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Maximizing Accessibility: Providing Summer Engineering Experiences for Racially, Ethnically, and Economically Underrepresented Youth

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Karl Reid is the newly appointed Executive Director of the National Society of Black Engineers (NSBE), a 30,000 plus student-governed association in Alexandria, Virginia whose mission is to increase the number of culturally responsible black engineers who excel academically, succeed professionally and positively impact the community. Dr. Reid comes to NSBE from the United Negro College Fund where he served as senior vice president of research, innovation and member college engagement. Prior to joining UNCF, Dr. Reid was Associate Dean of Undergraduate Education and Director of the Office of Minority Education at the Massachusetts Institute of Technology (MIT). Dr. Reid earned both his Bachelor's and Master's of Science degrees in Materials Science and Engineering from MIT, and his Doctorate of Education from the Harvard Graduate School of Education. His research interests include exploring the relationships between racial identity and self-efficacy, and their influence on the academic achievement of African American males in higher education.

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Dr. Fletcher is currently an Assistant Professor at the University of Arkansas at Pine Bluff (UAPB). Her research focus includes people of color and women in STEM and quality in K-12 and higher education. Prior to UAPB, Dr. Fletcher served as the Senior Manager for the Summer Engineering Experience of Kids (SEEK) program and the Director of Pre-college Programs for NSBE. Additionally, she spent time in industry holding technical and operations-based roles and has experience with outreach projects focused on STEM education and mentoring.

Gregory Meeropol, NSBE

Greg Meeropol is the Senior Director of Programs for the National Society of Black Engineers (NSBE). In this role, he supervises NSBE's pipeline of national programs serving 3rd grade through collegiate students as well as experienced professionals. A seasoned leader and former high school special education teacher, Meeropol reorganized and restructured NSBE's Programs Division to reflect strategic priorities and make better use of resources. Through its programming, NSBE strives to increase the number of black engineers graduating from college each year and to make Engineering a mainstream word in homes and communities of color.

Prior to NSBE, Meeropol served as Assistant Superintendent for Postsecondary & Career Education for the District of Columbia where he led the Tuition Assistance Grant (DC TAG) program and led the development of new initiatives like the College and Credential Completion Network (C3N), designed to share data, best practices and lessons learned across the DC middle and secondary

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Abstract

The drive for broader participation in science, technology, engineering, and mathematics (STEM) has resulted in a growing interest in out-of-school programs that bring enriching educational experiences to children from ethnic and racial groups that are traditionally underrepresented, particularly children from low-income households. Ideally, such programs would have clear strategies for recruiting students from low-income communities, thereby minimizing barriers to participation, such as transportation and cost. Although many local organizations are clear in their purpose, strategies that maximize access have not been widely tested, and effective practices are not always evident. Notably, there are few national-scale outreach programs designed to provide out-of-school engineering experiences for children in low-income communities. In an effort to diverge from this trend, the National Society of Black Engineers (NSBE) has provided engineering experiences to over 20,000 children since 2007 through the Summer Engineering Experience for Kids (SEEK) program, which is hosted in cities across the nation. In providing this magnitude of outreach, SEEK has developed a model for effectively increasing access to high-quality out-of-school engineering learning opportunities for youth in low-income communities. The aim of this paper is to 1) provide a detailed overview of the strategies used by NSBE that increase the likelihood of reaching students from low-income households via SEEK, and 2) examine the challenges in leading large-scale outreach efforts and lessons learned over time.

Introduction

As science, technology, engineering, and mathematics (STEM) fields continue searching for ways to diversify, there is growing interest in programs that bring engineering experiences to children from underrepresented ethnic, racial, and socioeconomic groups. However, a steady stream of federal investment has yet to mitigate one of greatest challenges facing STEM—reaching and engaging people from groups that are traditionally underrepresented (Byars-Winston, 2014; Gonzalez & Kuenzi, 2012; Ntiri, 2001). Because addressing this challenge is contingent upon the early engagement of young and diverse learners (Rohrbaugh & Corces, 2011), there is an urgent need for accessible, often out-of-school, STEM opportunities (Genalo, Bruning, Adams, 2000).

