Quality Approaches in Higher Education

INVITED ARTICLE

Understanding drivers for success of STEM intervention programs

Research to Practice: Identifying Best Practices for STEM Intervention Programs for URMs

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Abstract

Focusing on STEM intervention programs aimed at increasing the recruitment and retention of minority undergraduates traditionally underrepresented in STEM, this paper explores the perspectives of STEM Intervention Programs (SIP) administrators. Fifty-six SIP administrators from 10 large public, research universities were interviewed on what "works" to enable the successful administration of these programs, especially in terms of how they aid in the recruitment and retention of historically and traditionally under-represented minority (URM) undergraduates in STEM. The findings suggest that for the SIP administrators in this study, exhibiting a focus on student-centeredness, community building, and collaboration as well as sustaining these efforts is an integral part of effectively administering intervention programs targeting the recruitment and retention of URM undergraduates in STEM. In addition, this paper advocates for more research in support of SIPs.

Keywords

STEM, Student Support, Best Practices

Introduction

The importance of scientific gains to the United States' national and international position in a global economy has recently led to an adamant call for the production of more postsecondary and advanced degrees in the science, technology, engineering, and math (STEM) fields (National Academy of Sciences, 2011; National Science Board, 2010). The quality of STEM education in the United States, especially with respect to the low participation of racial minorities in these fields, (National Academy of Sciences, 2011; National Science Board) has been identified as cause for concern. Despite comprising more than 30% of college-aged adults (18-24), underrepresented minority (URM) groups (Blacks, Latina/os and Native Americans) continue to represent a severely lower percentage of students earning postsecondary and advanced degrees in STEM fields (DePass & Chubin, 2008; James & Carlson, 2012). In order to meet the challenge the nation faces of remaining competitive with other scientifically and technologically advanced countries, it is imperative that all members of the citizenry are utilized to adequately populate the STEM workforce (National Academy of Sciences, 2011; National Science Board, 2010). To this end, the United States can no longer fail to develop and nurture the talents of all of its citizens (BEST, 2004; Change the Equation, 2014; IHEP, 2009; Miller, 2011; National Science Board, 2010; Strayhorn, 2010).

Over the past several decades, various strategies have been devised and implemented to address the lack of diversity in the STEM fields (National Academy of Sciences, 2011; Tsui, 2007). At the postsecondary level in particular, STEM Intervention Programs (SIPs) have emerged on the campuses of virtually all four-year institutions of higher education not only as a means to foster, support, and sustain the interest of students in STEM, but also largely in a concerted effort to address the historical and perpetual underrepresentation of minority groups in STEM majors, as STEM graduates, and in the STEM professions (Tsui, 2007). Through a variety of services and activities including mentoring, tutoring, academic advising, and providing research opportunities, these intervention programs seek to increase the representation of URMs in STEM fields. Such programs improve the likelihood that they enter these fields, are retained through degree completion, and ultimately pursue advanced degrees in STEM fields and/or enter the STEM workforce (Strayhorn, 2010; Tsui, 2007).

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Although these types of interventions have been in existence for years now, some even decades, there is little research confirming their actual efficacy, particularly with respect to their efforts to successfully recruit and retain URMs in STEM or significantly decrease their underrepresentation in these fields (BEST, 2004; Leggon & Pearson, 2006; Tsui, 2007). Through a qualitative research approach, this work explores the perspectives of SIP administrators in an effort to understand what "works" in the administration of these interventions in terms of meeting the primary goals of recruiting, retaining, and graduating URM students in STEM. Garnering the views of those who design, implement, and direct these programs and the activities and services they provide will contribute to the research literature and provide insight on the efficacy of these programs and their benefits in support of URMs in STEM.

Literature Review

Programs designed to increase the representation of minority groups in STEM fields have been in existence for decades, and over the past 20 years have been rapidly growing in number. While most STEM intervention programs at the undergraduate level generally support students in the form of social, financial, and academic assistance and resources (George-Jackson & Rincon, 2011; IHEP, 2009), the types of services and programs they offer vary widely. Despite this variance, the main goal of SIPs is generally to support students. In that respect, SIPs tend to be student-centered, largely focusing on the academic, personal, and social support of students, which has been noted as integral to success among undergraduates in general, and even more so among underrepresented students (National Academy of Sciences, 2011; Reason, Terenzini, & Domingo, 2006; Tinto, 2012). Moreover, in their efforts to support students (particularly URM students), SIPs recognize the importance not only of establishing and maintaining a community that fosters students' sense of belonging (National Academy of Sciences, 2011; Tinto, 2012), but also of collaboration among academic and student affairs administrators to ensure that students are being supported in the most effective and efficient manner (National Academy of Sciences, 2011; Tinto, 2012).

