continued)

Question	Education	Mean		Standard deviation		p-value†
		Before	After	Before	After	
I think it is very difficult for people like me to become health professionals.	Elementary school (N=11)	2.91	2.71	1.87	2.14	1.0000
	Middle school (N=39)	2.63	2.41	1.26	1.55	0.4470
	High school (N=148)	2.61	2.41	1.27	1.46	0.0630
	Under graduate (N=32)	2.68	2.78	1.22	1.45	0.9460
	Beyond College (N=27)	3.25	2.90	1.07	1.09	0.4629
	Professional (N=10)	2.80	3.00	2.05	2.19	1.0000
	Parent (N=11)	2.50	3.14	1.85	2.04	0.5000

*Scale 1-5 from most negative to most positive responses with ‘Strongly disagree’= 1, ‘Disagree’ = 2, ‘Neutral’ = 3, ‘Agree’ = 4, and ‘Strongly agree’= 5
†two-sided Wilcoxon Signed Rank test, boldness indicates significance at 0.05 level
‘NA,’ test of significance was not possible due to no change in responses for all participants with non missing responses at before and after the initiative.

Furthermore, the comparison between females and males revealed no significant differences between the two groups for any of the statements (Table 6). However, it is worth mentioning that a more positive impact was observed for female participants than male participants in terms of “I am 100% confident I can become a health care professional” and “I think it is very difficult for people like me to become health professionals,” and the differences between the two groups are trending significant ($0.5 < p < 1.0$). The impact of the initiative on URM and non-URM was consistent with the total population for statements like “I am 100% confident I can become a health care professional,” “I know what colleges and health schools look for in applicants,” and “I think it is very difficult for people like me to become health professionals”; however, significant positive impacts were only observed within URM for the statements “I have the proper social support from school and family” and “I am smart enough to become a health care professional” (Table 7).

Table 6

Comparison of the Impact of the Conference between Female and Male

(N = 224; N = 94, respectively)

Question	p-value†
I am 100% confident I can become a health care professional.	0.0592
I have the proper social support from school and family.	0.2341
I am smart enough to become a health care professional.	0.1703
I know what colleges and health schools look for in applicants.	0.7024
I think it is very difficult for people like me to become health professionals.	0.0999

+ Two-sided Mann-Whitney test

Table 7

Comparison of the Impact of the Conference between URM and Non-URM

(N = 230; N = 22, respectively)

Question	p-value†
I am 100% confident I can become a health care professional.	0.7892
I have the proper social support from school and family.	0.8651
I am smart enough to become a health care professional.	0.7786
I know what colleges and health schools look for in applicants.	1.0000
I think it is very difficult for people like me to become health professionals.	0.8656

+ Two-sided Mann-Whitney test

The differences in impact between URM and non-URM were not statistically significant for any of the statements. In terms of the impact within each education level, consistent with the total population, a significant positive impact was found in high school and undergraduate students for the first four statements (Table 8). Moreover, a significant positive impact was found in middle school for the following three statements: “I am 100% confident I can become a health care professional,” “I am smart enough to become a health care professional,” and “I know what colleges and health schools look for in applicants.” Significant positive impacts were found in the beyond college group in terms of “I am 100% confident I can become a health care professional” and “I know what colleges and health schools look for in applicants.” No significant positive impact was observed for any of the statements within elementary, professional or parent groups. The differences in impact among different education levels were not statistically significant for any of the statements. Bar charts illustrating the change at post-conference from before conference by different demographic characteristics are shown in Figures 1-3.

Table 8

Comparison of the Impact of the Conference among Groups with Different Education Levels

Question	p-value†
I am 100% confident I can become a health care professional.	0.5748
I have the proper social support from school and family.	0.3970
I am smart enough to become a health care professional.	0.9627
I know what colleges and health schools look for in applicants.	0.1119
I think it is very difficult for people like me to become health professionals.	0.4868

+ Two-sided ANOVA

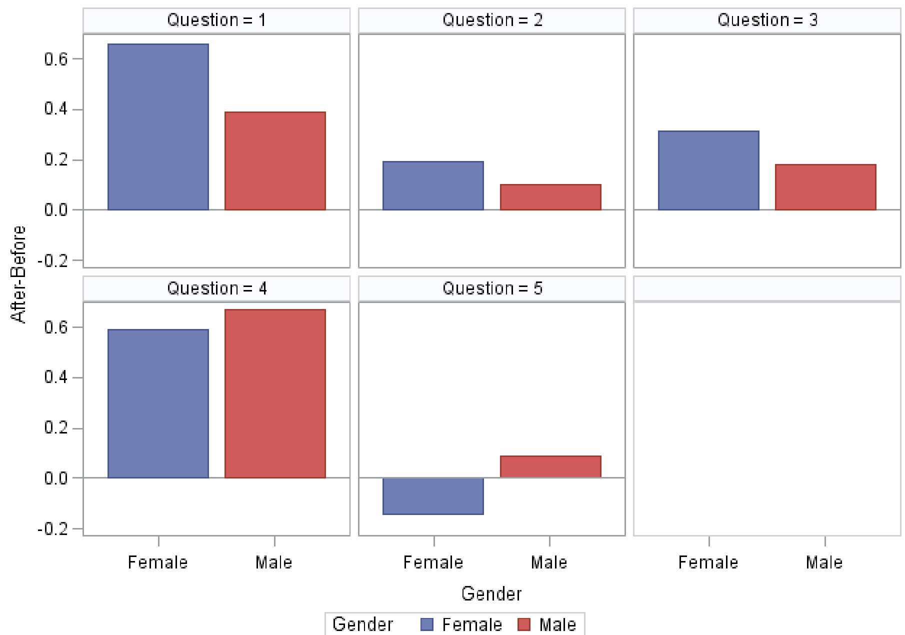
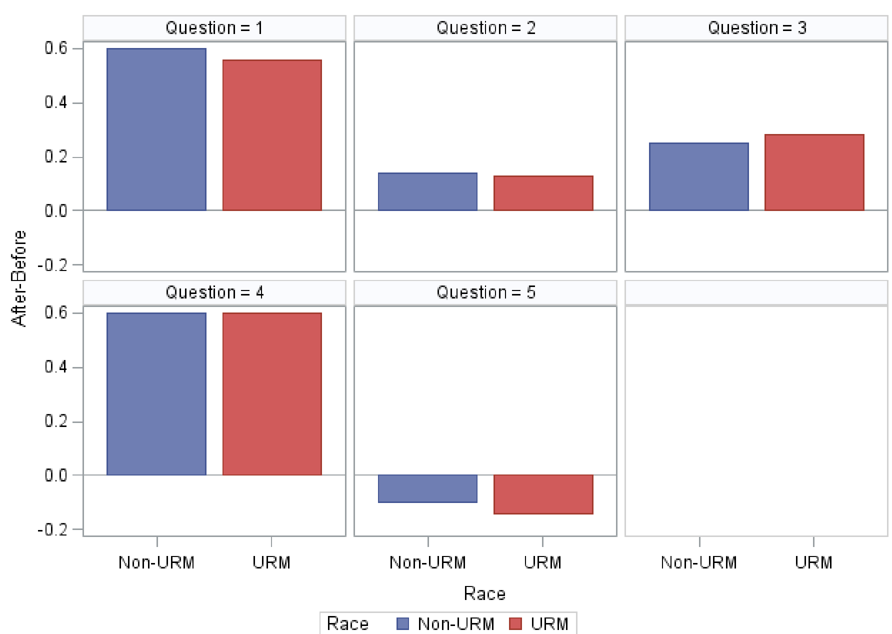


Figure 1. Mean change before and after initiative by gender



Note: A positive value indicates the change towards the direction of agrees, while negative value indicates the change towards disagree.

