

Running Head: From Opportunity to Merit

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STEM Intervention Programs: The Shift from Opportunity to Merit

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ABSTRACT

This paper seeks to highlight the process of shifting missions and guiding ideologies of intervention programs designed for and targeted towards underrepresented, undergraduate students in the science, technology, engineering, and mathematics (STEM) fields at large, public, research-intensive universities. This study draws upon qualitative data through semi-structured interviews conducted with 47 STEM intervention program directors and administrators. The findings reveal that with changes in the political economy of higher education, providing access and opportunities to historically marginalized populations has diminished in importance, while institutions' return on investment and measured diversity has taken precedence in recent years. Programs that were originally created to provide and expand opportunities in the sciences are now rewarding merit and are accepting fewer students based on increasingly rigorous selection criteria. As a result, the number of students who participate in, and benefit from these intervention programs has declined alongside this ideological shift. We argue that students accepted to participate in such programs based on measures of merit are high-achieving students who are likely to succeed in the STEM fields without participation in intervention programs, while students who would likely benefit and may not succeed on their own are underserved. The priorities and commitment to diversity of institutions offering these programs that have undergone such changes are critiqued.

INTRODUCTION

Transition to and through postsecondary education represents an important avenue of social mobility and economic productivity for many Americans. Obtaining a college degree is increasingly important in order to participate in the current global economy— particularly in the high-demand fields of science, technology, engineering, and mathematics (STEM). Access to and success in the STEM fields at the undergraduate level serves as a vital conduit to social mobility and economic opportunities, particularly for individuals from traditionally underrepresented groups.

The issue of underrepresentation in the STEM fields for domestic women, minorities, and low-income students (hereafter, “underrepresented”) remains to be a national concern, both for reasons of equity and the economy. As expressed by Smyth and McArdle (2004), the continued underrepresentation of these groups in STEM represents “lost personal and group opportunity, inhibition of national productivity, and the advancement of science” (p. 354). Despite decades of research on the topic, attempts to understand the underlying factors that contribute to this persistent underrepresentation in STEM remains to be complex and multi-faceted (Committee on Equal Opportunities in Science and Engineering, 2004). The host of individual, institutional, and societal factors that affect students’ affinity towards math and science throughout the STEM pipeline—beginning in elementary school, through college, and into the workforce—have been well documented, as recently highlighted by Clewell and Campbell (2002); Sonnert, Fox, & Adkins (2007); and Chen & Weko (2009).

Undergraduate education in the STEM fields is a critical juncture in the STEM education pipeline, with large, public, research-intensive universities producing a large number of STEM degrees each year. These types of universities are known to offer a wide variety of math- and

science-based degree programs, are on the cutting edge of science and technology developments, and boast impressive research portfolios. In addition—and perhaps most important to this study—these universities feature intervention programs that seek to increase the recruitment and retention of underrepresented students in STEM, and ultimately impact students’ educational outcomes, as well as contribute to the development of a productive STEM workforce.

Project STEP-UP

The study presented here is part of a larger study on underrepresented undergraduates in the STEM fields at large, public, research universities, called Project STEP-UP (STEM Trends in Enrollment and Persistence for Underrepresented Populations).¹ Project STEP-UP focuses on the individual and institutional factors that impact the educational outcomes of undergraduate women, students of color, and low-income students in STEM majors. Using qualitative and quantitative data, Project STEP-UP investigates trends such as students’ entrance into, persistence in, or movement out of STEM fields; reasons for and influences on students’ choice of major; and differences in students’ participation by type of STEM field. One component of the project seeks to understand how STEM intervention programs, which seek to improve the recruitment and retention of underrepresented students in the sciences, are designed, structured, funded, and assessed.

This paper specifically seeks to contribute to the current understandings of STEM intervention programs at large, public, research universities, and how such programs may aid in providing access to the STEM fields for underrepresented populations. Specifically, how STEM intervention programs are designed and implemented, as well as how their missions and goals change over time, are the subject of this paper. This study contributes to the project’s overall

¹ Additional information about Project STEP-UP can be found on our website at: <http://stepup.education.illinois.edu/>

goal of examining the factors that impact the enrollment, persistence, and degree attainment of women, racial and ethnic minorities, and low-income students in the STEM fields.

Large, Public, Research Universities

Large, public, research universities are key postsecondary institutions to the greater STEM community due to the array of scientific majors offered, the number of students they serve, their history of offering accessible higher education to underrepresented populations, and the scientific contributions made through research conducted on these campuses. In 2005, over 9.3 million students were enrolled in four-year colleges and universities across the country, and 62 percent of these were enrolled at public, four-year colleges (Integrated Postsecondary Education Data System, 2008). These institutions not only serve as an important point of access for underrepresented students, but also confer over two-thirds of both bachelor's and doctoral degrees awarded in STEM. Thus, studying institutional factors such as STEM intervention programs at large, public, research universities has implications for not only studying trends of programs that potentially effect a large number of students, but also in terms of informing STEM intervention programs.