Despite the proliferation of STEM intervention programs on many university campuses, and some notable gains in the participation of URMs in STEM fields, the percentage of URM students graduating in STEM continues to be significantly less than that of their non-URM counterparts (Change the Equation, 2014; James & Carlson, 2012; National Science Board, 2014). Consequently, SIPs have been plagued by questions around their actual efficacy, subsequently placing their continued existence into question. One of the most common critiques of SIPs is that their design and implementation have not typically been guided or informed by research, but rather have been implemented in a piecemeal style that has relied heavily on anecdotal information and intuitive approaches by those with a particular stake or interest in increasing the numbers of underrepresented students in STEM (DePass & Chubin, 2008). The consistent failure to use research to inform the design, implementation, and continuous improvement practices of SIPs is problematic largely because it is unknown what effects, if any, these interventions actually have. Yet, these programs continue to be developed, implemented, and funded despite the fundamental lack of empirical evidence of their efficacy and an absence of formal evaluations to assess their actual effectiveness (DePass & Chubin, 2008; Fleming, 2012; Leggon & Pearson, 2006; Ream, Lewis, Echeverria, & Page, 2014; Tinto, 2012).

As enrichment experiences like those provided via SIPs can have a significant impact on students' educational and career goals and choices, it is important to understand in a more systematic- and empirically-based way how and why SIPs are successful. In particular, it is important to identify the SIPs' components or mechanisms that are integral to increasing efficacy and URM participation in STEM. Currently, researchers remain unsure about what, if anything, these programs are doing that is or can be effective in significantly changing the tide of underrepresentation of minorities in STEM. However, the potential of these interventions to be a serious mitigating factor in the recruitment, retention, and completion of URMs in STEM majors as well as increasing their representation in the STEM professoriate and the STEM workforce, is a prime reason to conduct further serious, empirical research on this issue.

Data and Methodology

This research consists of an analysis of qualitative data collected as part of a larger study that explores the experiences of underrepresented undergraduates in STEM fields at 10 large, public research universities as well as the factors that affect their participation in STEM (STEPUP, 2011). The data used in this work is comprised of in-person interviews conducted with SIP program directors and administrators at these aforementioned institutions in 2009, 2010, and 2011. These administrators and program directors administered a variety of programs ranging from living learning communities, summer research programs, bridge/transition programs, and first-year experience programs. These programs offered student support services (such as mentoring, tutoring, and advising), and leadership and professional development, all with the end goal of increasing the recruitment, retention, and completion of underrepresented students in STEM.

The 10 institutions were all large, public, four-year, research institutions with very high research activity. Eight of the 10 institutions were primarily residential, while two were primarily nonresidential. Undergraduate enrollment ranged from 22,000 to 43,000, and comprised of between 7% and 13% URMs and between 42% and 52% women (IPEDS, 2012).

For the purposes of this research, secondary analysis of the data was restricted to first-time interviews with administrators, faculty, and staff affiliated with SIPs specifically targeted toward URM students (as opposed to other groups underrepresented in STEM, such as women). Therefore, a total of 56 interviewees met these criteria and were used as part of this research (See Table 1 for a profile of the participants).

The specific analysis for this study involved reviewing the interview transcripts for the 56 interviewees, using open-coding to organize data into "chunks" (Rossman & Rallis, 1998, p.171), and subsequently bringing meaning to these chunks of data by further categorizing them into themes.

Findings

The data analysis resulted in three major themes with respect to what administrators believed worked in their efforts to administer effective and successful SIPs for URMs: student-centeredness, community building, and collaboration.

These themes extend beyond the typical academic services and resources that are provided via most SIPs (e.g. tutoring, advising, research opportunities, etc.). These administrators consistently indicated that they believed these specific actions made a real difference in the effectiveness of their SIPs and in helping URM students in STEM, especially with respect to their retention and degree completion efforts.