Figure 2. Mean change at after initiative from before initiative by race

Here, positive value indicates the change towards the direction of more “agrees,” while negative value indicates a change toward more “disagrees.”

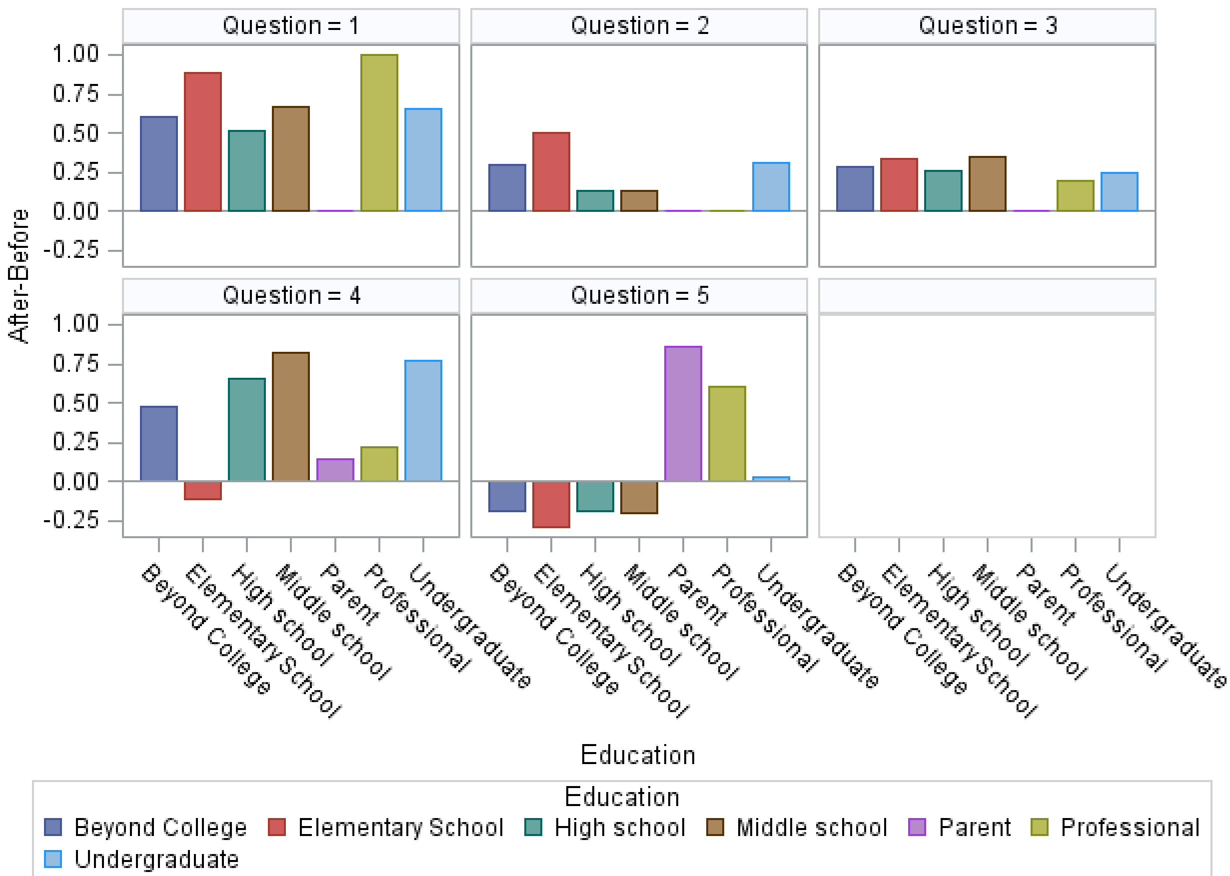


Figure 3. Mean change at after initiative from before initiative by education

Analysis of Building Capacity Impact

Three questions were asked to evaluate the participants’ perceptions of the impact of this initiative on building capacity. The total positive responses were computed as percentage of participants who chose “strongly agree” or “agree” and total negative/neutral responses were computed as percentage of participants who chose “strongly disagree,” “disagree,” and “neutral.” The exact one-sided binomial test was used to determine whether the proportion of respondents who chose positive responses was significantly higher than the proportion of respondents who chose negative or neutral responses. The results (Table 9) demonstrate that a significantly higher proportion of respondents agreed that they learned about different health professions and new resources to find out about health professions, and that the information learned will help them.

Table 9

Binomial Test Results for Questions regarding Impact of Initiative on Building Capacity

(N = 340)

Question	Percentage of positive responses	Percentage of negative/ neutral responses	p-value*
I learned about different health professions.	90.4%	9.6%	<**0.0001**
I learned about new resources to find out about health professions.	89.6%	10.4%	<**0.0001**
The information I learned will help me.	91.9%	8.1%	<**0.0001**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

The results further demonstrate that the initiative was effective in terms of building capacity for all groups with different demographic characteristics (gender, education, and race) (Tables 10-12). Significantly higher proportions of respondents in all subgroups agreed to the three statements: "I learned about different health professions," "I learned about new resources to find out about health professions," and "The information I learned will help me." The only exception was in the elementary school population for the statement, "I learned about new resources to find out about health professions," and was most likely due to the small sample size and insufficient power (large type II error). The chi-square test results showed no statistically significant difference between females and males (Table 13) or between URM and non-URM.

