Building a Networked Improvement Community (NIC) around Engaging Minority Males in STEM

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Abstract

The percentage of minority males in the science, technology, engineering, and mathematics (STEM) workforce is about half of their representation in the US population. Roadblocks that continue to challenge minority males include: disparity in access to high quality STEM educational resources, a lack of role models, and a shortage of highly trained, minority STEM educators. This work describes an INCLUDES Design and Development Launch Pilot that builds on an existing regional partnership of four Historically Black Colleges and Universities (HBCUs) that are working together to improve STEM outcomes for middle school minority male students.

Using collective impact-style approaches such as implementing mutually reinforcing activities through a Network Improvement Community (NIC) these partners are addressing the larger goal of improving STEM achievement in minority males, particularly in middle school. Activities of the NIC included a workshop to share best practices and define the NIC, workgroups to engage in improvement cycles, a website that will contribute to the knowledge base regarding effective strategies for enhancing STEM educational opportunities for minority males, and webinars. The project partners have also created a roadmap for a NIC to address the challenges described above. This paper describes a work in progress and will provides an update on the NIC to the broader engineering community.

Background

Minority males are underrepresented in STEM careers in comparison to their numbers in the general population. As shown in Figure 1, Black males are 5.6% of the US population but only 2.9% of the engineering workforce. In comparison, white males are 31.8% of the US population, but are overrepresented in the engineering workforce at 63.5%. Disparities between representation in the S & E workforce versus the population are observed for Blacks, Hispanics, and Native Americans (not shown), regardless of gender, with fewer Black and Hispanic males than females in the overall science and engineering workforce [1]. In addition to existing efforts supporting female students in S & E, this evidence elucidates the need for an emphasis on increasing early STEM opportunities for minority males as well. Roadblocks that continue to challenge minority males in their pursuit of success in STEM fields include: disparity in access to high quality STEM educational resources, a lack of role models; and a shortage of highly trained, minority STEM educators. Low-income youth, who are disproportionately minority students, are also less likely to be ready for college, as measured by college entrance examinations. Upon completion of high school, a smaller percentage of Black and Hispanic males are ready for college and they earn fewer college degrees than their white counterparts. According to a 2015 report [2], the number of college degree holders among Black and Hispanic males varies from 12% to 21%, versus 38% for white men. Nationally, initiatives are underway to develop the STEM pipeline through out-of-school time activities via partnerships between higher education, school districts and community organizations [3].

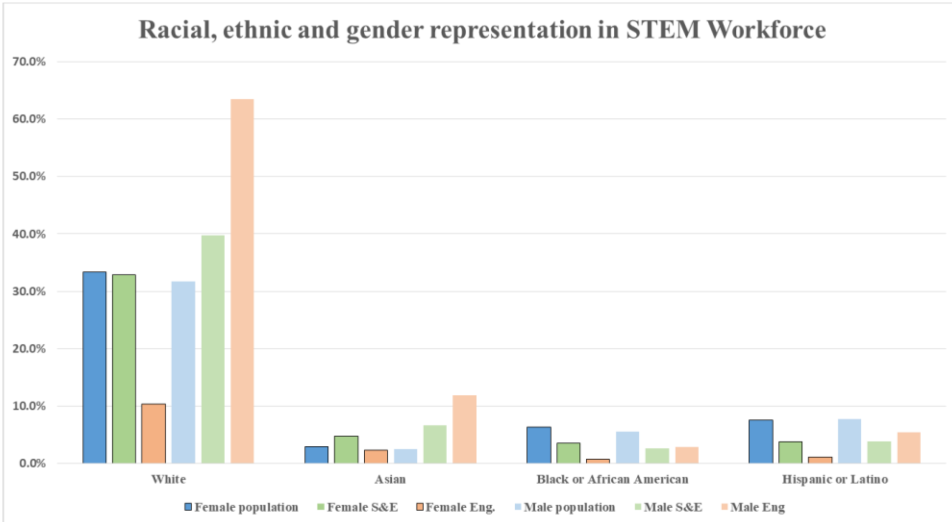

Figure 1: Black and Hispanics are underrepresented in the science and engineering workforce compared to their representation in the general population.

