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Increasing the College Completion of Underrepresented Students in STEM

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About the Minnesota Office of Higher Education

The Minnesota Office of Higher Education is a cabinet-level state agency providing students with financial aid programs and information to help them gain access to postsecondary education. The agency also serves as the state's clearinghouse for data, research and analysis on postsecondary enrollment, financial aid, finance and trends.

The Minnesota State Grant Program is the largest financial aid program administered by the Office of Higher Education, awarding up to $180 million in need-based grants to Minnesota residents attending accredited institutions in Minnesota. The agency oversees tuition reciprocity programs, a student loan program, Minnesota's 529 College Savings Plan, licensing and early college awareness programs for youth.

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Executive Summary

Context:

Nationally, the number of underrepresented students of color who earn undergraduate degrees in the Science, Technology, Engineering, & Mathematics (STEM) fields is not representative of the growing population. This is also true for the State of Minnesota and more must be done in the form of policy and accountability to ensure a healthy pool of STEM professionals that are representative of the changing demographics of the state. After years of developing institutional programs, targeted interventions, and student support services, the number of students of color in STEM fields has not improved and organizational change to support underrepresented students to degree completion will not occur until equity and diversity is made a campus-wide priority.

The Problem:

- Students of color are the fastest growing group of the U.S. population and the most underrepresented in STEM careers:
    - This population is expected to increase from 37% in 2012 to 57% in 2060.
    - Underrepresented students, for example, currently earn only 12% of degrees in engineering.
- There is a shortage of STEM graduates:
    - 1 million additional STEM graduates will be needed over the next decade to fill America's economic demand.
    - STEM-based jobs are expected to grow 17% in the next 10 years, outpacing the overall job growth of 10%.

How might the State of Minnesota help its colleges and universities facilitate degree completion?

- What's Working?
    - Increases access and support to help underrepresented students complete college
- What's Not Working?
    - Serves a limited number of underrepresented students
    - Programs are not institutionalized
    - Pocket programs that have limited impact on overall student completion

Research-Based Strategies & Initiatives:

- Social and Campus Integration:
    - High-impact engagement activities: internships, service learning, summer bridge programs
    - Mentoring: peer-to-peer and professional staff
- Academic and Student Support:
    - Faculty mentorship
    - Research opportunities

- Intrusive advising

- Transfer Alignment (increasing pipeline between 2- and 4-year institutions)
  - Transparency and alignment of transfer credits and of the transfer process
- Institutional Accountability
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1. Public policy that provides competitive grants for colleges and universities to target efforts to increase underrepresented student college completion in STEM

   Example: Kentucky's and New York's Department of Education competitive grants

2. Public policy that provides shared responsibility of funding that target efforts to increase underrepresented student college completion in STEM

   Example: Maryland's STEM Plan

3. Public policy that creates a state program for all interested applicants focused on STEM

   Example: Indiana 21st Scholars Program; New Jersey's STEM Scholars Program

4. Public policy aligns transfer curriculum between STEM programs at 2- and 4-year institutions

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- Practical Criteria
  - Institutional buy-in: involvement of faculty, staff, and administration in development and implementation
  - Flexibility: flexibility in implementation

Final Recommendation:

1. Public policy that provides shared responsibility of funding that target efforts to increase underrepresented student college completion in STEM

- Partnerships between government, community, business & industry, K12, and higher education
- Strategically invest more money around evidence-based practices: mentoring, research opportunities, and increasing alignment between two- and four-year institutions

2. Support the efforts of the Northstar STEM Alliance by aligning the first two years of curriculum among all 2- and 4-year institutions that have a Northstar STEM Alliance program to facilitate the ease of transfer

Introduction

The demand for expertise and professionals in the science, technology, engineering, and math (STEM) field is growing rapidly. In addition to this demand for STEM experts, the demographics of the nation are also shifting rapidly and the number of people of color is projected to continue to grow significantly over the next forty years. Although the demographics of the nation are shifting, this shift is not reflected in STEM fields, which has remained white and male dominated. The combination of the rapidly changing national demographics, the lack of diversity in STEM fields, and the increasing demand for STEM professionals, particularly in the healthcare system, has created an unavoidable predicament and requires swift, drastic, and immediate action by educators, policy makers, families, and communities if we are to correct this issue.