Table 10

Binomial Test Results for Questions regarding Impact of Initiative on Building Capacity by Gender (Female, N = 224; Male, N = 94)

Question	Gender	Percentage of positive responses	Percentage of negative/neutral responses	p-value*
I learned about different health professions	Female	90.7%	9.3%	**<0.0001**
	Male	91.9%	8.1%	**<0.0001**
I learned about new resources to find out about health professions	Female	89.6%	10.4%	**<0.0001**
	Male	91.9%	8.1%	**<0.0001**
The information I learned will help me	Female	93.1%	6.9%	**<0.0001**
	Male	89.5%	10.5%	**<0.0001**

Table 11

Binomial Test Results for Questions regarding Impact of Initiative on Building Capacity by Race/Ethnicity (URM, N = 230; Non-URM, N = 22)

Question	Race	Percentage of positive responses	Percentage of negative/neutral responses	p-value*
I learned about different health professions.	Non-URM	90.1%	10.0%	**<0.0001**
	URM	90.0%	10.0%	**<0.0001**
I learned about new resources to find out about health professions.	Non-URM	88.9%	11.1%	**<0.0001**
	URM	95.2%	4.8%	**<0.0001**
The information I learned will help me.	Non-URM	91.3%	8.7%	**<0.0001**
	URM	95.2%	4.8%	**<0.0001**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

Table 12

Binomial Test Results for Questions regarding Impact of Initiative on Building Capacity by Education Level

Question	Education	Percentage of positive responses	Percentage of negative/neutral responses	p-value*
I learned about different health professions.	Elementary school (N=11)	87.5%	12.5%	**0.0352**
	Middle school (N=39)	100.0%	0.0%	**<0.0001**
	High school (N=148)	92.9%	7.1%	**<0.0001**
	Undergraduate (N=32)	87.1%	12.9%	**<0.0001**
	Beyond college (N=27)	69.6%	30.4%	**0.0466**
	Professional (N=10)	100.0%	0.0%	**0.0039**
	Parent (N=11)	88.9%	11.1%	**0.0195**
I learned about new resources to find out about health professions.	Elementary school (N=11)	71.4%	28.6%	0.2266
	Middle school (N=39)	94.6%	5.4%	**<0.0001**
	High school (N=148)	87.9%	12.1%	**<0.0001**
	Undergraduate (N=32)	100.0%	0.0%	**<0.0001**
	Beyond college (N=27)	91.7%	8.3%	**<0.0001**
	Professional (N=10)	100.0%	0.0%	**0.0078**
	Parent (N=11)	88.9%	11.1%	**0.0039**
The information I learned will help me.	Elementary school (N=11)	100.0%	0.0%	**0.0078**
	Middle school (N=39)	86.5%	13.5%	**<0.0001**
	High school (N=148)	89.9%	10.1%	**<0.0001**
	Undergraduate (N=32)	100.0%	0.0%	**<0.0001**
	Beyond college (N=27)	100.0%	0.0%	**<0.0001**
	Professional (N=10)	100.0%	0.0%	**0.0039**
	Parent (N=11)	100.0%	0.0%	**0.0039**

Note. *One-sided exact binomial test, boldness indicates significance at 0.05 level

Table 13

Chi-square Test Results for Comparing Proportion of Positive Responses between Females and Males

Question	p-value*
I learned about different health professions.	0.7581
I learned about new resources to find out about health professions	0.5542
The information I learned will help me	0.3055

Note. *Two-sided chi-square test

Discussion

The holistic approach for the Mentoring in Medicine initiative aids in building social capital for participants based on the social capital indicators measured. A majority of attendees experienced increased confidence, knowledge, information, and interest in health profession careers as a result of participation in the initiative across all educational levels. A few parents also participated in this initiative. As mentioned previously, parental support is important in propagating social capital. In general, social capital can be considered as the benefit that occurs from a social relationship. Although social capital can be difficult to define or operationalize, one aspect that researchers mostly agree on is that social capital is different than physical, human or financial capital. Additionally, social capital differs from other types of capital because it is not held by any one individual, but rather is either contained within a relationship or network (Robinson, Schmid, & Siles, 2002) or within processes of social interaction (Bankston & Zhou, 2002). In this study, the impact of the Mentoring in Medicine initiative is shown in building capacity, a form of social capital, for increasing knowledge about the health professions career pathway. Statistically significant results were seen in participants as far as increasing confidence to become a health care professional, feeling smart enough to become a health professional, and knowing what colleges and health schools look for in applicants. Furthermore, participants learned about health professions and new resources to pursue their interests. However, it is important to note that convenience sampling and cross-sectional study design have inherent limitations. Therefore, the results of the participants' perceptions and opinions are limited to short-term evaluation.

Not all forms of social capital are created equally. Just as individuals have varying amounts of human and financial capital, so too can relationships and networks hold varying amounts of social capital. Analyzing social capital from the standpoint of a relationship between two individuals, it is easy to see how the different characteristics of the two individuals and the relationship itself influence how much can be gained through social capital. The individuals have their own personal characteristics, such as wealth, power, and knowledge, and their own networks which contribute to the dynamics of their relationships. Qualities of the relationship, such as how well the individuals know each other, how much time is spent together, and how often the individuals see each other may also affect the impact of the relationship on the individuals involved. The Mentoring in Medicine network created a safe place for individuals to express their concerns, receive advice, and connect with others who have been through the same path and receive mentorship (L. Holen, personal communication). This multilevel approach to relationship building, hence, may increase the amount of social capital that a student has to navigate the health professions pipeline and not feel alone in the effort. These characteristics, which create a composite view of the relationship, are potentially limitless. They are also influential in determining the value to be derived from the relationship. In the Mentoring in Medicine initiative, even short duration interactions and networks with health professionals and scientists played a role in increasing interest, knowledge, and awareness of the health professions and health professions career paths at different stages of the pipeline.

Theorists of social capital have discussed different ways that the aspects of social relationships or networks influence outcomes. While Coleman focused on the quality of relationships, loosely defined in terms of time spent between individuals, other researchers such as Granovetter (1983) and Lin, Ensel, and Vaughn (1981) have focused on issues of homogeneity and heterogeneity within relationships and networks. These researchers attribute different aspects of relationships as important to upward mobility and other positive outcomes. Other research has linked different forms of social capital to increased academic achievement and other positive academic outcomes. Specifically, these studies have found that social capital resulted in increased test scores, increased high school graduation rates, college completion, and overall years of educational attainment (Hagan, MacMillan, & Wheaton, 1996).

The Mentoring in Medicine initiative is a catalyst for increasing social capital by facilitating relationships with institutional agents such as health professionals and networks that otherwise would not have existed. Therefore, this paper shows how social capital operates within the context of the mentoring relationship established through the Mentoring in Medicine initiative. The benefits derived from this relationship are seen through an increase in knowledge and interests in the health professions career pathway.