Large-scale social change often involves multiple organizations focused on creating collective impact. Five conditions for collective impact include a common agenda, shared measurement systems, mutually reinforcing activities, continuous communication, and a backbone support organizations [4], [5]. Mutually reinforcing activities can be achieved using a Networked Improvement Community (NIC), "a distinct network form that arranges human and technical resources so that the community is capable of getting better at getting better" [6], [7]. A NIC is considered a scientific learning community that integrates research methods, improvement science, measurement practices and analytics to develop a theory of practice [7]–[9]. Using this approach, it is common to have a community of researchers and practitioners develop and test the impact of change ideas using a four-part rapid improvement cycle (Plan – Do – Study – Act). The goal is to identify and adopt change ideas that result in improvement. These techniques have been applied to significant systems-based challenges [10] such as K -12 teacher recruitment, preparation or retention [11], [12], and improving pass rates for developmental mathematics across multiple higher education institution types [13].

Starting in 2015 a corporate foundation partnered with, and funded, four historically black colleges and universities (HBCUs) to pilot a summer and academic year out-of-school program for middle school males. In the first three months they impacted over 480 participants and 52 teachers, while increasing participants' interest in STEM and STEM careers [14], [15]. As of the summer of 2017, the program has expanded to 16 HBCUs and Hispanic serving institutions and served over 1,400 students [16]. The program empowers underserved middle school students and their teachers in urban and rural communities by providing university-based engineering and science resources, instruction and professional development in 3D modeling and mobile application development with optional instruction in areas such as robotics and entrepreneurship. The program integrates knowledge from other out-of-school time programs [17], [18] and previous NSF-funded projects that target broadening the participation of underrepresented groups in STEM fields [19]–[23], and experience in meeting the needs of the local community by maximizing the capabilities of the host institutions.

In 2016, eSEM was established to extend the impact of this program by creating a Network Improvement Community focused on STEM achievement in minority males. The project has focused on the early stages of collective impact; generating ideas and dialogue and initiating action. This includes activities such as identifying stakeholders and establishing working groups, planning the community and identifying resources, reaching out to potential partners, and collecting data to establish metrics.

Planning Activities

During the first year, eSEM project partners engaged in activities for planning, developing and expanding the NIC [24]. Planning activities included collaboration during bi-monthly strategic planning meetings to establish and refine common goals, measurable objectives and shared measures, mapping the problem-solution space for the coordinated work, and organizing a workshop to establish the NIC. The initial problem space envisioned for the project (Table 1), based on the literature, provided the basis for communicating about the NIC and growing partnerships. Three targets for improvement were selected, based on the expertise of the proposal team; increasing interest in STEM coursework and careers, improving STEM identity and personal development, and improving STEM instruction. For each target, a cause of failure and proposed solutions are hypothesized based on the literature.

Table 1: Envisioned problem space

Targets	Causes of Failure	Hypothesized Solutions
Increase minority male students' interest in STEM course work, STEM careers, and enrollment in college	Lack of accessibility to high-quality STEM coursework and resources	Increased access to high-quality, engaging STEM course work
Improve minority male students' STEM identity, sense of belonging and personal development.	Lack of engineering and science role models and mentors, and a lack of a sense of connection, feelings of belonging, and sense of identity in STEM fields	Increased access to mentors, role models and business leaders; Increased personal development skills, growth mind set, and the promotion of a STEM identity.
Improve STEM instruction through teacher professional development and access to STEM resources.	Lack of teacher training in engineering, science and technology	Increased access to professional development resources for teachers of minority males in underserved communities.

Research on mentoring has been found to have positive behavioral and academic outcomes [25]. Some research has pointed to the importance of role models and mentors who come from similar ethnic backgrounds as the students [26] and who may have the potential to promote a sense of engineering identity, defined as the interface between academic performance, institutional connectedness, gender role and mentors in engineering [27]. Ethnically matched mentors and role models have been promoted in an effort to facilitate students' ability to envision themselves occupying these positions, instill a sense of academic self-efficacy [28] and enhance students' academic self-concept in mathematics and science [29].