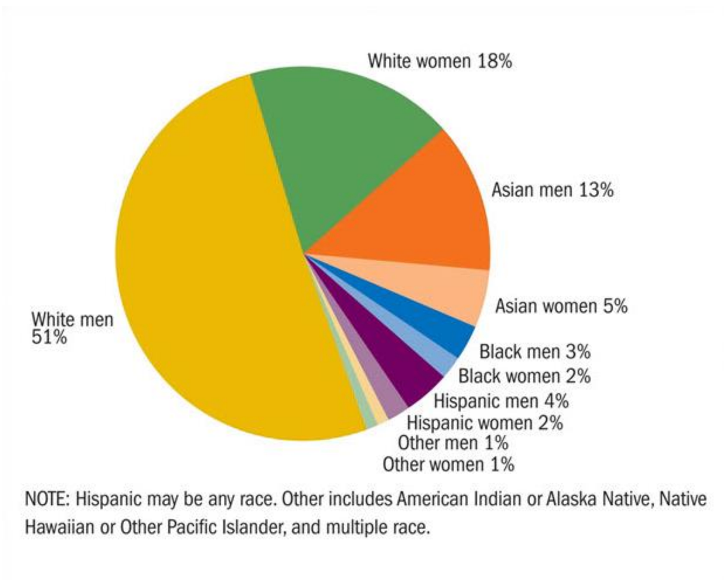
Background

We have a national crisis that is comprised of two large-scale issues:

Issue one: There is a shortage of STEM graduates across the nation. Economic data show that 1 million additional STEM graduates will be needed over the next decade to fill the nation's economic demand. STEM-based jobs are expected to grow 17% in the next 10 years, outpacing the overall job growth of 10%[1].

Issue two: Underrepresented students of color (defined as Black, Latina/o, Native American, Southeast Asian students) are the most underrepresented in STEM fields[2]. Underrepresentation of students of color in STEM fields is an issue because of the rapidly shifting demographics in the nation. In 2012, approximately 37 percent of the population in the United States were underrepresented people of color[3], which is a percentage projected to increase to 57 percent by the year 2060.

Scientists and Engineers working in science and engineering occupations: 2010



Source: Nation Science Foundation

When combined, these two issues (the high demand for STEM professionals and the lack of underrepresented students in these fields) create an unprecedented crisis and require attention and immediate action that demands the attention of policy makers, educators, communities, and citizens of Minnesota. The STEM field has started to recognize there is a national crisis at hand. Freeman Hrabowski, president of University of Maryland-Baltimore County, stated, "It's well-documented that the United States needs a strong science and technology work force to maintain global leadership and competitiveness. The minds and talents of underrepresented minorities are a great, untapped resource that the nation can no longer afford to squander. Improving STEM education of our diverse citizenry will strengthen the science and engineering work force and boost the U.S. economy[4]." In order to address this issue in Minnesota, we need to ensure, right now, that all students - particularly underrepresented students - are able to access and complete STEM degrees.

In response to this crisis, a number of programs and policies to address completion of STEM degrees among students of color have been created including bridge programs, research programs and mentorship initiatives[5]. While current programs and policies have seen some success in the increased enrollment of students of color in STEM fields, the number of undergraduate students who complete STEM degrees remains the same, and the number of students of color in graduate STEM fields is even more troubling[6]. The underrepresentation of students of color in the STEM fields can help explain the minimal number of students of color in graduate programs, therefore, it is important for policy makers to consider effective approaches toward access, retention, and completion for students of color in the STEM fields.

Population

As a result of the national crisis before us, and as articulated above, this report focuses exclusively on low-income and first-generation students as well as underrepresented students of color, defined as Black, Latina/o, Native American, Southeast Asian students (referred to from here on out as “students of color”). This report addresses the severe underrepresentation of students of color, low-income, and first-generation colleges students in STEM fields.

Problem Statement

The combination of the rapidly changing national demographics, the lack of diversity in STEM fields, and the increasing demand for STEM professionals has an unavoidable crisis and requires swift and drastic action by Minnesota educators, policy makers, families, and communities if we are to address this national crisis.

Current Practices

To support the success of underrepresented students in STEM, institutions across the nation have employed a number of research-based strategies or initiatives. These include strategies that aim to increase social and campus integration, academic and student support, transfer alignment, and leadership accountability.

Social and Campus Integration

Formal and informal social connections between faculty and students play an important role in students' professional learning[7]. Some evidence supports high-impact engagement activities, such as internships, service learning, summer bridge programs, are successful indicators of retention of underrepresented students[8]. Summer transition programs provide the structure for STEM students to begin to understand what is expected of them as a STEM major. Such programs also provide opportunities to enhance their knowledge and interest in the STEM field. These opportunities ultimately lead to students' retention in their major[9].