Mentoring as a Form of Social Capital

Mentoring programs have been shown to be instrumental in increasing educational achievement. A mentoring relationship allows relationship building and networking with another person. Various studies differ on the aspects of the mentoring relationship that are most beneficial. It is likely that mentoring needs to be looked at holistically in terms of the overall social capital conferred on participants in the form of knowledge, networks, and opportunities. Mentoring programs can be beneficial to students; however, further evaluative evidence is needed to show whether they work for both short- and long-term options. In the Mentoring in Medicine initiative, we see how interactions with health professionals at various stages in the pipeline can increase participants' interest and knowledge in pursuing health profession careers. Social capital provides a great framework in which the benefits of mentoring relationships can be captured. Trust is also very important in catalyzing social capital; hence, these mentoring relationships will have to be facilitated on a foundation of trust knowing that networks will follow through on promises (Coleman, 1988).

Since social capital is also built through knowledge and information resources, which can come from networks and mentors, Coleman's (1988) framework suggests that a mentoring relationship can be considered a form of social capital. In terms of education information, information from mentors may range from direct knowledge disseminated as tutoring assistance, research and internship opportunities, recommendation letters, and other factors for upward mobility and achievement in higher education. Coleman states that the key to achieving greater benefits from social capital is through stronger bonds based on frequency of contact and duration of mentorship. Thus, mentoring may only provide increases in academic achievement and serve as a powerful form of social capital if the relationship between mentee and mentor is strong.

Although strong ties are important, there is also a role for weak ties in conferring social capital. The role of weak ties in the Mentoring in Medicine initiative will be explained further in the next section.

Social Capital: Weak and Strong Ties in Relationships

Weak ties played an important role in the Mentoring in Medicine initiative. These ties resulted from relationships with health professional mentors during conferences and workshops held to build capacity at different stages of the pipeline. These weak ties formed through relationships in the MIM network often resulted in valuable resources such as advice, referrals, recommendation letters, and other assistance which should help advancement toward successful outcomes (L. Holden, January 2011). Originally outlined in relation to social network theory, Granovetter's (1973) theory of social capital explains that two basic types of social relationships exist: those that are based on either strong or weak ties. Strong ties occur between close family members and friends. Weak ties are explained as relationships with acquaintances or friends. Granovetter further explained that these weak ties form a network of heterogeneous members through which valuable social connections are created and upward mobility can be obtained. Granovetter defined tie strength as a composite of several correlated factors, including time, closeness, and intimacy involved in the relationship. Therefore, frequency of contact and duration can have an impact on strength of social capital. This is similar to Coleman's theory; however, the amount of time spent between individuals is highlighted as important in activating social capital. Hence, in the Mentoring in Medicine initiative, although not captured in the data, interactions with networks facilitated at the conferences developed into year-long mentorship resources and connections. This intensity of connections with the mentor can play a role in activating social capital for the mentee.

Granovetter further explained a form of weak ties as bridges. Bridges occur when a weak tie exists between two people such that certain information or influence can only pass through that connection. However, not all weak ties can be bridge ties, as weak ties are a necessary but not sufficient condition of a bridge tie. For example, an individual can be connected to a mentor in the MIM program through contact once a year, and this would be a weak tie. A bridge would occur from this connection, if the mentor put the mentee in touch with networks for further opportunities. Bridge connections open doors to opportunities that would not otherwise be available, because they often provide access to socially distant people who have information that closer friends and relatives do not have. Granovetter explained that with bridge ties, the fewer indirect contacts one has, the more limited one would be in terms of potential resources.

Granovetter also explained the role of weak ties for individuals who are trying to find new jobs. He found that weak ties between individuals produced more favorable outcomes than strong ties. Among a sample of non-working class employees, those who found their jobs through existing network connections were more likely to have obtained their job through a weak rather than a strong tie. This is also applicable when trying to obtain information for the science and health professions opportunities. In this work, Granovetter's measure for tie strength was based solely upon frequency of contact and not the multiple dimensions listed within his theoretical framework. Similarly, in the Mentoring in Medicine initiative, we saw how networks in the form of weak ties played a role in increasing informational resources for health profession careers and hence social capital. Social ties in the context of the mentoring relationship can lead to increased opportunity, educational attainment, and achievement for the mentee. Other researchers have extended Granovetter's theories and developed additional components of tie strength.

In work further expanding social tie theories, Lin, Ensel, and Vaughn (1981) explained that social capital are embedded in the positions of contacts an individual reaches through his or her social network. In this work, the authors showed that an individual of lower status would need to use weak ties from those who were higher in status in order to obtain jobs of higher occupational status. Their analysis showed that males in the labor force obtained higher-status jobs indirectly through weak ties. Weak ties led to higher-status individuals, which led to higher-status jobs, because weak ties represent contacts, who are different than the individual, in terms of socioeconomic status indicators. As stated previously, trust is an important indicator in terms of being able to effectively translate social capital into networks and opportunities. Lin et al. (1981) also found that the educational status of the connection had a significant and positive result on obtained occupational status. Individuals who found jobs through connections with higher academic attainment than themselves were hired for higher-status positions. These studies adjusted Granovetter's original social tie theory by indicating that the main importance of a relationship is the difference in status, that is, the initial status of an individual compared to the status of a contact. Hence, we can see a cyclic effect where social capital is coupled with socio-economic status and begets more social capital and further opportunities for those who are well connected. Also, in the context of mentoring, weak ties play a role in the upward mobility of disadvantaged individuals who may not have a network of high socioeconomic status individuals in terms of educational attainment. In this case, the mentor serves as a bridge to other networks. The Mentoring in Medicine initiative utilizes the strengths of these social ties as social capital for individuals from underrepresented minority and disadvantaged backgrounds. These ties are maintained throughout the year as a form of increasing informational and support resources for individuals to navigate the health professions pipeline. Additionally, due to the holistic approach of the Mentoring in Medicine initiative, in that the outreach also caters to parents, this information can help to bridge the information gap not only at the student level but also the parent level.

Limitations

A sample of convenience has inherent limitations because it is not representative of the entire population; therefore, results cannot be generalized to a broader population. Additionally, this study used perceptual, subjective data, which may be considered a limitation. Although perceptive data are meaningful, they are a variable measure for success. Additionally, the data were only collected at one point in time and have limitations inherent in cross-sectional study design. An additional limitation is that surveys were only given after the initiative. A pre and post survey would have been ideal. Future studies implementing the pre and post survey design coupled with qualitative data will further strengthen the study.

Conclusion

Overall, this initiative enhanced knowledge, confidence, social support, and information for participants through social network and weak ties to assist students with navigating. The Mentoring in Medicine program is unique in that it is the only model targeting each level of the pipeline ranging from elementary school through graduate/health professions school for both students and parents. Parental involvement in pipeline initiatives is also important in increasing social capital. Given the unique framework for this program, it is recommended that this initiative be replicated on a national scale to build social capital along each stage of the pipeline.