Of the set of universities included in this study, six are also classified as land-grant universities. Land-grant universities are a unique set of institutions due to the history of their formation and their mission. The Morrill Act of 1862 charged land-grant colleges and universities with the purpose of educating the nation's citizens, particularly in the areas of mechanics, industry, and agriculture. The founding and expansion of colleges and universities as a result of the Morrill Act increased overall access to higher education. Today, these institutions continue to play a unique role in American higher education and have carried on the tradition of educating the nation's higher education students in the sciences.

CONCEPTUAL FRAMEWORK

This paper seeks to examine the nexus of STEM intervention programs, the notions of educational opportunity and meritocracy, and the roles of large, public, research universities providing access to STEM majors to students from underrepresented populations.

Participation in STEM

The ability to participate and succeed in the STEM fields at the collegiate level is a multi-year and largely additive process that begins as early as elementary school. Factors that negatively impact STEM participation and success for women and students of color result in a “leaky pipeline” (Blickenstaff, 2005, p. 369), as fewer women and minorities persist in the STEM pipeline from year to year. May and Chubin (2003) classify factors that impact any students’ ability to remain in the STEM pipeline as “pre-college preparation, recruitment programs, admissions policies, financial assistance, academic intervention programs, and graduate school preparation and admission” (p. 27). While academic preparation and performance are important factors to STEM participation (Elliot et al., 1996; Felder et al., 1995), financial aid (St. John et al., 2004) and departmental or institutional factors can also impact students in STEM (Elliot et al., 1996; Smyth & McArdle, 2004; Turner & Bowen, 1999).

STEM Intervention Programs

Generally speaking, the type of intervention programs featured in this study are designed to increase the recruitment and retention of underrepresented populations, and in turn, seek to expand access to and success in higher education, as well as in specific disciplines. STEM intervention programs specifically aim to increase the representation and improve the educational outcomes and experiences of students that have historically been the least represented in these fields. The majority of STEM intervention programs can be found in the

“hard sciences” where women, students of color, and low-income students are most underrepresented. In other words, where intervention programs are most needed. However, it is important to note that STEM intervention programs also exist in fields such as the agricultural and health sciences, where differences in rates of participation and success between underrepresented and well-represented groups are not as severe.

STEM recruitment and retention programs attempt to address many of the issues highlighted by the research done in minority student persistence. Examples of programs include academic bridge programs, research opportunity programs, tutoring and mentoring programs, financial aid, and social networks. STEM intervention programs may be designed to address four key factors of academic success for underrepresented students: academic & social integration; knowledge and skill development; support & motivation, and monitoring & advisement (Hrabowski & Maton, 1995; Maton, Hrabowski, & Schmitt, 2000). Reflecting these four factors, many programs are hybrids, offering multiple services to students which collectively seek to improve the academic experiences of students, to create social networks of support, and to create meaningful relationships with a mentor or advisor. Other examples of intervention programs include living-learning communities, leadership development programs, and supplement student organizations.

In 2007, Watson and Froyd conducted a study of engineering intervention programs, which were classified into three categories: 1) Interventions focused on community building by creating and sustaining networks to help each other; 2) Interventions focused on cognitive ability developments that are designed to help students understand their academic weaknesses, and create interventions to strengthen them; and 3) Interventions focused on occupational choice development by exposing students to careers and practice.

Interventions focused on community building aim to attract and retain underrepresented students by capitalizing on their sense of belonging and identity. An example of community building would be student organizations, such as the National Society for Black Engineers (NSBE) or the Society of Women Engineers (SWE). The theory behind these types of intervention programs is based on students recognizing themselves as engineers in a supportive environment of likeminded peers.

Interventions focused on cognitive ability development include pre-college courses, transition from high school to college, or gate-keeping courses. Watson and Froyd (2007) surmised that while cognitive ability development interventions claim to be effective, the effects are simply “effective and useful ‘band aids’ that address surface issues in cognition to get students past certain barriers” (p. 22), rather than actually changing the student’s cognitive ability.

Lastly, Watson and Froyd (2007) examined interventions which focused on occupational choice development by exposing students to the challenges, needs, and situations of engineers. However, it is difficult to determine the effectiveness of these interventions because it is difficult to determine who and when someone may have had an impact on a student’s decision.

Tsui (2007) conducted a literature review that examined effective strategies for increasing diversity in STEM fields by reviewing intervention programs aimed at redressing the race/ethnicity disparities in STEM participation. Tsui sought to review any empirical evidence of intervention programs on the effectiveness of the strategies in their efforts to increase minority participation in STEM. Ten intervention strategies were discussed: summer bridge programs; mentoring; research experience; tutoring; career counseling and awareness; learning center; workshops and seminars; academic advising; financial support; and curriculum & institutional

reform. Given the ten strategies, Tsui concluded that there is no single best strategy, but instead suggests that the use of an integrated approach is the best way of developing and implementing intervention programs for underrepresented students. Integrated program approaches, such as the Meyerhoff Scholars Program at the University of Maryland at Baltimore County and the Minority Engineering Program, employ a mixture of these ten strategies.