While national interest in attracting underrepresented youth to STEM has amplified, so too has the awareness that effective outreach must address barriers that hinder access for underrepresented populations (Ntiri, 2001). These challenges include, but are not limited to, accessibility of application materials, transportation, and cost for participants (Ntiri, 2001). Although, presumably, those aiming to reach underrepresented youth at a community level (e.g., educators, organizations) incorporate a number of strategies to address issues of access, few organizations have effectively addressed these barriers at a large scale. Consequently, strategies that maximize access have not been widely tested, and effective practices are not well documented.

The purpose of this paper is to provide a detailed overview of strategies used by the National Society of Black Engineers (NSBE) to reach over 20,000 children since 2007 in cities across the nation through its Summer Engineering Experience for Kids (SEEK) program. Additionally, this paper highlights the challenges in doing so and details lessons that NSBE has learned over time.

Because of the notable absence of national outreach programs that provide out-of-school experiences for underrepresented youth populations, we also discuss challenges to growing, developing, and sustaining an outreach program of this scale, including engaging and mobilizing community support in areas that are largely marginalized. Through SEEK, NSBE offers a model for effectively increasing access to high-quality out-of-school learning opportunities for students from low-income households. In the following sections, we outline: (1) how NSBE uses its *SEEK Potential Index* in the selection process for cities for camp locations; (2) how NSBE advertises SEEK and approaches student recruitment; and (3) how NSBE subsequently completes the selection of SEEK campers.

Overview of SEEK

Led by NSBE, SEEK is designed to provide an enjoyable three-week summer engineering experience for students in grades 3-5. During the program, students engage in hands-on activities meant to grow their skills in math, science, critical thinking, and teamwork. Most importantly, camp goers are exposed to activities meant to increase their knowledge and improve their perceptions of engineering as a field and future career option. Though not exclusively for a specific population, SEEK places special emphasis on racially underrepresented and low-income students. Expanding in number of sites each year, SEEK currently operates at 16 sites across the nation, with each site hosting 75-300 students.

Approaches that Address Access

The abundance of outreach endeavors across fields has resulted in countless approaches to addressing barriers to access. When aiming to reach underserved and marginalized communities, approaches to address issues of access are equally as important as the intervention itself. According to Domina (2009), outreach programs tend to adopt one of two strategies: (1) the targeted approach, which provides services to small, selectively chosen groups of students (Groutt, 2003); or (2) the schoolwide approach, which provides services to all students in select schools (Domina, 2009). Ideally, outreach programs adopt the strategy that best serves the community they wish to reach. In NSBE's case, this strategy was a targeted intervention program.

Targeted Intervention Programs

Targeted models are based on the assumption that interventions directed at the target population can alter the educational and career trajectory of participating students (Domina, 2009). This approach has been increasingly popular in STEM disciplines as it allows stakeholders to offer specialized services to increase the presence of underrepresented groups (Valla & Williams, 2012). Additionally, STEM-focused organizations and programs have used targeted approaches to build curriculum, provide skill training opportunities, and engage target audiences in information sessions about the field (Perna & Swail, 2001). Consequently, literature pertaining to the effectiveness of targeted interventions commonly focuses on the impact and outcomes of the aforementioned interventions (i.e., curriculum building, skill training) (Jeffers et al., 2004).

Assessing the impacts and outcomes of targeted interventions may play a pivotal role in understanding and addressing barriers to STEM access; however, focusing solely on these factors may negate the importance of process-level barriers to access. These barriers can present themselves during processes such as selecting site locations, student selection processes, and marketing campaigns. With much of the literature on access focused on programmatic outcomes

and impacts, process-level barriers are commonly overlooked. Because targeted interventions aim to bring services to select populations, further exploring the process-level barriers faced by these populations may have tremendous implications for how we conceptualize and address issues of access in STEM fields.

Conceptual Framework

The concept of access is discussed across health, education, and social science and thus carries different meanings in different contexts. To examine strategies for maximizing accessibility to out-of-school engineering experiences for underrepresented youth populations, we must first examine the ways in which access is conceptualized. A review of the literature shows a number of studies that examine issues of access. However, few of these studies offer explicit frameworks for defining access. Furthermore, as an issue that has conceptual and practical components, no single definition fully captures both the conceptual and practical aspects of access. For this reason, multiple definitions inform our conceptualization of access.