In recent years, there has been strong interest on the impact of personal improvement on performance in a variety of domains ranging from growth mindsets to growth goals. Growth mindsets focus on an individual's belief regarding how much their intelligence, skills and abilities can change over time. Those with a growth mindset believe these characteristics can change, with effort. Growth goals are those goals that are designed to increase competence, performance, or other personal characteristics. Both growth mindsets and growth goals have been shown to positively impact student academic outcomes such as engagement and grade point average, including in mathematics courses [30].

Building the Networked Improvement Community

The first step in building the NIC was an opportunity for campuses offering male initiatives, community organizations, leading experts and researchers, to obtain insight into research outcomes and the national discourse around male STEM achievement. This meeting was centered around a two-day workshop titled “Building a Networked Improvement Community Around Engaging Minority Males in STEM” hosted by the eSEM project at Morgan State University, in May 2017. The objectives of the workshop were to 1) encourage collaboration between researchers and practitioners around improving STEM outcomes for minority males in the middle grades, 2) determine common goals, and 3) establish roadmap and research agenda with input from experts. The workshop included over 50 participants and provided presentations from researchers on black male achievement [31], impact of informal learning environments [16], [32], and mathematics education [33]–[35]. In addition, several established NICs provided insights on successes and challenges with integrating research into practice [36], [37]. These presentations were designed to provide a background on some of the broadening participation challenges we were interested in addressing. In addition, since many of the attendees were involved in informal learning, examples of results from two large initiatives were provided. The pre-workshop survey indicated that almost 60% of workshop attendees were new to networked improvement communities, thus they were provided with some webinars that were developed for NSF INCLUDES Launch Pilots (www.includescenter.org).

Once at the workshop, participants spent time developing a preliminary driver diagram (Figure 2) and defining next steps for the NIC. Driver diagrams are an important aspect of improvement science and ensure that the members of the network articulate hypotheses about drivers for their problem. The driver diagram can then be tested and refined [7]. At the eSEM workshop, the driver diagram development process started with the identification and refinement of primary drivers for the aim of improving STEM outcomes for minority school middle males. The five drivers that were identified related to educators, mentoring, family support, retention and STEM content, extending the problem space from Table 1. The drivers and change concepts were refined over multiple break-out sessions and primarily based on the literature and practitioner experience. Secondary drivers and change ideas were then considered and serve as a starting point for NIC improvement cycles. This driver diagram serves as a guide for the work of the NIC over the next year.