Tsui (2007) also observed that of the ten strategies reviewed, research experience and mentoring have received more attention in the literature than summer bridge programs, learning centers, workshops & seminars, and academic advising. While the latter have not received attention via empirical studies, implementers of such strategies believe in their effectiveness, which is most likely judged through informal study, anecdotal evidence, and observations. Additionally, the needs of underrepresented students in the STEM fields tend to overlap with the needs of women, students of color, and low-income students regardless of their major. This implies that programs offering tutoring, internships, research, mentoring opportunities, and advising are also important for determining students' interest, satisfaction, and retention in higher education and specifically in STEM.

Tsui (2007) concludes that more empirical research needs to be done. From the review of literature, most of the research is descriptive in nature, lacks empirical data on the effectiveness of measured outcomes in relation to the purpose of the program, and is informal in nature (i.e., not publically available). It is suggested that comprehensive, intensive evaluations be conducted with the results broadly disseminated.

Examples of STEM Intervention Programs

Both Watson and Froyd (2007), and Tsui (2007) give a typology for different types of intervention programs. In this section, we provide examples of a few effective STEM

intervention programs that reflect the type of STEM intervention programs we included in our study.

The Meyerhoff Scholars Program, the first program discussed; would be considered an integrated approach, according to Watson and Froyd (2007). Located at the University of Maryland Baltimore County (UMBC); the program is attracts “high ability” minority students, namely African-American students. High ability is defined as having a mean SAT Math score of 657, a mean SAT Verbal score of 623, and a mean high school GPA of 3.77, with no lower than a B in any high school math and science courses. Preference is given to students that have taken advanced placement courses in math and science. (Maton, Hrabowski, & Schmitt, 2000). To provide a structure in order to retain the students and aid their transition to graduate programs in STEM, the program has 14 components: financial aid, recruitment, summer bridge program, study groups, program values, program community, personal advising and counseling, tutoring, summer research internships, faculty involvement, administrative involvement and public support, mentors, community service, and family involvement. Maton, Hrabowski, & Schmitt (2000), conducted a study to determine program effectiveness by comparing two different African-American study samples: (1) Science, Engineering, and Mathematics (SEM) students who were offered Meyerhoff scholarships but chose to attend a different institution; and (2) a historical cohort of academically comparable SEM students at UMBC. The researchers concluded “that a well-designed university-based intervention can increase the numbers of African American undergraduate college students who succeed in science, mathematics, and engineering.” (Maton, Hrabowski, & Schmitt, 2000, p. 648). In addition, Meyerhoff students were more likely to graduate in a SEM major, graduate with a competitive GPA, and enter STEM graduate programs.

Consider, Read, Elucidate hypotheses, Analyze, data, and Think of the next Experiment – otherwise known as CREATE—is a research experience-based intervention at City College of New York. CREATE is an upper-level elective course where students read four journal articles and dissect each component of the paper. By participating in the program, students are oriented to research papers, the research process, and are able to “actively orient themselves in the topic area” (DePass & Chubin, 2008, p. 71). This process allows students to examine all parts of the research and experiments presented in their assigned readings. The goal of the program is to aid students in “demystifying scientific papers and to humanize the process of science” (DePass & Chubin, 2008, p. 71). The results from the program’s assessment showed growth in students’ logical thinking, ability to integrate concepts, and improved attitudes about science and scientists. The last example of a STEM intervention program is an early academic intervention program sponsored by the National Institutes of Health, called Minority Opportunities in Research (MORE) for new students at California State University—Northridge. The MORE program aims to increase students success by encouraging students to participate in research programs such as the Research Initiative for Science Enhancement (RISE) and the Minority Access to Research Careers (MARC). MORE also includes early academic advising for first year biology majors, and the Summer Math Workshop Series, which targets first-year students with low scores on the university’s mathematics placement exam. Students participate in this program during the summer prior to their freshman year. Throughout each week, in day-long classes, participants review algebra and geometry three days a week, English once a week, and take a weekly field trip. Students are paid \$800 and given a calculator for participating in the program. Although the early academic advising component of the program has not yet been evaluated and its effectiveness is unknown, the Summer Math Workshop series has been formally evaluated.

The results showed that students who participated in the math workshop took higher level mathematics courses in their first year of college and had a higher pass rate in their math classes.