Table 1 - Conceptual frameworks of access across disciplines

Source	Definition	Field
Carlson & Sullivan, 1999	Access is a construct of equality and equity in which a broad range of student populations have the opportunity to reach, participate, and excel in mathematics and pre-engineering experiences	Engineering and Applied Sciences
Clement and Shade, 1999	Access enables activities that are only partially identified beforehand. Access is outlined by three questions: 1.) Access for what purpose(s)? 2.) Access for whom? 3.) Access to what?	Communication Informatics
Levesque, Harris, Russell, 2013	Access is defined by five dimensions of health care services including, approachability, acceptability, availability and accommodation, affordability, and appropriateness.	Health Care

As illustrated in Table 1, access can pertain to a broad range of barriers including social, educational (Carlson & Sullivan, 1999), and limitations to obtaining goods and resources (Levesque, Harris, & Russell, 2013; Clement & Shade, 1999). Informed by the definitions found in the literature, we conceptualize access as a three-stage process. Figure 1 illustrates how components of these definitions are integrated into a multidimensional framework that addresses: (1) an overarching definition of access; (2) the population in need of access; and (3) measures for assessing the degree of access achieved. This integrated framework facilitates a more complete examination of access to engineering outreach programs as it identifies the overarching philosophy informing access as well as practical ways to address identifying populations in need and measuring the effectiveness of outreach interventions.