Mentoring conducted by peer and professional staff also affects underrepresented students' retention. Mentoring needs to be provided by multiple types of people, including faculty, staff, and peers in order to be most effective[10]. Peer mentoring achieves formal peer-to-peer contact as well as facilitates the opportunity for new students to informally rely on upper-level students for information about how to navigate the educational system. Tutoring and study groups have been identified as important components to successful retention of underrepresented students. Staff mentoring typically provides the support needed to sustain student interest in the STEM fields, especially through the academically rigorous coursework as well as through unfriendly environments for underrepresented students[11]. Also, mentoring needs to be addressed holistically. In other words, mentoring needs to address the academic, social, and cultural realms of students' lives[12]. Advising staff need to monitor students closely regarding academic planning as well as personal concerns that may arise[13]. Although mentoring needs to be provided by multiple people, the role of faculty mentors specific to mentoring through research has the most impact on student retention[14] (as discussed in the next section).

Academic and Student Support

While undergraduate students of color report family as a motivating factor to persist, they also express a limited ability of families to provide academic support beyond emotional reassurance[15]. Therefore, several scholars agree that faculty-student mentoring programs are an important part of the solution to address completion[16]. During the first and second undergraduate years, STEM students transition into the college environment and academic rigor, which for many first-generation students of color may be the first time they experience college-level work. Mentor programming is an effective support strategy to implement for first-year STEM students of color. As students progress through their undergraduate years, however, relationships with faculty become increasingly important[17]. At this stage, beyond the second undergraduate year, faculty relationships are essential for life-long career decisions, research opportunities, and post-graduate study[18]. Mentorship pushes beyond positive interactions with faculty towards a more intentional and comprehensive academic experience for STEM students of color to succeed in their chosen major[19]. Faculty relationships and mentorship can help support STEM students of color throughout their undergraduate career.

Formal research opportunities at the undergraduate level provide students with connections to the discipline as well as to faculty. Both of these connections have been shown to increase the retention of underrepresented student[20] and the confidence students have in their research skills[21], and the knowledge of the discipline beyond surface level understanding.[22] Underrepresented students engaged in STEM research at the undergraduate level develop a desire to pursue both careers and advanced degrees in STEM fields.

Intrusive advising models include intentional and proactive outreach to students[23]. Each student is assigned a professional adviser to assist with program modifications and classroom-based issues. Advising sessions include problem-solving and decision-making skills by working through problems and difficulties with students[24]. One of the first intrusive advising programs implemented by Western New Mexico University in the early 1980’s resulted in the attrition rates dropped from 66% to 25% in two years[25].

Transfer Alignment (increasing pipeline from 2- to 4-years)

Transparency for transfer credits and transfer process greatly affects underrepresented students’ retention. Institutional partnerships between 2- and 4-year institutions is an important area to consider. Creation of pipeline programs to facilitate successful transfer from 2- to 4-year institutions is one of the most effective ways to recruit and retain underrepresented STEM students. However, the two institutions must work together to ensure a smooth transition for students.

Institutional Accountability

Higher education leaders and leadership plays an important role in how postsecondary institutions function. The literature illustrate the central role that leaders and leadership can, and does, play in higher education towards creating environments and organizations that support the success of all students, especially underrepresented students.

Advancing key institutional priorities, such as an equity agenda, can best be guided and driven by university and college leaders and leadership[26]. Leaders, such as presidents, can advance an equity agenda in ways that other campus leaders cannot because executive leaders have the authority or leverage critical to institutionalization[27]. Some scholars have argued that leaders and leadership is perhaps the most important factor in ensuring institutional transformation and institutionalizing an equity agenda[28]. Many efforts have been made within colleges and universities to improve the success of underrepresented students, especially with the stark acknowledgement that these students will drive the future of the United States economy, communities, and global competitiveness[29].

Evidence of Current Practices in Minnesota

The NorthStar STEM Alliance is an example of a current initiative that seeks to increase the access and success of underrepresented students in STEM. With the financial support of The National Science Foundation (NSF), the NorthStar STEM Alliance has mobilized to address the underrepresentation of first generation students of color in STEM fields. Through established partnerships between two and four year colleges and universities the NorthStar STEM Alliance provide financial support to these campus sites to focus specifically on the academic achievement of students of color. NorthStar programming includes engagement in research opportunities alongside faculty, peer mentorship initiatives, and conference participation to gain exposure to the profession. Additionally, participating institutions have the flexibility to create their own support initiatives reflective of their student-specific needs. According to the NorthStar STEM Alliance progress report[30] it "has achieved 293 graduates in five years of the Alliance, which is 107% of the Year 5 goal of 272 graduates."