Meritocracy

The programs highlighted here seek to create opportunities for access and success for students who otherwise may not choose to enter or persist in the STEM fields. However, operating alongside programs that seek to expand opportunities in higher education is the notion of and use of meritocracy. The idea of meritocracy is that, *ceteris paribus*, students rise to opportunity based on their talents and skills as opposed to their ascriptive traits (i.e. race and ethnicity, gender, disability, etc.) (Alon & Tienda, 2007). The concept of meritocracy dates back to Plato and was made popular by Thomas Jefferson and the idea of the “*natural aristocracy*.” In higher education, meritocracy was popularized by James Bryant Conant, former president of Harvard University (Lemann, 1999). For Conant, merit was determined by students’ performance on standardized testing, namely the Scholastic Achievement Test (SAT). It was his intention to assist highly selective institutions such as Harvard to identify talented students from disadvantaged backgrounds (Lemann, 1999). Standardized tests have also been used in discriminatory ways as a mechanism by which to restrict students from particular backgrounds from gaining admission to colleges and universities.

Today, measures of merit are used to reward students for academic achievements, and can typically be found in admission and financial aid policies and programs. In addition to the use of standardized test scores, merit can also be based on a student’s class ranking, course performance, and grade point average. The use of merit in higher education has enabled increased institutional selectivity based on rigorous admissions criteria. However, policies and programs that rely solely on measures of merit continues to discriminate against students from

disadvantaged backgrounds, particularly those who do not have access to high-quality secondary schools. In this sense, meritocracy ignores structural inequities that exist in society, and often hinder students' academic performance.

Despite this, admissions policies and financial aid programs are increasingly shifting from providing opportunities for higher education to rewarding students' academic achievements. Alon & Tienda (2007) conducted a study to evaluate the significance of merit criteria in college admission for equalizing opportunity and increasing diversity. They provide the definition of meritocracy as being "a social system where individual talent and effort, rather than ascriptive traits, determine individuals' placements in a social hierarchy" (Alon & Tienda, 2007, p. 489). In their study, they examined impact of Affirmative Action policies and meritocracy in college admissions. Their findings indicate that as Affirmative Action policies at universities change, and the as the use of test scores and performance measures such as class rank in admission decisions increase, minority and low-income students are placed at a greater disadvantage for college admission. Therefore, an increased focus on meritocracy decreases the potential enrollment of underrepresented students at selective universities. Acknowledging the importance of policies and programs that create opportunities and help level "the playing field" goes against the tradition of meritocracy as the sole measure of opportunity.

STEM intervention programs are necessary to provide access and opportunity to STEM degrees and occupations for traditionally underrepresented students, which may operate against or in competition with overall notions of meritocracy within higher education. This paper seeks to investigate the intersection of STEM intervention programs and their purpose and ideology—with a focus on meritocracy—within the context of large, public, research universities to explore how intervention programs' goals and program components have shifted overtime. Specifically,

the extent to which the changing mission and purpose of STEM intervention programs mirror the ideological shift from opportunity to merit found in higher education. The data and methodology used in the study are presented next, followed by a discussion of the results of the study.

DATA & METHODOLOGY

Examining the design, implementation, and impact of STEM intervention programs on underrepresented undergraduate students represents a single component of the Project STEP-UP, which was described in detail earlier. This component of the project sought to investigate STEM intervention programs at large, public, research-intensive universities through the use of qualitative data gathered through semi-structured interviews with STEM intervention program directors and administrators. The programs targeted in the study are specifically designed to improve the recruitment and retention of underrepresented undergraduate students across a variety of STEM fields. However, the majority of the programs included in this study were housed in fields such as Engineering, Computer Science, and the Physical Sciences. Few programs were housed at the campus-level, or within field such as the Agricultural Sciences or Health Sciences. Interviews were conducted with 47 program administrators and directors of STEM intervention programs at nine universities.² The data was collected in 2009 and 2010.

Participants were purposefully selected by searching each university's websites for STEM intervention programs targeted toward underrepresented undergraduate students, including women, students of color, first-generation students, and low-income students. While the specific missions, goals, services, and targeted populations of each program included in the study varies, each program aims to increase the enrollment, persistence, and graduation rates of

² Data collection at the tenth university took place in November 2010. Seven program directors and administrators were interviewed, but their information was not included in the analysis presented here.

underrepresented students in the STEM fields. Examples of intervention programs in the study include, but are not limited to: summer research programs, mentoring and tutoring programs, leadership development programs, and first-year experiences for underrepresented students in STEM (e.g., designated housing, first-year seminars, etc.).

Participants included administrators, faculty, and staff of STEM intervention programs. A total of 119 individuals from nine universities were invited to participate in the study. Of the 47 participants, 11 were male, 36 were female; 22 were white, 19 were African American, four were Hispanic, one was Native American, and one was Asian American. On average, interviews were completed in one hour, with two interviewers from the research team per interviewee. In addition, a total of 97 documents and reports were gathered from the STEM intervention programs, which include annual reports, survey instruments for evaluation purposes, pamphlets, and brochures.³

The interview protocol asked respondents questions pertaining to the history, mission, goals, services, structure, funding, and outcomes of the program they administer or direct (see Appendix A). In addition, interviewees were asked about their own background and responsibilities within the SIP. Questions pertaining to the original purpose of the program, how the program has changed over time, and who participates in the program are of particular interest to this paper. Interviewees were asked the following questions:

1. Can you tell us a little bit about the program? For example...
 - a. When did the program begin?
 - b. Why was the program developed? What prompted the program's creation?
 - c. What is the mission or primary goals of the program?
 - d. How is the program structured?
 - e. What specific services does the program provide? (*Possible probe*: For example, does the program offer academic or mentoring services?)
 - f. What ideas guided the design and implementation of the services offered in the program? (*Possible probe*: Did you see that students needed better opportunities

³ These documents are not the focus of this particular study.