Student-Centeredness

SIP administrators in the study noted the importance of ensuring that all aspects of the SIP were completely student-centered in order to successfully direct their programs and services in a manner that works for the URM students. These administrators explained that placing their focus on students in every way possible was one of the most important things they could do as administrators of SIPs for URMs. In describing more fully what it meant to have an absolute focus on students, these administrators discussed the importance of building relationships with students and getting to know them not only academically, but also personally and socially. One administrator noted the importance and effect of relating with students on these various levels by stating:

> So, the program isn't just academic, and I guess that's what I really want to stress, because I feel like sometimes in the programs that I have been talking to, they're so worried about helping the student be academically successful. And unless you know that the students are coming from multiple backgrounds, where academics is what's keeping them—but they have children at home, or their parents are not working and they're paying their parents' bills or something—unless you learn the root of that student and learn how to develop them as a person, then academics is always gonna be secondary. So, we try to do both of that. I think that's the reason the program is successful, because we know each student by name…We don't forget one. They come in and see us all the time…they can just come in here and hang out…To them, I'm home…I think it's all about making that student feel like they have someone here.

This administrator not only highlights the importance of getting to know the students that they serve, but also how making this relationship building with students an integral part and priority of the SIP benefits the targeted students and contributes to the overall success of the SIP. In fact, the administrators in this study seemed to be keenly aware of the critical effect of their efforts to practice being student-centered for both the continual wdevelopment and improvement of the SIP, as well as the success of the students they serve. One administrator stated:

> Well, I think [we] are really focused on needs assessment and really looking to our students and the experience

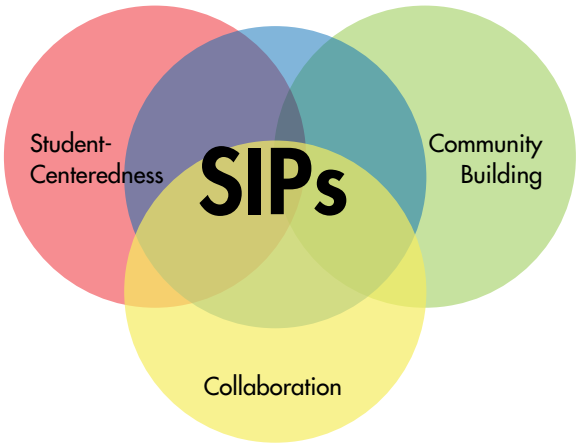

Figure 1: Model for Successful SIPs for Underrepresented Minorities

Table 1: Profile of Participants (N=56)

	N	%		N	%
Female	21	38%	Male	35	62%
African American	25	45%	Bachelor's	6	11%
Latino	2	3%	Master's	17	30%
Asian American	1	2%	Ph.D. (in progress)	6	11%
Native American	1	2%	Ph.D. (earned)	19	34%
White	27	48%	Did not indicate	8	14%

Source: Project STEP-UP, 2013

> they're having and sort of what they tell us in terms of, you know, continuing to evolve the program and add new components. So a big example of that is a few years ago when we started the program after we noticed that we had these 40 sophomores who were doing a lot for the program and the first-year students, but sort of what are they gaining from a professional development standpoint and academically from the program? And so, that's why we really try and spend some time monthly with them, focusing on their specific needs.

This administrator's statement highlights how he or she assessed student needs to better programs and services and ultimately utilized a continual improvement model for the SIPs based on student participants and their changing needs.

As another example of being completely student-centered, one administrator spoke to the importance of prioritizing the needs of the targeted SIP students over everything else, even against the larger goals of the specific department or college related to increasing the numbers of underrepresented students in STEM. This administrator explained:

> When I look at the needs of diversity in a college like [ours], my approach is always systemic. So, I'm…you know… not as interested in a numbers game. You know, get me 10 of these and 15 of these, you know, so we can match up our numbers needs with somebody's idea of what the right quotient of brownness is in a place. If the environment isn't there to support students and their educational goals and needs in a culturally appropriate manner, it seems to me that you've wasted your time.

Overall, many of the administrators provided accounts of their efforts to administer SIPs that were absolute in their student-centeredness. These administrators indicated that they accomplished this goal by building academic and personal relationships with the students, advocating for them in all aspects of their education, taking time to understand their needs, and subsequently making it a priority to meet those needs.