Chapter VI

CONCLUSION, SUGGESTIONS, AND RECOMMENDATIONS

The lack of participation by underrepresented minorities (URMs) in science and health profession fields has led to methods to increase awareness of overcoming the challenges that arise from such low participation, particularly in groups underrepresented in the science and health professions pipeline. Therefore, STEM pipeline initiatives have received considerable attention in terms of funding initiatives. Research indicates that low participation and performance in Science, Technology, Engineering, and Mathematics (STEM) has become an increasingly severe issue for underrepresented minorities, including Black/African Americans, Hispanics, Native Americans, Alaskan citizens, and Native Pacific Islanders. Although Hispanics, Black/African Americans, and Native Americans represent one-third of the U.S. population, these groups are disproportionally underrepresented in their attainment of STEM bachelor's, master's, and doctorate degrees and in their participation in the STEM workforce. Specifically, Hispanics and Black/African Americans hold only 3.4% and 4.4%, respectively, of science and engineering jobs.

Similar statistics abound in education, where the number of STEM doctoral degrees awarded in 2005 to the underrepresented groups combined was less than 10% of all degrees awarded. In response to these alarming statistics, a number of initiatives now work to increase participation among underrepresented populations, and to address resulting social equity problems along with the overall problem of low participation and performance by U.S. citizens.

The particular form of social capital which has been examined is the knowledge, information, resources, networks, and mentorship needed to navigate the pathway for science and medicine careers. The outcomes of three initiatives known as 1) E-matching, 2) achieving Successful Productive Academic Research Careers (SPARC), and 3) Mentoring in Medicine were reported as part of three manuscripts in this dissertation. Summaries, recommendations, and form of social capital are reported in the Tables 1-4.

Conclusion

The six parts of this dissertation explain the different roles of social capital in navigating the STEM pipeline through the lens of three pipeline initiatives. This study aimed to bridge the gap in the literature on the role that pipeline programs can play in increasing social capital. By researching outcomes on three pipeline initiatives currently working with or in schools, this research helped to bring together all these elements in a clear and consistent manner. The result is a means of bringing social capital to urban students through informational resource, mentoring, and network access as an embedded component of advancing and navigating through the science and health professions pipeline and not merely as an episodic component they may or may not have the luck to encounter (Corbit, 2002).

In the first manuscript, the use of E-matching was explored as a way to enhance and facilitate networks between high school science teachers in under-resourced schools and biomedical research universities. E-matching is shown as a vehicle to improve social capital for both the participating teacher and students for access to science career informational resources.

This approach can address some of the science exposure disparities seen in many urban classroom settings and, with the increased social capital experienced by both student and teacher, can serve as a pipeline to increase diversity in the STEM fields.

In the second manuscript, the researcher administered a survey among a convenience sample of 93 attendees of the SPARC initiative which included pre-college, college, and post-baccalaureate students and teachers. Data were analyzed using SAS v 9.3. Outcome measures of social capital included: 1) capacity building through a) expanding mentoring, b) expanding networks, and c) expanding professional development opportunities; 2) increased knowledge about translational science and the path to translational science careers; 3) exposure to scientists from diverse groups; and 4) overall impact of initiative on participants. Overall, the initiative showed a statistically significant difference in expanding networks, increasing knowledge and interest in translational science careers, exposing students to scientists from diverse groups, and an overall positive impact on the participants of the initiative.

In the third manuscript, the researcher administered a questionnaire among a convenience sample of 340 attendees at the Mentoring in Medicine (MIM) conference which included elementary ($n = 11$), middle school ($n = 39$), high school ($n = 148$), undergraduate ($n = 32$), and above college ($n = 37$) respondents. Data were analyzed using SAS v. 9.3. Outcome measures included: 1) impact of the Mentoring in Medicine initiative on perception of the health professions, 2) impact of the Mentoring in Medicine initiative on interest in the health professions, and 3) impact of the Mentoring in Medicine initiative on building capacity to pursue a career in the health professions. Overall, this initiative showed a statistically significant difference ($p < 0.001$) in increasing capacity to pursue health professions careers across educational levels. From the results of the survey, it can be concluded that the Mentoring in Medicine initiative builds capacity across all educational levels for health professions careers. Furthermore, recommendations are provided for replication of this initiative to build capacity for health professions careers at earlier stages of training. Mentoring in Medicine was founded to serve as a bridge between existing science and medicine pipeline programs.

Numerous pipeline summer programs exist in the United States and internationally to get more underrepresented minorities interested in health careers in science, technology, engineering, and mathematics. However, anecdotal evidence suggests that summer program participants lack additional year-round support needed when in between summer programs (Corbit, 2002). For example, students who have gone through the MIM pipeline program mentioned going to their pre-med advisor or calling on people they came into contact with during their summer program; however, students did not have a “home base” or “safe haven” or “extended academic family” to go to when problems occurred. This home base often serves as a place for like-minded individuals who might not be the norm among peers to network, ask for help, and receive further encouragement.

Science and health professions pipeline programs were created to enhance pathways and prepare pre-college, college, and graduate students to navigate through the pipeline. There is a significant lack of research and evidence to support the “success” of academic preparation programs. One key reason is that there is no common definition of a successful academic preparation program (Friedman & Quinn, 2006). In this study, success was defined as the ability to impart the social capital that students require to navigate the science and health professions pipeline.

Another reason for the lack of the documented success of academic preparation programs is the difficulty of collecting and analyzing the data, both on a quantitative and qualitative level (Friedman & Quinn, 2006). Programs receive sources of funding at the federal, state, and private levels; however, many of these programs do not have evaluation measures (Friedman & Quinn, 2006). Hence, in the second manuscript evaluating the SPARC initiative, a logic model is shown that evaluates both process and outcome measures of the SPARC initiative and can be used as a model for evaluating short-term and long-term impact of initiatives. Effective evaluation is important in terms of evidence-based initiatives.

In the three outreach initiatives described as part of this research, parental involvement varied to different degrees. The importance of a parent involvement component of the outreach programs was reinforced by the data showing that students relied on parents as their primary influence and source of information about college. In a 1993 study by the U.S. Department of Education, 77% of students reported being advised about college from their father and 83% from their mother. Although students did get advising from school counselors and teachers, it was at a lower percentage, 65% and 66%, respectively. Therefore, parental involvement in these pipeline programs as conduits of social capital for the science and health professional pipeline is important.

Policy mechanisms exist that provide research experiences for underrepresented and disadvantaged student populations at the pre-college and college level; however, challenges exist that may affect assessing the impact of these research experiences (Robinson et al., 2002). As mentioned previously, these challenges vary from administrative, data collection instruments or a lack of data collection.

Social Capital

In recognition of the challenges that students encounter when attempting to navigate the higher education pipeline, the influences of the student's home, school, and community environment can either contribute to or hinder success. The literature suggests that students are more likely to be academically successful if they have appropriate social capital. The aspect of social capital explored in this study was the social capital contained within social interaction, relationships, and networks. As a result of the relationships and interactions facilitated through the initiatives, there was an increase in knowledge of science, health career paths, translational science, and expanded mentoring and networks.