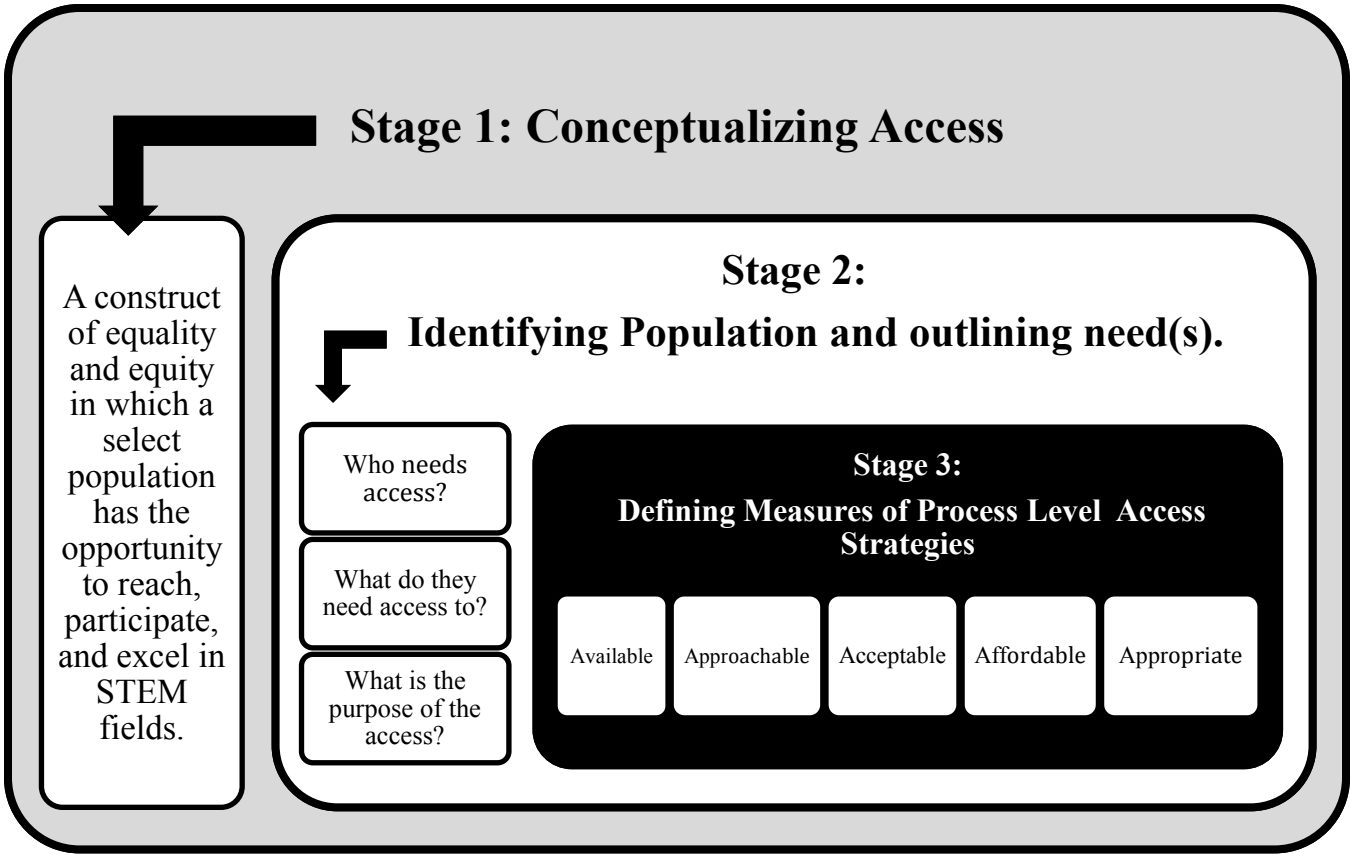

Figure 1 - Integrating Frameworks of Access

Each of these stages reflects aspects of outreach that should be deliberated upon to begin addressing issues of access. During Stage 1, outreach organizers must identify their conception(s) of access. For Stage 2, outreach organizers identify the population for which they aim to provide services. During this stage, they are tasked with identifying the service in which the population of interest needs access to and the purpose for granting access. At times, the conceptualization stage may overlap with stage two as defining access may involve defining the target population and needs of this population. As demonstrated by NSBE, identifying target populations and the experiences for which access is required (i.e., Stage 2) may begin by distinguishing an overarching objective, such as increasing representation of underrepresented communities in STEM fields.

Once Stages 1-2 are addressed, numerous interventions and strategies that can mitigate barriers impacting the overarching objective may be employed (i.e., SEEK, marketing, recruitment, and student selection). Stage 3 outlines five measures of success commonly used in outreach literature (Table 2). Unlike Stages 1 and 2, which most likely occur during the development of outreach programs (i.e., deciding what the outreach program will entail and who it will target), Stage 3 highlights measures of success for ongoing interventions aimed at mitigating barriers to access *throughout* the duration of the outreach program. As a result, Stage 3 is the primary focus of the remainder of this paper and further operationalized in Table 4.

Table 2: Five Key Constructs of Access

	Availability	Approachability	Acceptability	Affordability	Appropriateness
Definitions	The STEM experience is physically accessible and can be reached in a timely manner.	Individuals are aware that STEM programming exists and it will have an impact on participants.	An aspect of access that relates to the sociocultural factors that impact individuals' decisions to take part in STEM experiences.	An individual's economic ability to spend resources and time to engage in STEM programs.	The fit between the STEM experience and the students participating.

Outreach Strategies

Mitigating barriers to out-of-school engineering experiences for underrepresented youth requires deliberate strategies for maximizing access. These strategies must address broad barriers as well as those that are unique to the community of interest. Employing a targeted approach to outreach, NSBE must recognize both national and local barriers to provide engineering experiences that are accessible and engaging for their target audience. Central to NSBE's outreach approach is a four-stage strategic plan, including: (1) city identification, (2) school/site identification, (3) advertisement and marketing, and (4) selection and enrollment. While many of these strategies are common among outreach programs, increasing access requires an additional layer of planning in which stakeholders must not only identify what approaches to implement, but also how best to implement them based upon the target population. In the following sections, we will provide an overview of each stage and discuss issues of access that have presented themselves over time.