Community Building

Another theme that emerged among these administrators as something that works in successfully administering SIPs for underrepresented students was having a strong focus on, and a commitment to, being and providing a supportive community for students. In particular, many of the administrators in this research discussed the necessity of underrepresented students having a solid academic and social community as they entered and progressed in STEM fields. One administrator noted the important role of SIP administrators in facilitating the establishment and maintenance of a community for underrepresented STEM students, stating:

> A lot of our students that are in our program are very good students. They were the leaders at their high schools. They're high achieving. They're coming to [this university], so you know they did well. But when they get here, they're very much in the minority, so we have found that there's a disconnect between who they hang out with socially and who they hang out with academically… So, we're really developing a social academic community to build confidence and to make relationships and things. And we're already pretty motivated, which helps.

This administrator highlights the importance of SIPs engaging in community building to provide a support system and ultimately aid in the persistence and completion of URMs in STEM.

Moreover, the SIP administrators in this work were also explicit about the positive effects that providing a supportive community had not only on the larger goals of the SIPs (e.g. improved retention and completion rates among URMs in STEM), but also on students' future career choices and goals. One administrator pointed out:

> I think people have preconceived ideas of what your capabilities might be by just looking at you. And, unless they have other types of experience they tend to go with those expectations and act on them. So, many times students are guided out of areas that they should not be guided out of. So, over the course of my summer program because students did not have knowledge about some of these areas we were able to better inform them. So, how you make decisions, who helps you facilitate those decisions and what they do in the facilitation process, I think is very, very key. And I think too often individuals who would be mentors may be well intended but because of their perspectives tend to give information that might not be the best for the individual. So, one of the things we try to do with our STEM programs is to make sure that these students are only provided information where they are supported in what is it they want to do. And, assuming they get certain parts. I mean you have to have obviously the academic part. But to provide that level of support that many times that is all they need because they need someone to tell them yes you can do this. I mean too often they hear well you know maybe you should try something else. So, hearing that they can do it plus interacting with other students who look like them who are similarly situated they develop again that community support. I think that has been again a major accomplishment of the program in terms of helping with success.

Ultimately, SIP administrators in this study were adamant about the role of community building as a critical aspect of SIPs for their success and effectiveness in serving URMs in STEM.

Collaboration

Both formal and informal collaborative efforts were another component of SIPs that the administrators in this study said were important to their success in serving URM students in STEM. In particular, these administrators discussed a range of collaborative activities that they were involved in to ensure that students not only received the services, programming, and information that they needed, but also received them in the most efficient and timely manner. One administrator of a SIP targeted at URM students in the applied health sciences was explicit about the role of collaboration in efficiently administering the intervention, stating:

> We've worked a lot with a lot of the other programs on campus. So, for example, the Office of Minority Student Affairs…we met this summer, because the students that I service they service also. So, it's an issue of dislocation of services, and how can we not duplicate but learn that students can receive different information from multiple people, and it's okay to have an army around them. So, we work together to make sure that the language and the services that we provide are more streamlined for the student. So, instead of having two meetings with me and saying the same thing again, sometimes we'll have joint meetings where the student sees all three of us in a room, and that lets them know that we're all supporting them.

This administrator highlights how collaboration contributes to the effectiveness of SIPs for URM STEM students by allowing for the easier dissemination of information, services, and programming, which, in turn, impacts students' experiences and outcomes.

Other administrators discussed the importance and benefits of collaborating with faculty for the intervention in general and student participants in particular. One administrator explained:

> Across the departments, we have a core group of people that would do anything to support these initiatives. I've been working with one faculty for the seventeen years that I've been here, every year. And if I don't do something with him then he seeks me out and wants to know what can he do? He travels to HBCUs. He has sat on committees of undergraduate students at HBCUs that he's been trying to recruit. He sat on their committees, and then once they've finished their degrees, he's transitioned them here into his program. I have faculty members that do that.

Likewise, another administrator was also clear about the important role of collaboration in the administration of SIPs for URM students, succinctly stating, "I think we have a lot of work to do quite honestly. And I'm not sure if the program can work in a vacuum to accomplish our goals. I think it involves a lot of, as you mentioned, collaboration with other units, with our faculty and with the student culture." Furthermore, this administrator also discussed the benefits that accrue to URM STEM students as a result of SIPs being involved in multiple collaborative efforts:

> It is a very nice partnership that we have with the Engineering Library where we are able to coordinate tutoring resources and mentoring resources for all engineering students. It is our hope that through my engagement with that we have a lot of our students that are marginalized, either students of color or first generation college attendees or even international students that are marginalized and we hope that they can feel a little bit more supported here in the College … I'm in touch with the cultural centers. I think that's kind of important. Collaboration there is more in terms of information sharing and in terms of getting our students visible on the southern part of our campus, as well, although it's very hard. But we want to make sure that the students connect with them, as well.