What is Working and What is Not Working?

Programs such as the NorthStar STEM Alliance emphasize a variety of critical elements to support students of color including peer mentorship, exposure to research opportunities, and collaboration with faculty members. These strategies have proven to increase engagement and graduation rates for students of color in STEM. While these initial results are promising, there are limitations to the current structure of existing collaborations with institutions. Because many initiatives, such as NorthStar, are not institutionalized within colleges and universities, students are not reached at the point of admission and their exposure to these programs and opportunities is limited.

Lack of institutionalization also results in minimal incentives for faculty to participate in research partnerships with students, which impacts the ability for students to engage in research and mentorship with faculty. In order to increase participation in targeted programming and initiatives, students must be exposed to these opportunities early on in the transition process. The reliance on external organizations such as the NorthStar STEM Alliance on the part of higher education institutions also removes accountability from these institutions to address the underrepresentation of students of color in STEM fields. Institutions, then, rely heavily on the external programs to address the needs of students without having an institutional investment of their own.

Policy Alternatives

As this report considered the research-based approaches to supporting college completion of underrepresented students in STEM and as it examined what has worked and what needs to be improve, there are four policy alternatives proposed for the state of Minnesota that could better support the success of underrepresented students in STEM.

Public policy that provides competitive grants for colleges and universities to target efforts to increase underrepresented student college completion in STEM.

To implement many of the research-based practices, colleges and universities need to invest in resources. By providing competitive grants offered by the state, colleges and universities are able to make the case for the investment that they are willing and have the capacity to do. The grants offered may enable colleges and universities to have catalyst funds to invest in a new program or support funds to expand existing programs.

There are a few states that provide competitive grants to support various education initiatives. For example, Kentucky legislation provides funding to both the Council on Postsecondary Education and the Kentucky Department of Education to support STEM Education initiatives throughout the state[31]. This Request For Application (RFA) will allow local school districts to apply for a grant to establish and sustain existing PLTW Engineering Pipeline and Biomedical Science and CTE Energy Grant career pathway for students to enter postsecondary related programs and related careers.

In New York, the Mathematics and Science Partnerships (MSP) program[32] is a competitive grant program intended to increase academic achievement of students in mathematics and science by supporting and enhancing the content knowledge and instructional practices for teachers of mathematics and science. Partnerships between high-need school districts and the STEM departments in institutions of higher education are at the core of an innovative comprehensive systems approach to improve efforts for teaching and learning in mathematics and science. Minnesota could learn from these state examples and implement similar models.

Public policy that provides shared responsibility of funding that target efforts to increase underrepresented student college completion in STEM.

The resources needed by colleges and universities to implement the research-based strategies and programs could be leveraged by collective partnerships between higher education and other partners such as K12, business and industries, government organizations, community organizations, and philanthropy. Each of these partners has assets that can be "shared," allowing for maximization of resources. For example, business and industries could provide internships for underrepresented students in STEM; STEM students could provide problem-based research that supports community organizations; and philanthropic organizations could provide grants for summer bridge programs.

Other states have built collective efforts to support STEM. In Maryland, the governor called for a task force focused on STEM. The task force came up with seven recommendations in the areas of education, workforce development, and research & economic development[33]. The recommendation proposed an unprecedented mechanism for coordination, resource dissemination, and idea sharing among all of Maryland's STEM stakeholders, including P-12 teachers, students, parents, higher education faculty, business and community leaders, economic development officers, researchers, and policymakers.

Public policy that creates a state program for all interested students focused on STEM.

Minnesota could decide to create a program of its own aimed towards STEM awareness, access, and success. This program, funded by the state, could be open to all applicants through a competitive application process. The program would be tailored to the needs of Minnesota's communities and be built based on best-practice models that includes job shadowing, mentoring, and conferences.

A couple of states have state-supported programs to increase college access and success. Indiana has invested in the 21st Century Scholars[34], a program aimed to increase college access and completion for all students. It is a competitive program that enables students to get free college tuition for four years. Students in the program start in 7th and 8th grade and complete a Scholar Success Program during high school. All students are encouraged to participate in Scholar Success Program but 21st Century Scholars are required to complete all of the required activities each year during high school to receive the scholarship for college.

New Jersey has a program aimed at students to increase awareness and access[35]. The main component of the program includes four conferences that promote various STEM fields. The program is competitive and is open to students from 10th grade to PhD.