Stage 1: City Identification

For NSBE, addressing barriers begins with identifying cities for SEEK camp placements. NSBE's city identification process attempts to maximize access by offering the camp in locations where the target population likely resides. As one of the more noteworthy of NSBE's four steps to outreach, the SEEK index guides the identification of potential cities to host a SEEK camp. The SEEK index, developed internally by NSBE, scores potential cities based on six key factors, each of which is weighted differently:

1. Income - Magnitude of income inequality compared to the median income. The Gini coefficient (a statistical measure of income and wealth distribution within a nation) is used to identify this factor.
2. African American Population - Percent of total African American population within city.
3. NSBE Infrastructure - Number of active NSBE chapters within 50 miles of the city.
4. STEM City Ranking - The city's ranking based on STEM presence in the city.
5. Adult College Completion Rates - Percent of adults with college degrees
6. Free and Reduced Lunch Qualifiers - Percent of students who receive free or reduced lunch.

NSBE uses the SEEK index to identify and select cities where new camps will be developed to maintain their objective of reaching racially underrepresented youth in low-income communities. NSBE developed the index in response to disproportionately high numbers of SEEK camp enrollees coming from middle class households—a problem that NSBE attributed to the geographical location of the camps. Attempting to create a more balanced system for selecting

sites, NSBE leveraged their expertise to develop a system that would reveal the extent to which a city reflected the target population of SEEK. Currently, SEEK has 16 camp sites with plans to extend to 3 more cities in 2018. Figure 2 shows current camp locations.

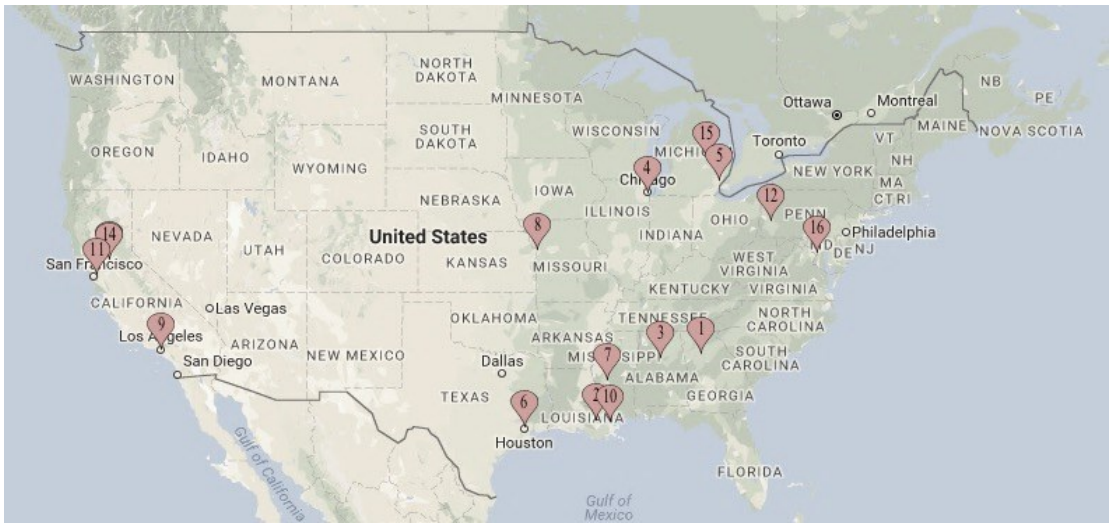

Figure 2- Map of SEEK Camp Locations

While NSBE uses the index as a guide for identifying cities for new camp locations, there are additional factors taken into consideration when selecting cities. For example, some cities have received low SEEK index scores, yet certain communities and populations within that city could still benefit from the presence of a SEEK camp. In these situations, NSBE weighs additional factors, such as community support and demographics of specific communities, and funding to assess the benefits of a camp placement. In addition, some cities have had a SEEK camp prior to the formulation of the SPI and, because of ongoing community investment, have been effectively "grandfathered in."

Stage 2: School/Site Identification

One of the greatest challenges in developing outreach programs is selecting the appropriate site location (Petitpa, Cornelius, Roalte, & Jones, 2005). In addition to providing a reachable location for participants, locating the appropriate site requires selecting sites where community partnerships can be developed (Petitpa et al., 2005). These partnerships can provide more insight into specific barriers impacting the target communities within the area, better enabling NSBE to address them.