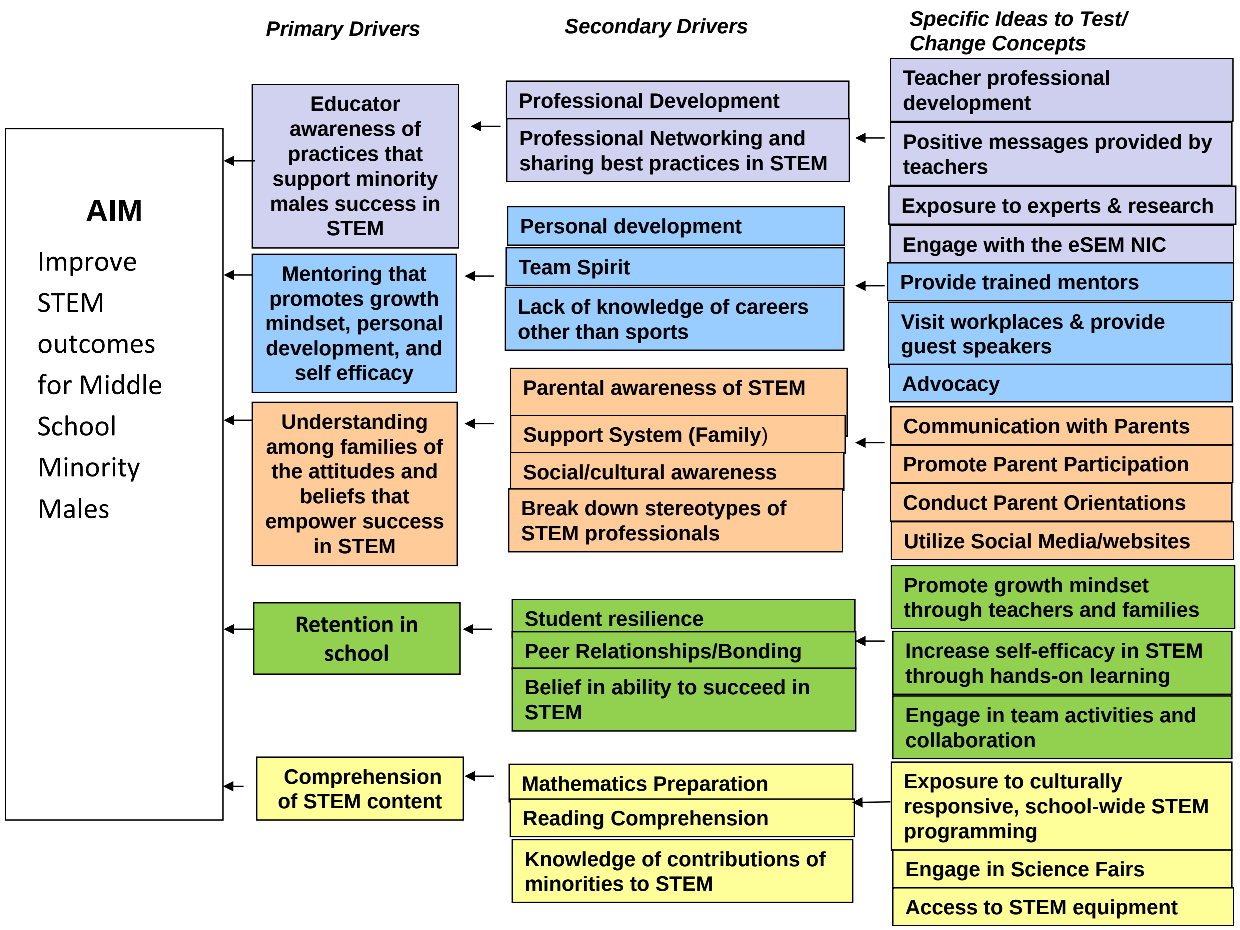

Figure 2: Driver diagram developed during the NIC workshop.

Based on the primary drivers identified in the driver diagram and roadmap, an organizing structure was developed for eSEM that allows the project team to focus on building the NIC, ensuring communication among members, and evaluating progress toward goals. The roadmap will also help guide efforts toward collective impact in addressing the challenge of improving STEM outcomes for minority males in middle school. The roadmap includes an overarching aim, drivers, ideas for change, action steps, timeline for action steps and status of progress. The roadmap drivers mirror the primary and secondary drivers on the driver diagram with two additional drivers related to scaling and sustaining the NIC. This roadmap influenced the organizing structure which has four major components; the 1) Coordination Hub, which has five committees, 2) Mini-backbone, 3) NIC, which includes four workgroups, and 4) Evaluation Team (Figure 3). Researchers and organizations were recruited to join the NIC between November 2017 and February 2018. They indicated a formal commitment to the NIC and elected to join a workgroup through a form on the project website. Due to the geographic distribution of the NIC members, care has been taken to promote continuous communication through virtual interactions, webinars and the project website (www.esem-includes.org), through the efforts of the Coordination Hub.