- for mentoring, a need to improve the climate in order to improve persistence, etc.?)
- g. Has the goal or the mission of the program changed since its inception, and if so, what precipitated the change?

For this paper, researchers utilized an open coding strategy to organize data into broader themes and issues. Open coding is concerned with describing, identifying and categorizing the phenomena of interest (Stauss and Corbin, 1990). Upon development of coding and pattern-matching logic was used to identify distinct characteristics of institutional programs and common themes and issues across all the campuses. Pattern matching logic compares empirically based patterns with theoretical and conceptual frameworks (Yin, 2003).

To reduce concerns for internal validity, researchers examined various sources of data - interviews from participants, observational field-notes and documents (external and internal). This triangulation of data allowed researchers to check data collected through one source (interviews) with data collected through other sources (observation notes; external and internal documents). Additionally, to address reliability, researchers meet periodically to compare data interpretation notes and ensure that conclusions were plausible given the data collected.

RESULTS

Two main themes were discovered through the data analysis: 1) A shift in program mission and purpose from providing opportunities to rewarding merit; and 2) An increasingly rigorous selection process and qualification requirements of student participants. These themes were mainly found in summer research programs (SRPs) and supplemental programs to gate-keeping courses offered at each of the nine campuses in the study. The name, structure, duration, and disciplinary focus of the programs vary, but each program is associated with STEM departments and colleges.

From Opportunity to Merit

The programs of focus in this study were originally created to provide access and opportunities for underrepresented student to conduct research in the STEM fields, as well as enhance their overall higher education experience. A number of programs were specifically created to engage underrepresented students in research experiments with faculty members, to accelerate the students' socialization into scientific disciplines, and to foster the creation of a community of scholars among participants. However, in recent years, the focus and goals of these programs have shifted, from providing opportunities for students to conduct scientific research on campus with a faculty mentor, to recruiting high-achieving students to the host institution's own graduate programs. A number of directors and administrators for summer research programs (SRPs) highlighted a shift in their intervention program's mission and goals, as well as the services offered by the program, including the following account:

The [summer research] program has changed for most of [the universities that offer this program]. It was a program that was meant to provide students with an opportunity to conduct research. And so the focus wasn't necessarily on getting them into graduate school right away. Because we even took sophomores so it would be a couple of years before they could even consider that. But it was more a chance for them to work with a faculty member and to understand what graduate education was about, what research was about. And so it wasn't as rigorous of a program.

-Sandra

This quote not only discusses how the program has changed over time, but also the type of student being served and the increasingly competitive nature of the program. Another administrator noted an expectation that students in the SRP will apply to graduate programs, and that this change related to the program's stated goals:

[T]hose things have evolved and we're right now at the place where we're really wanting to see which of these students will be admitted by the departments. We know that there are many that are admissible, so we're wanting them to gain admission. That's a real—it's a more clearly stated goal than what we've had in

the past. Again, in the past it was, “Let’s bring these students in and give them this opportunity, and let’s change the world. Let’s make sure students have this kind of exposure,” and at that time it was the proper legal thing to do. But now we have to look at things differently and try to correct whatever is the issue here and deal with our issue of inclusion. So, we are working toward those goals. I’d say that’s where we are—working toward those goals.

-Beth

The above quotation also hints that changes in the legal landscape may also have impacted the program, its mission, and the type of students it serves. While there is a noted shift away from simply providing underrepresented students with the opportunity to explore the sciences, towards recruiting students for graduate-level work, legal mandates that affect public universities may in part help explain this shift.

Regarding the magnitude of the observed changes, one program director noted that her program, which was founded in the late 1980s, at one time served over 100 students per summer, and focused on providing students with hands-on research experience. The program currently serves less than 30 students per summer, with the explicit goal of recruiting each student to the university’s own graduate programs. Again, the goals of the program changed over time, with the guiding ideology shifting from providing students with opportunities to rewarding merit.

Selection of Program Participants and Participant Qualifications

With the shift in the purpose and goals of the programs, several administrators discussed how the required qualifications of SRP participants have subsequently changed over time, including the requirement of higher standardized test scores, higher GPAs, and only accepting advanced undergraduate students to the program. Several STEM intervention program administrators spoke of increasingly rigorous application requirements, compared to previous standards for the same intervention program. The following quote serves as an example of this

shift, and highlights the importance of undergraduate GPA in terms of graduate program admission and financial aid:

It [the summer research program] has changed drastically in the past three years. When I started the average GPA score for students was a 3.0. And while admissible to graduate programs in STEM fields, that's not going to get you any love. So this year we are just finalizing our cohort. We're at a 3.65 [GPA] for the students in our cohort.