Lastly, this study highlighted the role of short duration initiatives in facilitating social capital. The efficacy of short duration initiatives is often overlooked and undervalued, but through a social capital lens can contribute to the cumulative social capital for an individual to successfully navigate the science and health professions pipeline.

Recommendations

As suggested earlier, social capital can be activated by institutional agents. These agents have the power to provide a network of resources and support for lower socioeconomic students, enhancing their ability to enter an institution of higher education. This study highlighted three pipeline programs as a form of social capital in these students' lives, connecting them to opportunities for support, empowerment, and knowledge-based resources.

This dissertation suggests that all students, particularly those from underrepresented populations, can receive beneficial social capital from institutional agents in the form of knowledge, support, networking, mentorship, and information for advancing through the science and health professions pipeline. A strong system of support is pivotal to overcoming perceived biases about abilities to navigate the science and health professions pipeline.

Given the instrumental role that institutional agents, networks, and informational resources played in imparting social capital in the participants, this dissertation supports solidifying infrastructures for imparting social capital, particularly for underrepresented and disadvantaged students through both short duration (one-day experiences) and year-long experiences. Of particular importance is raising awareness of the institutional agents for the important role that they play, both formally and informally, in building social capital. Also, acknowledging the shortage of evaluation of pipeline programs, this study raises greater awareness about evaluating these programs, particularly looking at the role of the science and health professions pipeline programs in imparting social capital on participants.

Table 1

SPARC Results and Recommendations Summary

Initiative	Participants	Results	Recommendations
SPARC	93 (students)	• Attendees were able to build capacity through mentoring, networks, professional development, understanding of process for developing a research career. • Although over 80% of participants reported being in a summer program, over half reported that they did not have a mentor. • As a result of SPARC, 1/3 of participants who were in were in a summer program without a mentor were able to identify a role model in science as a result of the SPARC initiative. • Majority of attendees had an increased knowledge of translational science, increased interest in science and increased motivation to study science.	• Existing pipeline programs need to build the social capital of participants by expanding beneficial mentorship networks. • Both short-duration and long-duration programs need to include social capital indicators in the evaluation of both short-term impact of initiative and long-term impact through longitudinal data.

Table 2

E-matching Results and Recommendations Summary

Initiative	Participants	Results	Recommendations
E-matching	36 (teacher and students)	• Puts the needs of the school first to fill gap in curriculum with real-world experience • Connection of students with scientists, trainees and administrators • Information about summer programs • 4 students accepted to Rockefeller summer program • Teacher co-authored publication • Teacher invited for other professional development opportunities (i.e. SPARC) • Empowerment of the teacher voice with tools and resources to shape the science exposure needs of students	• Policy: Selection criteria changed to increase diversity (i.e., more holistic review of applications). To increase social capital, one must consider policy recommendations. • Teacher Social Capital: Social capital important for both teacher and student. Conferring social capital on teacher in the form of professional development will increase the social capital of the teacher's students. • Importance of Interactions: One-on-one interaction with research investigators before application process may help to open doors for promising applicants who may not look as "polished" on paper.

Table 3

Mentoring in Medicine Results and Recommendations Summary

Initiative	Participants	Results	Recommendations
Mentoring in Medicine	340 (students and parents)	Increase social capital: • Feeling smart enough to become a health professional • Confidence to become a health professional • Knowing what colleges and health professions schools look for in applicants ▪ Learning new resources to pursue interest ▪ Learning about the health professions	• Program is unique, the only model reaching from elementary through the health professions level for both students and parents. • Parental involvement in pipeline initiatives is also important in increasing social capital. • Currently, this initiative is in two states (NY and CA). Replication of this initiative on a national scale is needed to build social capital along each stage of pipeline.

Table 4

Social Capital Summary across Three Manuscripts

E-matching	SPARC	Mentoring in Medicine
✓ Knowledge ✓ Information ✓ Access ✓ Networks with Institutional Agents ✓ Resources	✓ knowledge ✓ mentorship ✓ networks ✓ Information	✓ Social support ✓ Knowledge ✓ Information ✓ Networks ✓ Mentoring

Future Studies

In future studies, I plan to examine the experiences that contribute to or hinder the social capital of underrepresented minorities in the academic medicine leadership and research career pipeline. I also seek to understand the role that social capital plays in academic promotion, retention, and administrative advancement within academic health centers. As stated previously, a recent landmark study showed huge disparities in the receipt of R01 grants awarded to White and Black/African American populations when qualifications, education, and other factors were controlled for. Tabak and Collins (2011) also recently mentioned that there is very little evaluation of tracking the efficacy of existing programs. It is likely that despite the existence of these programs, social capital and the strength of networking and mentoring relationships are playing important roles in these disparities. Numerous studies support the importance of a holistic approach which emphasizes community building in the institutional culture and climate as an important factor in the retention of URMs. Therefore, this research sought to address an important contextual lens through which to further understand both barriers and facilitators of social capital in underrepresented minority populations. The hope is to support retention efforts and inform institutional culture on ways to improve STEM and health equity and a more diverse workforce in leadership, research, and senior administrative positions at academic health centers.

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APPENDIX A

SPARC Survey

1. Please indicate your gender:

	Female	Male
Gender	○	○

2. Please indicate your race:

	American Indian, Native American, Alaska Native	Asian	Black/African American	Native Hawaiian or Pacific Islander	White/Caucasian
Race	○	○	○	○	○

Other (please specify)

3. Please indicate your ethnicity

	Hispanic or Latino	Not Hispanic or Latino
Ethnicity	○	○

4. Please state your grade:

	9	10	11	12	Undergraduate	Post Baccalaureate	Graduate Student
Grade	○	○	○	○	○	○	○

Other (please specify)

5. Age

6. Please answer Yes or No to the following:

	Yes	No
Is this your first time attending a workshop and conference on translational science?	○	○
Do you have a science mentor?	○	○
Are you currently in a summer program?	○	○

7. How did you hear about this workshop?

8. As a result of participation in this conference:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am better able to identify, change or expand possible research networks	○	○	○	○	○
I am better prepared to identify, change or expand possible mentoring relationships	○	○	○	○	○
I have a role model in science	○	○	○	○	○
I have someone to discuss my career interest with	○	○	○	○	○
I now have a better understanding of the process for developing a research career	○	○	○	○	○
I will seek further information to develop and enhance my research interest	○	○	○	○	○

9. This outreach:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Increased my knowledge about translational science	○	○	○	○	○
Decreased my interest in science	○	○	○	○	○
Increased my motivation to study science	○	○	○	○	○
Decreased my interest in translational science	○	○	○	○	○
Made me realize science is boring	○	○	○	○	○
Increased my interested in science	○	○	○	○	○
Increased my interest in translational science	○	○	○	○	○
Decreased my motivation tc study science	○	○	○	○	○
Increased my interest in participating in more science programs	○	○	○	○	○