Acknowledging the importance of community support and local champions, NSBE's key strategy for selecting camp sites is finding schools with leadership willing to engage in partnerships with SEEK. For example, in Houston, NSBE has developed community support from local businesses, schools, and organizations, resulting in a high level of parental involvement and student retention as well as recruiting mentors from local colleges and universities. This is a type of partnership NSBE aspires to achieve at all camp sites. Beyond the purpose of sharing or leveraging resources, partnerships are also about sharing philosophies that enable students to excel in the outreach program and beyond. Essentially, NSBE aims to find partners that are enthusiastic about collectively building a positive culture that potentially persist beyond the summer engagement to year-round support of STEM initiatives. To effectively gauge the likelihood of co-constructing a

unified culture and philosophy for students, principals and teachers at each potential site are interviewed by NSBE's senior director.

Stage 3: Advertisement and Marketing

Advertisement and marketing are vital to recruiting youth from target populations (Pfiel, 2005). Parents' and students' initial perceptions of programs may be determined by the initial marketing materials to which they are exposed. Ranging from radio advertisements to social media campaigns, NSBE uses multiple approaches to market SEEK. Although NSBE's approach may not be unique, their marketing and advertising is designed to leverage partnerships with schools to provide information that can connect the program with parents. NSBE's core strategy is to inform and recruit parents, as they are key contributors in helping build the SEEK community.

Regarding accessibility, NSBE's approach to advertisement and marketing does not fully encompass the principles of target population identification as it is outlined in our framework. Although NSBE's approach would most likely reach the target population, their marketing technique casts a wide net that extends beyond the target population. Furthermore, internet-based marketing strategies may give students and parents outside of the target population an advantage in accessing the camp. However, additional stages of outreach such as student selection aid in balancing the shortcomings that may result from NSBE's marketing approach.

Stage 4: Selection

Lastly, employing a selection process that screens participants in an equitable way is critical. If interest in a program exceeds capacity, this is an important step in ensuring that populations best served by engineering outreach programs gain access to these programs. Additionally, having a clear and detailed selection criterion provides a measurable way in which organizations can evaluate their selection process. Learning from past experiences, NSBE has reworked their selection criteria to develop a system that increases equitable and measurable methods.

Table 3: Racial Demographic Summary

Race	Number of Students	Percent of SEEK Camp Goers
American Indian or Alaska Native	3	0.13 %
Asian	37	1.63 %
Black or African American	1870	82.20 %
Hispanic or Latino	148	6.51 %
Multiracial (with African-American)	122	5.36 %
Multiracial (without African-American)	12	0.53 %
Native Hawaiian or Other Pacific Islander	3	0.13 %
Other	41	1.80 %
White	39	1.71 %
Total	2275	100.0 %

Note: Total does not included respondents who did not report racial demographic information. N=2576.

Similarly to the SEEK index, SEEK's student selection process has changed over the years to increase enrollment of students from low-income households. Initially, student selection was based on a first come, first serve basis. Though the absence of explicit selection criteria may initially appear equitable, it poses a significant barrier for students from low-income communities when viewed from an access lens: students from middle to upper middle-income households are more likely to enroll first because of greater internet access or the speed at which their parents would become aware of the opportunity. To better reach students from low-income households, however, NSBE adjusted the selection criteria, prioritizing students determined to be most likely to benefit from the SEEK experience in instances where interest in the program exceeded capacity, which was not always the case. When necessary, this need is determined based on the following factors: household income, gender, age and grade, zip code, previous SEEK participation, sibling participation, and membership with a NSBE partner organization. Table 3 summarizes the final demographic breakdown of SEEK applicants in 2017.

Additional Strategies

The abovementioned outreach strategies are crucial tactics employed by NSBE to achieve the objectives of their outreach program SEEK. However, they are not the only strategies utilized by NSBE to increase access. Other tactics employed by NSBE that could easily be translated to other STEM outreach endeavors are: (1) staffing programs with young African American mentors, (2) offering programs free of charge, (3) maintaining a continual presence within the community of interest, (4) and developing culturally- and grade-appropriate curriculum and assessments. Strategies similar to these should also be considered when addressing access.