-Maria

Recall that first quote noted that the program used to accept sophomores to their program. As the programs in this study have shifted their goals, the targeted audience of students has also changed from accepting rising sophomores and juniors to ushering in rising seniors into targeted recruitment to specific graduate level programs. Advanced undergraduate students now not only need to have an interest in scientific research, but also be high achieving students who are planning to pursue graduate study in the sciences. The changing targeted population also minimizes the opportunities for exploring scientific disciplines through SRPs, as juniors and seniors who are now targeted have likely already declared a STEM major. Limiting opportunities for exploration of the STEM fields may disadvantage freshman and sophomores who may opt into a STEM major if exposed to an intervention program early in their undergraduate experience.

As a result of changing missions and goals, the components of SRPs have also changed over time. Previously, students spent the duration of the program in labs conducting research, working closely with faculty members to learn about research in the academy, and exploring scientific careers. A number of the programs directors and administrators noted that newer program components focused on preparing students for graduate studies, including GRE preparation courses and practice tests, sessions on how to complete graduate school applications, and guidance on writing personal statements. One SRP even requires program participants to

complete a portion of the host institution's graduate school application during the course of the program.

DISCUSSION AND IMPLICATIONS

The selected quotes from the data reflect a shift from providing opportunities to many underrepresented students in the STEM fields to recruiting a small number of high-ability underrepresented students who may be good candidates for graduate school. Whereas large, public, research universities have historically expanded access to traditionally marginalized groups, including underrepresented students in the STEM fields, this ideological shift moves away from providing access towards a system of meritocracy.

For students who stand to benefit from STEM intervention programs, and whose enrollment, persistence, and success in STEM depends partially on the services provided by intervention programs, this shift has the potential to further narrow the STEM pipeline. The new program participants, as described by the program administrators and directors, will likely succeed in STEM at both the undergraduate and graduate levels regardless of participating in a summer research program. Based on a philosophy of expanding access and providing opportunity to those who would otherwise not have it, STEM intervention programs in the past have sought to impact those in the margins—students who otherwise may not continue in the STEM pipeline. The notion that the revised programs are labeled as “intervention programs” is itself troublesome. A more appropriate classification of such programs would label them what they are—recruitment programs into graduate school.

The notions of opportunity and meritocracy are not necessarily dichotomous; however, how these programs have changed over time lends them to be treated as such. If the programs remained oriented towards access and opportunity, and had simply added components of

graduate school preparation without changing the criteria by which participants are selected or the number of students served, then perhaps access could work together with meritocracy. Yet the programs featured in this study underwent a near-complete transformation by altering the targeted population, participant requirements, program mission, and the desired outcomes.

In addition to contrasting opportunity with meritocracy, the observed changes may be unintended consequences of other phenomena. As noted in one of the quotations in the preceding section, the observed changes may in part be due to legal or policy changes at a particular institution or in the state in which the public university is located. Other factors that may help explain the observed shift include the declining economy, reduced funding for public universities, and decreased budgets. With scarce resources, scrutiny and expectations of program outcomes may have escalated in recent years, particularly in terms of what the utility of the program for the host university. These possibilities represents an area of future research, which would consider the political, legal, and economic context of the programs, and how contextual changes may impact the delivery, design, and missions of STEM intervention programs featured in this study.

In terms of the implications of the findings for large, public, research universities, we offer two observations. The first is that the desire to recruit highly-qualified students to graduate programs is understandable, particularly if the STEM intervention program is viewed as a return on institutional investment. In efforts to boast rankings, compete for high-ability students, and attract world-class faculty, selecting and recruiting high-ability students is one avenue by which to achieve a particular set of goals for a university's graduate programs. The second observation is that while the university's own interests are at stake, large, public, research universities have historically had a mission of serving the public, providing opportunities for social mobility, and

contributing to a highly-skilled workforce, particularly in the STEM fields. The potential loss of talent, at the critical juncture of undergraduate education, may be a permanent loss of STEM talent. In critiquing the university's use of STEM intervention programs as recruiting tools, we must ask if the university's mission and goals have shifted as well—from providing opportunities, serving as a point of access, and commitment to diversity, to rewarding merit in high-ability students. Given the ideological shift in financial aid from need-based awards to merit-based awards, it may be possible that STEM intervention programs and large, public, research universities are experiencing a similar shift.

Recommendations for the directors and administrators of programs that experience the ideological shift described in this paper include being pro-active, rather than re-active. Administrators should conduct regular, formative evaluations and assessments of their programs to demonstrate the value and worth of their services to others, particularly within their institutions. If the changes observed are driven by budgetary constraints, the ability to diversify funding sources may be a possible solution to continue to serve a larger group of students, even if the specific components within the program still change. Lastly, for directors and administrators that are committed to diversifying the STEM fields and to providing opportunities to students who may not otherwise enter or succeed in the STEM fields, such mission should be balanced with any emphasis given to graduate school recruitment and preparation. Programs may benefit from adding components that prepare students for graduate school, but these activities should be pursued in a way that does not displace students who would benefit from participating in the program the most. In this sense, program administrators and directors should view the notions of opportunity and meritocracy as complementary, rather than competing, concepts.