Ultimately, the SIP administrators in this study credit initiating, facilitating, and being actively engaged in collaborative efforts, particularly those with the best interest of students at their core, as a critical and necessary component of effectively and successfully administering the intervention and its programs and services to URM students in STEM.

Suggestions for Best Practices

This work reveals that administrators of SIPs which target URM undergraduates have concrete ideas about best practices and what works in the administration of their interventions and in ways that are particularly effective for the students they serve. The findings of this study demonstrate that these administrators recognize and practice student-centeredness, community building, and collaboration as a means to effectively aid in the retention and completion of underrepresented students in STEM. Specifically, these SIP administrators articulated the important role that taking these actions played in not only the academic achievement and success of URM STEM students but also in their connection and engagement with STEM and the individual institutions.

Thus, this work provides several examples of best practices for administrators of SIPs aimed at supporting underrepresented students to utilize. Administrators can practice student-centeredness in multiple ways including getting to know students, helping them to feel welcomed at the institution, and addressing not only their academic needs, but also personal and social needs. Similarly, administrators can actively establish and maintain communities to further provide the means for students to become integrated and feel a part of the institution. Finally, recognizing the importance of collaborating and actively engaging in collaborative efforts with various institutional entities to provide URMs the necessary academic, personal, and social support they need is an integral role of SIP administrators working with underrepresented students in particular.

Moreover, the three themes uncovered in this work support existent research findings that are the foundation for some of the most successful SIPs in terms of facilitating the entrance of URMs into doctoral programs. In fact, there are several factors that have been identified as effective in increasing the participation of URMs in STEM: enhancing substantive knowledge and technical skills; offering support at all levels—financial, academic, professional, and social; facilitating the creation of networks and sustaining them; and providing bridge experiences focused on facilitating successful transitions from one educational milestone to the next and on helping students become socially and academically integrated (Maton & Hrabowski, 2004; Maton, Hrabowski, & Schmitt, 2000). The three themes that resulted from this research are well aligned with the established practices that have been deemed effective and successful for SIPs targeting the retention and completion of URMs in the STEM fields. In accordance with these findings, it would be prudent for SIP administrators of interventions that specifically target URMs in STEM to make student-centeredness, community building, and collaborative efforts a priority and integral part of the administration of their SIPs.

Conclusion

This work provides other avenues and areas of exploration for future research as we continue to build the research knowledge on how and why SIPs work or are successful for URM undergraduates. However, the identification of effective components of SIPs, some of which are described in this work as student-centeredness, community building, and collaboration, is only the first step—effectively and continually implementing these components is equally as important to a quality approach to identifying best practices for intervention programs that support students. With the addition of this work and other research on educational interventions, SIP administrators can begin replicating and employing the factors that are determined to work, especially the non-academic factors that supplement the academic work of these programs. Furthermore, effective implementation in the form of the institutionalization of the SIPs themselves is also important. More commitment from the institution to the intervention and its mission and goals is needed to establish SIPs as an integral part of the fabric of the institution and its goals and commitments (e.g., Tinto, 2012). To aid with institutionalization, SIPs should incorporate regular and frequent evaluations not only to sufficiently engage a continual improvement model for the intervention, but also to use the results of these formal assessments as evidence of their effectiveness year to year and across programs. These assessments should include the benefits achieved by the SIPs for the targeted students, as well as the institution. Ultimately, the goal of future efficacy research on SIPs for URMs should be to identify the best practices to determine the effectiveness of the specific intervention as well as to quantify them and subsequently replicate them in other programs to increase their overall effectiveness and their sustainability. Future efforts to inform the development and implementation of effective SIPs must be guided by rigorous and systematic research and evaluation to sustain these much needed intervention efforts for targeted students.

Note: This article is updated from the conference paper, "What Works in STEM Intervention Programs (SIPs) for Underrepresented Minority Undergraduates: Perspectives from SIP Administrators," presented at the *2013 ASQ Advancing the STEM Agenda Conference* at Grand Valley State University, Grand Rapids, MI.

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