Table 4: Summary of NSBE's Key Strategies

<table>
<tr><th></th><th>Availability</th><th>Approachability</th><th>Acceptability</th><th>Affordability</th><th>Appropriateness</th></tr>
<tr><td>Definitions</td><td>The STEM experience is physically accessible and can be reached in a timely manner.</td><td>Individuals can identify some type of STEM programming exist, the program can be reached, and will have an impact on participants.</td><td>An aspect of access that relates to the sociocultural factors that impact individuals' decisions to take part in STEM experiences.</td><td>An individual's economic ability to spend resources and time to engaging in STEM programs.</td><td>The fit between the STEM experience and the students participating.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td rowspan="5">Key Strategies</td><td>Utilizing SEEK index to select appropriate cities</td><td>NSBE's continual presence/returning subsequent summers</td><td>Recruiting and employing racially similar mentors</td><td rowspan="5">Offering SEEK free of charge.</td><td>Culturally appropriate curricula</td></tr>
<tr><td>Partnering with local champions to identifying camp site locations</td><td>Internet and paper-based marketing strategies.</td><td>Prioritizing applicants who are siblings of camp-goers</td><td>Grade appropriate curriculum and assessment</td></tr>
<tr><td colspan="2">Internet and paper-based application strategies</td><td rowspan="2">Student selection process</td><td rowspan="2">Mentors from STEM, education, and social science fields.</td></tr>
<tr><td></td><td>Engaging parents in SEEK related activities</td></tr>
</table>

Impact of NSBE's Outreach Strategies & Future Work

As a result of the strategies outlined above (summarized in Table 4), NSBE has begun addressing many of the barriers impacting access to engineering experiences for underrepresented youth. However, the reduction of barriers is ongoing and there is much room for continued growth. There is also a need to account for cost-of-living variations, which is not currently built into the assessment process, and evaluate the impact of these strategies across SEEK sites.

As illustrated by the distribution of reported household incomes during SEEK's last cycle, family income (Table 5) was fairly evenly dispersed among the six categories in which income was indexed, and a majority of the students whose parents/guardians reported their family income came from households where the income was $50,000 or less. However, in some instances this distribution was more skewed. For example, a majority of the students in Atlanta came from homes where the income was $90,000 or more; whereas in Twin Rivers, Sacramento, a majority of the students came from homes where the reported income was $30,000 or less. These skewed income distributions suggest that even with seemingly successful outreach endeavors, challenges to perfecting outreach strategies will remain.

Table 5 - SEEK Student Income Summary, 2017

	All Camps		Atlanta		Twin Rivers (Sacramento)	
Family Income	**# of Students**	**% of Students**	**# of Students**	**% of Students**	**# of Students**	**% of Students**
Unreported	295	11.45%	17	10.97%	27	30.68%
$0 - 30,000	527	20.46%	13	8.39%	37	42.05%
$30,001 - $50,000	520	20.19%	27	17.42%	12	13.64%
$50,001 - $70,000	364	14.13%	23	14.84%	9	10.23%
$70,001 - $90,000	285	11.06%	21	13.55%	2	2.27%
$90,001+	585	22.71%	54	34.84%	1	1.14%
Total	2576	100%	155	100%	88	100%

Implications

Discussions of large scale engineering out-of-school programs are lacking in STEM and engineering literature. Furthermore, outreach literature across different fields lacks a clear conceptualization of access. Purposed with outlining the outreach strategies of NSBE's national SEEK program, this paper may inform strategies for addressing barriers to out-of-school engineering experiences for underrepresented populations as well as conceptual implications for a more comprehensive framework of access.

Outreach in Engineering

NSBE's SEEK program is currently held in 16 cities, providing services to over 20,000 youth since its inception in 2017. Utilizing a four-stage approach to outreach, SEEK has developed a strategy that addresses barriers to engineering experiences for underrepresented populations. Most notably, SEEK's index and student selection criteria offer a blueprint for programs and organizations that aim to design outreach endeavors addressing process level barriers to access. These two

components of NSBE's outreach strategy highlight the importance of identifying population specific barriers and developing strategies that address those specific barriers.