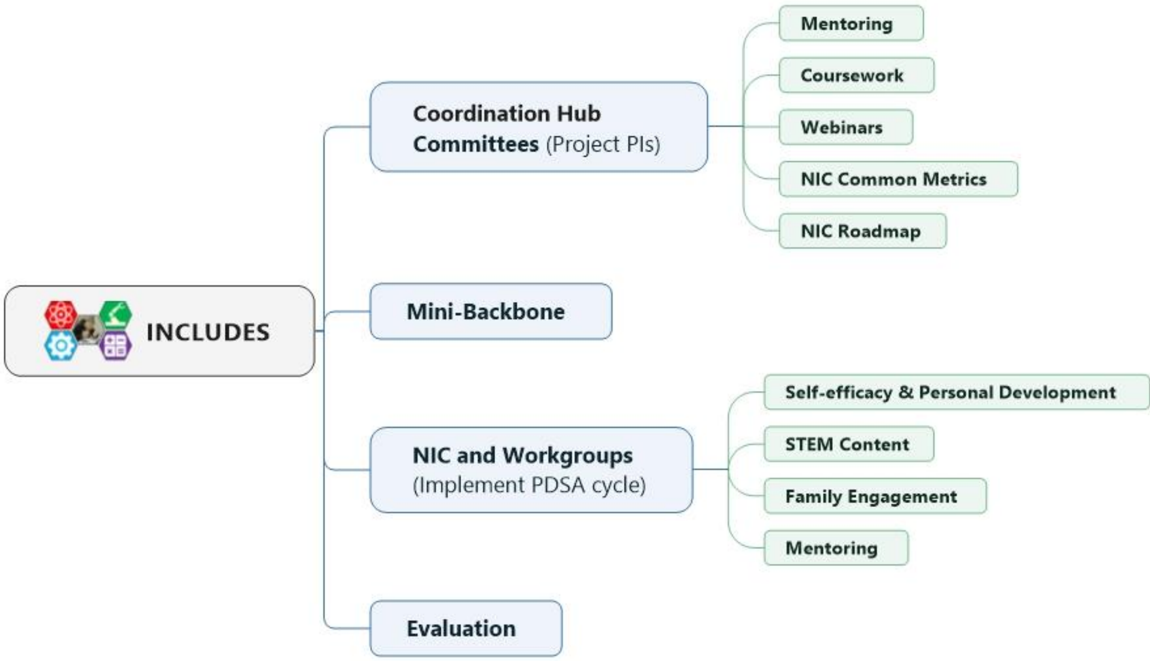

Figure 3: eSEM project structure

Evaluation and Measures of Success

Some NSF projects utilize an evaluation of summative and/or formation evaluation based on a logic model created during proposal development. The project metrics are monitored during, and at the end of the project by an independent evaluator. The evaluation of this INCLUDES project utilized a developmental evaluation framework which includes the evaluation team in collaborative program creation to provide real-time feedback. It is appropriate for innovative, complex, uncertain social innovations and projects that are in very early stages, and may need an evaluation process that learns from, and adapts to, the implementation process. Thus, the program may change objectives and metrics during implementation as part of an iterative process [38]–[40]. At the first Principal Investigators meeting, this type of evaluation was recommended for all Design and Development Launch Pilots since this was a new approach to broadening participation and the NSF was in the early stages of defining the structure of the National INCLUDES Network.

The external evaluation team attends most in-person and virtual eSEM meetings to evaluate, advise, and create qualitative and quantitative measures. They track process measures such as the frequency of eSEM and NIC meetings, the attendance rate of eSEM and NIC participants in meetings and the number of new partners and organizations that engage with the NIC. The evaluation team monitors the project timeline to determine if milestones are being achieved on schedule and reviews documentation, such as meeting agendas, notes and minutes. The evaluation team also measures how well the network is meeting the conditions of collective impact, measures products such as the website and roadmap, and monitors progress regarding research questions that target increasing the number of underrepresented males involved in

STEM. The evaluation team captures growth and progress of the network and administers pre/post surveys for the workshop and webinars that capture the perspectives of workshop participants.

Conclusion

The eSEM project has made significant progress towards developing a common agenda among NIC participants, sustaining continuous communication with core partners, and laying the foundation for mutually reinforcing activities, developing a shared measurement system, and utilizing backbone support for the promoting and growing a network improvement community. The NIC workgroups provide a mechanism to test and implement strategies and actions that will ignite change and allow for measuring improvements across multiple organizations.

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