10. As a result of this conference, how likely are you to do the following:

	Unlikely	Somewhat likely	Very likely	Not sure	Not Applicable
Pursue a science major					
Apply to more science enrichment programs					
Read more science literature					
Participate in science discussions					
Tell others about science					
Pursue a career in translational science					

11. Prior to today:

	Yes	No
I had knowledge of translational science		
I have met atleast one female scientist		
I have met at least one male scientist		
I have met at least one African American/Black, Hispanic/Native American Scientist		

12. Please answer the following question

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
It is important to increase racial/ethnic diversity in the science field					

13. Please rate the following aspects of today's initiative

	Poor	Fair	Good Excellent	NA
Introduction and Overview				
Role of Academic Research in Health Disparities				
What is Translational Science				
Mentoring/Career Panel				
Networking				

14. Please rate your view of the networking/roundtable discussion you attended

	Poor	Fair	Good	Excellent	NA
A closer look at translational science careers	○	○	○	○	○
Careers in Medicine	○	○	○	○	○
Life of a Medical Student	○	○	○	○	○
Careers as a Physician Scientist	○	○	○	○	○
Networking Tips for Advancement in Science and Medicine	○	○	○	○	○

15. What did you like most about the conference and workshop? (Feel free to write below)

16. What did you like least about today's conference and workshop? (Feel free to write below)

17. What would you change about future conferences? (Feel free to write below)

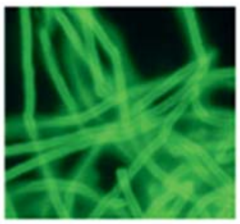
18. What additional topics would you like to see presented at future conferences? (Feel free to write below)

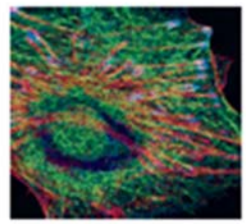
APPENDIX B

SPARC Diversity in Translational Conference Program

SPARC DIVERSITY IN TRANSLATIONAL SCIENCE CONFERENCE

Location: Caspary Auditorium, The Rockefeller University





4:45–5:15 p.m. – Registration and sign-in

5:15–5:25 p.m. – Introduction and Overview

Bernice B. Rumala, M.A., Ed.M., M. Phil. (Ph.D. candidate)
SPARC Co-Chair, Community Engagement Specialist, The Rockefeller University Center for Clinical and Translational Science

5:25–5:50 p.m. – Role of Academic Research in Health Disparities

Carla Boutin Foster, M.D.
SPARC Chair, Director of CEDREC, Weill Cornell Medical College

5:50–6:10 p.m. – What is Translational Science?

Salihah Dick
Tri-Institutional M.D./Ph.D. student, Weill Cornell Medical College

Neil Renwick, M.D., Ph.D.
Scientist, The Rockefeller University Center for Clinical and Translational Science

6:10–7:10 p.m. – Mentoring/Career Panel and Q&A

Mentoring/Career Panel Participants:

Salihah Dick
Tri-Institutional M.D./Ph.D. student, Weill Cornell Medical College

Christopher Dy, M.D., M.S.P.H.
Resident in Orthopedic Surgery, Hospital for Special Surgery

Jessica Hippolyte, M.P.H.
Weill Cornell Medical College, SCALE Study

Ana Tuyama, M.D.
Clinical Scholar, The Rockefeller University Center for Clinical and Translational Science

Bernice B. Rumala, M.A., Ed.M., M. Phil. (Ph.D. candidate)
SPARC Co-Chair, Community Engagement Specialist, The Rockefeller University Center for Clinical and Translational Science (Ph.D. Candidate – Columbia University, Department of Mathematics, Science and Technology)

Neil Renwick, M.D., Ph.D.
Scientist, The Rockefeller University Center for Clinical and Translational Science

Marina Caskey, M.D.
The Rockefeller University Center for Clinical and Translational Science

7:10–7:20 p.m. – Overview of Benefits of Participating in Summer Programs

Elizabeth Wilson Anstey, M.A.
Dean of Student Affairs, Weill Cornell Medical College

Fred Johnson
Office of Physician in Chief, Memorial-Sloan Kettering Cancer Center

7:20–8:00 p.m. – Dinner and Networking/Round Table Discussion (See Networking/Round Table Discussion Categories)

8:00–8:20 p.m. – Evaluations

Networking/Round Table Discussion Table Categories

- A closer look at Translational Science Research Careers
  - Table Leaders: Dan Gareau, M.D./Ph.D., Clinical Scholar, The Rockefeller University Center for Clinical and Translational Science
  - Nicole Ramsey, Tri-Institutional M.D./Ph.D. student
  - Daniel Okobi, M.D./Ph.D. student, NYU School of Medicine
- Careers in Medicine
  - Table Leaders: Christopher Dy, M.D., M.S.P.H., Resident in Orthopedic Surgery, Hospital for Special Surgery
  - Marina Caskey, M.D., Clinical Scholar, The Rockefeller University Center for Clinical and Translational Science
- Life of a Medical Student
  - Table Leaders: William Shipman, Tri-Institutional M.D./Ph.D. Student
  - Salihah Dick, Tri-Institutional M.D./Ph.D. student, Weill Cornell Medical College
- Careers as a Physician Scientist
  - Table Leaders: Neil Renwick, M.D., Ph.D., Scientist, The Rockefeller University Center for Clinical and Translational Science
  - Ana Tuyama, M.D., Clinical Scholar, The Rockefeller University Center for Clinical and Translational Science
  - Diana E. Lake, M.D., Memorial-Sloan Kettering Cancer Center
- Receiving Mentoring and Networking Tips for advancement in science and medicine
  - Table Leaders: Carla Boutin Foster, M.D., SPARC Chair, Director of CEDREC, Weill Cornell Medical College
  - Katherine Ellington, M.D. student and V.P. for Community Development AMSA
  - Nii Koney, M.B.A., M.D. student, Weill Cornell Medical College
- Public Health, health professions (Physician Assistant Careers) and Process of Applying to College/Graduate School
  - Table Leaders: Jessica Hippolyte, M.P.H., Weill Cornell Medical College, SCALE Study
  - Harry Pomeranz, M.S., P.A.-C., Weill Cornell Medical College
  - Jeanne Garbarino Ph.D., Post-doctoral Associate
- Science Enrichment Experiences and Process of Applying to Medical School
  - Table Leader: Elizabeth Wilson Anstey, M.A., Dean of Student Affairs, Weill Cornell Medical College

Funding: The SPARC Initiative is supported by The Rockefeller University NCRR Grant award number UL1RR024143, Weill Cornell Office of Faculty Diversity and Memorial-Sloan Kettering Cancer Center Office of Diversity Programs.