Public policy that aligns transfer curriculum between STEM programs at two-year colleges and four-year universities.

To ensure a seamless pipeline between students who transfer from two-year colleges to four-year universities, the state of Minnesota could require colleges and universities to align their curriculums in STEM. This would allow for transfer agreements that clearly articulate STEM programs, curriculum, and courses, allowing for students have less "wasted credits." A few states have already moved in this direction to align transfer curriculum. In Florida, most students begin their college careers at community colleges. As opposed to the national trend of students losing credits during transfer, Florida has ensured students who transfer finish with roughly as many credits in approximately the same amount of time as non-transfer students[36].

Washington has focused their policy around the facilitation of transfer for STEM students by creating the Associate of Science-Transfer Degree. Students who earned the AS-T degree were more likely to complete a bachelor's degree than were students who simply followed the already-in-place transfer agreement[37].

Criteria to Evaluate Success

To assist in the evaluation of which alternative would best support the project outcome of increasing the college completion of underrepresented students, both evaluative criteria and practical criteria were considered[38].

Evaluative Criteria

Efficiency

The initiatives not only maximizes the private gains of underrepresented students but also maximizes of the public good, enabling the public to benefit from the results. In addition, the initiatives designed for underrepresented students have the ability to impact all students.

Cost-effectiveness

The usage of resources in terms of time, money, and people needed to implement and sustain initiatives.

Equity

Programs and strategies used increases the equity and inclusion work in postsecondary institutions, increasing the culture and climate of the institution to better support the success of underrepresented students.

Practical Criteria

Institutional buy-in

Initiatives that allow for the involvement of faculty, staff, and administrators within the development and implementation enable the institution to own the initiative and be empowered to support its success.

Flexibility

Initiatives that allow for flexibility in implementation enable the stakeholders to design what works best for them.

Application of Criteria to Alternative Public Policies

Initiatives	Impact on All Students	Cost Effectiveness	Equity	Institution Buy-In	Flexibility
Policy that provides competitive grants for colleges & universities to target efforts	Initiatives at colleges and universities can impact all students	Institutions allocate own funding	Increases equity	Faculty, staff, & administrators design program that best fits the institution	Flexible in design and delivery
Policy that provides shared responsibility of funding that target efforts	Initiatives at colleges & universities can impact all students	Cost is shared by partnerships	Increases equity	Faculty, staff, & administrators work with other partners	Flexible in design and delivery
Policy that creates a state program for all interested students focused on STEM	Program targeted to students interested in STEM	High cost initially to invest in programs; some cost for sustainability	Increases equity	State-run program that seeks input from faculty, staff, and administrators	Flexible in design and delivery
Policy that aligns transfer curriculum in STEM	Aligned transfer curriculum impacts all transfer students	Initial costs to design curriculum; overall limited costs for sustainability	Equity is indirectly impacted	Faculty actively involved in transfer curriculum design	Flexibility in design and delivery

Final Recommendations

After applying the evaluative and practical criteria to each of the public policy alternatives to weigh the strengths of each alternative towards meeting the overall outcome of increasing the college completion of underrepresented students in STEM, this report proposes two final recommendations:

Recommendation 1

Enact public policy that provides shared responsibility of funding that targets efforts to increase underrepresented student college completion in STEM fields through:

- Partnerships between government, community organizations, business and industry, K-12, and higher education
- Strategically invest more money around evidence-based practices: mentoring, research opportunities, and increasing alignment between two-year and four-year institutions

This public policy calls for focused initiatives targeted towards underrepresented STEM students in higher education. This type of focus will require higher education to have an institutional investment in STEM initiatives as opposed to supporting external add-on programming. In addition, by calling for a shared responsibility of funding, institutions are not left to support STEM initiatives on their own. Although the shared responsibility model may require more time, efforts, and work for partnerships, it is the most cost-effective model because it leverages the resources and support of various stakeholders. In addition, it is the most “shared” model that allows for all stakeholders to be actively involved, to collectively gain, and to collaboratively be responsible for the process and outcomes.

Recommendation 2

Support the efforts of the NorthStar STEM Alliance by aligning the first two years of curriculum among all two-year and four-year institutions in Minnesota (that have a NorthStar program) to facilitate the ease of transfer.

This public policy calls for curricular alignment between two-year and four-year institutions. This policy would benefit both underrepresented STEM students as well as maximize the impact on all transfer students across institutions. In addition, it allows for faculty across multiple institutions to collaborate and partner to better support student success through designing a transfer curriculum that best meets the needs of all stakeholders.

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