Conceptualizing Access

The term access carries various meanings across different disciplines. However, a common trend amongst these definitions is that they tend to address a single aspect of access. As demonstrated by NSBE's summer outreach program, SEEK, providing access to engineering experiences is a multifaceted process. This process begins with first conceptualizing what access is for the target population and subsequently devising a plan that addresses process-level barriers such as marketing strategies, site location selection, and student selection. There is no standardized way to address these barriers as they will differ across populations and locations. In spite of this, our conceptualization of access offers a framework that can be applied in different contexts in order to develop strategies for addressing conceptual and practical aspects of access.

Conclusion

The purpose of this paper was to examine NSBE's strategies for ensuring the Summer Engineering Experience for Kids (SEEK) program is accessible. We address how NSBE works to maximize access to engineering experiences for kids in the 16 cities where SEEK camps are held. Although some of the strategies employed by NSBE may be common amongst outreach programs, NSBE's tactics for identifying cities and engaging in multiple levels of community partnerships illustrate the necessity for outreach that acknowledges both national and localized barriers. NSBE's SEEK program offers a viable blueprint for not only scaling up engineering outreach programs, but also for developing outreach strategies that are designed to purposefully address the various issues of access faced by underrepresented youth from low-income communities. Although the strategies implemented by NSBE cannot be adopted by all outreach programs, outlining NSBE's approach may highlight components that go into developing an effective and accessible engineering learning experience for youth from these target communities.

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References

Byars-Winston, A. (2014). Toward a framework for multicultural STEM-focused career interventions. *The Career development quarterly*, *62*(4), 340-357.

Carlson, L. E., & Sullivan, J. F. (1999). Hands-on engineering: Learning by doing in the integrated teaching and learning program. *International Journal of Engineering Education*, *15*(1), 20-31.

Clement, A., & Shade, L. R. (1999). The access rainbow: Conceptualizing universal access to the

information/communications infrastructure. *Community informatics: Enabling communities with information and communications technologies*, 32-51.

Domina, T. (2009). What works in college outreach: Assessing targeted and schoolwide interventions for disadvantaged students. *Educational Evaluation and Policy Analysis*, *31*(2), 127-152.

Genalo, L., Bruning, M., & Adams, B. (2000). Creating AK 12 Engineering Educational Outreach Center.

Gonzalez, H. B., & Kuenzi, J. J. (2012). Science, technology, engineering, and mathematics (STEM) education: A primer. Congressional Research Service, Library of Congress.

Groutt, J. (2003). Milestones of TRIO history, part 1. *Opportunity Outlook*, *21*, 21-27.

Jeffers, A. T., Safferman, A. G., & Safferman, S. I. (2004). Understanding K–12 engineering outreach programs. *Journal of professional issues in engineering education and practice*, *130*(2), 95-108

Levesque, J. F., Harris, M. F., & Russell, G. (2013). Patient-centered access to health care: conceptualizing access at the interface of health systems and populations. *International journal for equity in health*, *12*(1), 18.

Perna, L. W., & Swail, W. S. (2001). Pre-college outreach and early intervention. Thought & Action, 17(1), 99–110.

Petitpas, A. J., Cornelius, A. E., Van Raalte, J. L., & Jones, T. (2005). A framework for planning youth sport programs that foster psychosocial development. *The sport psychologist*, *19*(1), 63-80.

Pfeil, A. B. (2005). *Going places with youth outreach: Smart marketing strategies for your library*. American Library Association.

Ntiri, D. W. (2001). Access to higher education for nontraditional students and minorities in a technology-focused society. *Urban Education*, *36*(1), 129-144.

Rohrbaugh, M. C., & Corces, V. G. (2011). Opening pathways for underrepresented high school students to biomedical research careers: the Emory University RISE program. *Genetics*, *189*(4), 1135-1143.

Valla, J. M., & Williams, W. M. (2012). Increasing achievement and higher-education representation of under-represented groups in science, technology, engineering, and mathematics fields: a review of current K-12 intervention programs. *Journal of women and minorities in science and engineering*, *18*(1).