LIMITATIONS

The study exhibits a number of limitations. The data was gathered from all large, four-year, public, research-intensive, and predominately white universities. Therefore, the ability to generalize these results is limited. In the process of recruiting potential participants, the researchers scanned publically available information on each university's website, looking for STEM intervention programs. If a program was not listed online, or was not located by the researchers, it was not included in the study. In addition, the response rate of invited participants is based on their self-selection to participate in the study.

In addition, the STEM intervention programs that are featured in the study are housed in certain STEM fields, such as engineering and computer science, where students of certain demographics are most underrepresented. While participation of underrepresented students in other STEM fields, such as the agricultural sciences, are important, there are not as many STEM intervention programs in these fields. In other words, the STEM intervention programs discussed in this study represent a narrow set of STEM fields, and are not to be generalized across a broad set of math- and science-based disciplines. Finally, there are no contemporaneous statements from students participating in the programs over the course in which the missions and purpose of the programs changed.

The views expressed in this study are solely the opinions and observations of the program directors and administrators, and may not reflect the opinions or experiences of the students who have participated in the same set of programs, nor reflected in the program's literature. Along similar lines, the data collection efforts are limited to the perceptions of the administrators and directors interviewed in the study. Their perceptions may not be accurate, and/or may be biased in terms of how they interpret the mission and goals of their programs. In addition, the data relies

on the memories of the administrators, and their familiarity of the intervention programs, regardless of how long they have been working directly with the program. Given the set of limitations outlined here, the results offered should be interpreted with caution.

CONCLUSION

This study sought to gain a better understanding of how STEM intervention programs have changed in recent years. The results reveal that as institutions have shifted the goals of programs from providing opportunities to rewarding merit, fewer students who would benefit from the opportunity to conduct research and explore scientific careers have access to and benefit from such programs. Instead, the SRPs described in this study are primarily serving high-achieving students who are likely to succeed in STEM without participating in SRPs. At the expense of students who may have otherwise benefitted, large, public, research universities are seeking to benefit themselves by recruiting a small number of highly-qualified underrepresented students to their own graduate programs.

If the observed changes are attributed to an “evolution” of STEM intervention programs, and that these changes are welcomed in light of changing goals, expectations, and contextual realities, criticism can still be made in terms of the declining number of students who are served. The next logical step may be to determine how programs can provide opportunities to underrepresented students while at the same time helping students enter and succeed in graduate programs. In other words, is there a way to scale-up current programs so that more students have the same opportunities to prepare for and enter graduate programs of study? What resources will be needed for such efforts?

Given the continued call for increased participation in STEM fields for underrepresented students, STEM intervention programs at the undergraduate level must balance between providing opportunity to students while at the same time recruiting students to graduate level study in the STEM fields. Large, public, research universities which seek to impact educational outcomes via opportunities, should review the missions and goals of SRPs on their campuses to determine the extent to which they provide opportunities or are a narrow conduit to their own graduate programs. Opportunities for scaling up current programs—albeit with limited resources—should be explored.

Finally, the study also provides much needed empirical evidence as to the structure and effects of STEM intervention programs on underrepresented undergraduates. Although this study is not an evaluation of STEM intervention programs nor does it measure how such programs impact students' recruitment or retention in the STEM fields as Tsui (2007) called for, it highlights the changing missions and program components of SRPs. As the United States and institutions of higher education seek to increase the number of degrees awarded in STEM fields and diversity of those fields, it is important to consider the role of large, public, research universities in the education of underrepresented students in the STEM, as well as how the structure and mission of SRPs influences students' accessibility to programs may impact their entrance into and success in STEM majors.

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Appendix A

STEM INTERVENTION PROGRAMS: INTERVIEW SCRIPT AND QUESTIONS

Participant
Code

Site Code

Consent
Form
Received

Contact
History
Log

We are traveling to several large, public, research universities this semester in an attempt to better understand how STEM intervention programs are designed, how they operate, and why these programs are successful. In this interview, we would to ask you some questions about how the STEM intervention programs that you are involved with operates on your campus and how you view its effectiveness. May we proceed? May we record this interview?

I previously sent you a voluntary consent form by email. Did you have a chance to review it? Do you have any questions regarding this form before you sign it? (COLLECT SIGNED CONSENT FORM) If you have any concerns after the interview, you may contact me to request that the interview be erased or removed from the data collection. In the event that this happens, we will of course honor your request and remove your interview from the data collection.

Allow me to begin with a brief preview of what the interview will cover. We will be discussing STEM intervention programs and their design, implementation, impact on students, and their benefits. We are particularly interested in how these programs operate at large, public, research universities such as this one.