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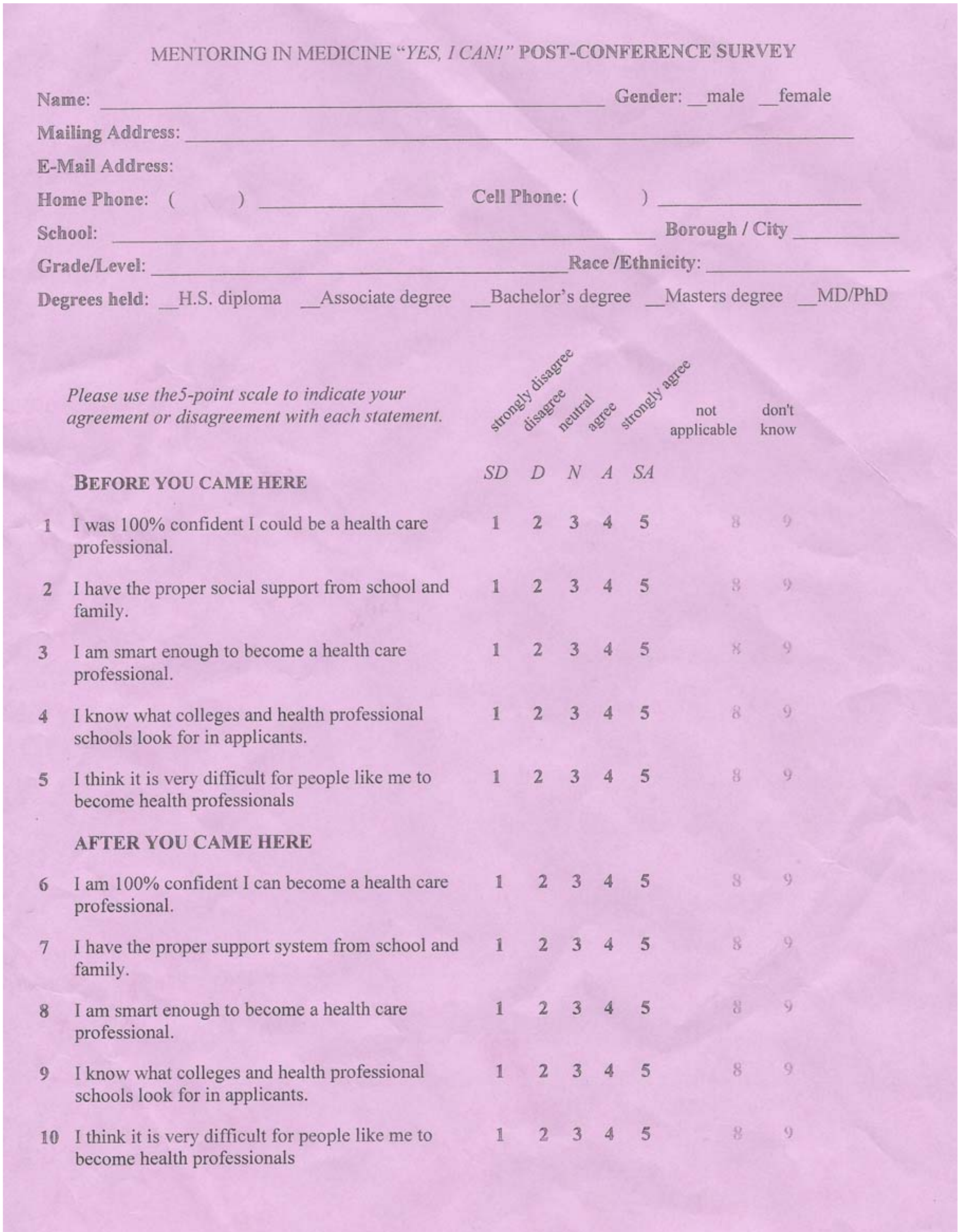
APPENDIX C

Mentoring in Medicine Survey



MENTORING IN MEDICINE "*YES, I CAN!*" **POST-CONFERENCE SURVEY**

Name: ________________________________ **Gender:** __male __female

Mailing Address: ________________________________

E-Mail Address:

Home Phone: ( ) ______________ **Cell Phone:** ( ) ______________

School: ________________________________ **Borough / City** __________

Grade/Level: ______________________ **Race /Ethnicity:** ______________

Degrees held: __H.S. diploma __Associate degree __Bachelor's degree __Masters degree __MD/PhD

Please use the5-point scale to indicate your agreement or disagreement with each statement.		strongly disagree	disagree	neutral	agree	strongly agree	not applicable	don't know
	BEFORE YOU CAME HERE	*SD*	*D*	*N*	*A*	*SA*		
1	I was 100% confident I could be a health care professional.	1	2	3	4	5	8	9
2	I have the proper social support from school and family.	1	2	3	4	5	8	9
3	I am smart enough to become a health care professional.	1	2	3	4	5	8	9
4	I know what colleges and health professional schools look for in applicants.	1	2	3	4	5	8	9
5	I think it is very difficult for people like me to become health professionals	1	2	3	4	5	8	9
	AFTER YOU CAME HERE							
6	I am 100% confident I can become a health care professional.	1	2	3	4	5	8	9
7	I have the proper support system from school and family.	1	2	3	4	5	8	9
8	I am smart enough to become a health care professional.	1	2	3	4	5	8	9
9	I know what colleges and health professional schools look for in applicants.	1	2	3	4	5	8	9
10	I think it is very difficult for people like me to become health professionals	1	2	3	4	5	8	9

MENTORING IN MEDICINE "*YES, I CAN!*" **CONFERENCE EVALUATION**

(For Students, Parents and Health Care Professionals)

		strongly disagree	disagree	neutral	agree	strongly agree	not applicable	don't know
	ABOUT THE CONFERENCE							
1	I learned about different health professions.	1	2	3	4	5	8	9
2	I learned about new resources to find out about health professions.	1	2	3	4	5	8	9
3	The information I learned will help me.	1	2	3	4	5	8	9
	WORKSHOP 1							
	Title________________________							
4	I had fun at the workshop.	1	2	3	4	5	8	9
5	I learned new information at the workshop.	1	2	3	4	5	8	9
	WORKSHOP 2							
	Title____________________________							
6	I had fun at the workshop.	1	2	3	4	5	8	9
7	I learned new information at the workshop.	1	2	3	4	5	8	9
	LUNCHEON							
8	The food was good.	1	2	3	4	5	8	9
9	I learned information during the lunch.	1	2	3	4	5	8	9
10	I felt that my questions were answered.	1	2	3	4	5	8	9

COMMENTS

What did you like best about the conference?

1.____

2.____

What could be improved about the conference?

1.____

2.____