We will use this information, along with data on the program interventions, to ultimately illustrate how such programs are designed, implemented, change over time, and impact underrepresented students in the STEM fields. If at any time, you feel that these questions could be answered by any reports or evaluations you have conducted on the program, please feel free to refer us to those documents.

Please remember that your participation in this interview is completely voluntary and that any information you provide will be confidential. As a reminder, this conversation is being recorded

and following the transcription of our conversation, the digital file will be destroyed. All identifying information will be kept confidential. Do you have any questions before we begin?

[Start recording]

BACKGROUND INFORMATION:

We'll begin with a few introductory questions.

1. How long have you worked at this institution? How long have you been in this position?
2. How long have you been involved with _____ [name of the program]? What are your specific duties in your current position? Have you worked with any other STEM programs at this institution or any other institutions? If so, which ones?
3. I'd like to ask you a few questions about your background and expertise:
 - a. What is your educational history? Do you have a background in STEM?
 - b. What was your work experience prior to your current position?
 - c. What made you choose to enter this type of work (in your current position)?
 - d. How do you keep current with the research that addresses the work you do in this program?

HISTORY AND GOALS OF THE PROGRAM:

I'm now going to ask you a number of questions regarding the history and goals of the program.

4. Can you tell us a little bit about the program? For example...
 - a. When did the program begin?
 - b. Why was the program developed? What prompted the program's creation?
 - c. What is the mission or primary goals of the program?
 - d. How is the program structured?
 - e. What specific services does the program provide? (*Possible probe:* For example, does the program offer academic or mentoring services?)
 - f. What ideas guided the design and implementation of the services offered in the program? (*Possible probe:* Did you see that students needed better opportunities for mentoring, a need to improve the climate in order to improve persistence, etc.?)
 - g. Has the goal or the mission of the program changed since its inception, and if so, what precipitated the change?

I'm now going to ask you a number of questions specifically about the students the program serves.

5. What population of students do you serve or target?
 - a. How do you recruit prospective students to participate in the program?
 - b. How do you determine eligibility?
 - c. How do you advertise the program?

- d. What types of students are most likely to take advantage of the resources offered by the program?

STRUCTURE AND SUPPORT OF THE PROGRAM:

I'm now going to ask you a series of questions regarding the organizational structure and support of the program.

6. Where in the administrative structure of the college or campus is the program located? Has it always been located there?
7. How might the organization of the department or college impact service delivery?
8. How is the program staffed? (*Possible probe:* If the program staff includes student workers: Are the student workers enrolled in STEM majors? What is the diversity of the student workers in terms of gender, race, ethnicity, and economic background?)

I have a few questions on how the program is supported, both the financial support of the program and other expressed forms of commitment.

9. How is the program funded? Does the source of funding impact delivery? If so, how?
10. What is the level of funding from the college, campus, and external sources? (*Possible probes:* Approximately what percent of support for this program is offered by the university? What are the additional sources of support and what do they cover? Over the last five years, has the level of support changed and in what direction?) How does the program benefit its internal and external sponsors?
11. Can you describe the type and level of support of the program from the college dean? Upper-level administrators? Faculty members?
12. What are the forms of collaboration with other units and/or faculty members on campus that the program benefits from? (*Possible probe:* Are there units with which you share resources, staff, courses, etc.?)

OUTCOMES OF THE PROGRAM:

The following questions are related to outcomes of the program. We are interested in determining how well the design of the program meets its stated goals and the needs of the students.

13. Does the program meet its mission and stated goals?
14. How successful is the program at achieving its stated goal(s)? By what criteria is success determined? To what do you attribute its success or lack of it?
15. Has the program been formally evaluated (i.e., internally or externally)? What was the focus of the evaluation and what were the results? Would you be willing to share a copy of the evaluation(s) with us?
16. What do you see as the immediate and long term impacts of this program on students? (*Possible probes:* Why do you feel that this program is beneficial to students? How do you feel that this occurs? How do you measure the impacts?)

17. What component(s) appear to be most beneficial and useful to students? Why?
18. Do you follow-up with program participants after receiving services? For how long and how frequently?
19. Have there been any modifications or adjustments to the program? If so, how has the program changed? What informed these changes? (*Possible probes*: Did you collect and analyze data, conduct focus group interviews, or gather any other data that informed your decisions? In other words, were these modifications based on research?)
20. Is there is an area of the program you would like to expand or improve upon? If so, what would it be?

WRAP UP

Thank you very much for your time. At this point...

21. What else is important for us to understand about the operation and impact of your intervention program on your campus?
22. Is there anything else that you would like to add regarding your intervention programs?

Thank you for sharing your time and perspective. Please feel free to contact us if you have any further questions (*give participant business card*). We appreciate all of the information and insight you've provided and know that your answers will be very helpful in our research project.

[Stop Recording]

INTERVIEWER COMMENTS / IMPRESSIONS / SYNTHESIS