Board 205: Being Mentored and then Mentoring: A Four-Year Success Story with CISTAR and NSBE SEEK Partnering in an NSF-funded Research Experience and Mentoring (REM) Summer Program

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Being Mentored and then Mentoring: A Four-Year Success Story with CISTAR and NSBE SEEK Partnering in an NSF-funded Research Experience and Mentoring Summer Program

Abstract

In this paper supporting a poster for the ASEE NSF grantee session, CISTAR and NSBE SEEK celebrate four years of successfully partnering in a combined summer Research Experience and Mentoring (REM) program funded, in part, by the National Science Foundation (NSF). The summer REM program begins in the first 6 weeks of summer with participating students receiving a stipend and engaging in the summer research program for the Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR). For their last 4 weeks of summer, REM students receive a stipend and are part of the National Society of Black Engineer's Summer Engineering Experiences for Kids (NSBE SEEK) program.

The rationale for this combined summer program rests on the Identity-Based Motivation literature showing positive outcomes for students who identify more as an engineer and feel a sense of belonging in the field. Further, the design of the REM program aligns with research specifically showing that a diverse, inclusive culture, and a culture that reinforces having altruistic cultural values (i.e., giving back to one's community; valuing social justice; helping others), is motivating, particularly for students from racial/ethnic groups underrepresented in engineering/STEM. It is these commonalities across the two summer experiences that, we argue, are critical to the success of the REM program.

In other papers, the positive outcomes of CISTAR's part of the REM program have been well documented based on external evaluation reports that include a host of pre- and post-surveys and interviews. Similarly, NSBE SEEK's program outcomes have been described in papers, and document the positive outcomes for SEEK kids, mentors, parents, and stakeholders. In this paper, we focus on the success of the partnership by turning the lens only on the REM students–first as CISTAR researchers and then as NSBE SEEK mentors–and capture the synergies across both parts of the REM program.

Overall, the REM program has helped to increase the number of Blacks and other underrepresented groups in engineering. Reflecting the applicant pool, CISTAR has been able to attract a diverse cohort of engineering students (~75% are Black; ~50% are female) who are curious about research, but also want to spend part of their summer "giving back" by mentoring kids. Similarly, the partnership has helped NSBE SEEK offer their SEEK mentors, who are passionate about mentoring kids, an option to spend part of their summer learning research skills that will help them grow professionally. Most importantly, the REM program is a win for participating students who want to have two experiences in one summer that:

(i) grow their engineering identities;
(ii) increase their feelings of inclusion and belonging in engineering; and
(iii) support altruistic cultural values by showing that mentorship and "giving back" is an integral part of being a good engineer.

Coming up on our fifth year, CISTAR and NSBE SEEK are excited to continue this partnership and grow this program to scale. In closing, we hope that reading about this partnership between CISTAR and NSBE SEEK–why and how it has been successful–will inspire and help to propagate similar types of programs in other Centers that share goals of broadening representation and supporting altruistic cultural values in engineering.

Introduction

Beginning in 2019, the National Science Foundation (NSF) Engineering Research Center for Innovative and Strategic Transformation of Alkane Resources, CISTAR, in partnership with the National Society of Black Engineers (NSBE), has offered a Research Experience and Mentoring (REM) Program. This unique 10-week combined summer program offers undergraduate students a summer stipend to engage in cutting-edge energy research under the guidance of mentors in CISTAR labs at Purdue University for the first six weeks of the summer. Students then receive a second stipend to be a mentor at a NSBE Summer Engineering Experience for Kids (SEEK) camp for the final 4-weeks. NSBE SEEK is a summer program for Black and other children from underserved populations in 3rd to 5th grades. As SEEK mentors, the REM students have one week of training, and then engage kids in 3-weeks of hands-on, team-based engineering design projects to inspire and excite the kids about becoming the next generation of engineers and scientists.

Commonalities that Strengthen the Partnership. As CISTAR and NSBE SEEK have the shared goal of increasing representation of Black individuals in engineering, the summer program is formed from the respective missions of both partners. As part of its mission as a NSF Engineering Research Center, CISTAR seeks to increase the number of engineers from underrepresented communities – such as Black Americans – in search of "developing a diversified, well-trained workforce." NSBE SEEK, similarly, works to achieve the NSBE challenge to graduate 10,000 Black engineers annually by 2025. In addition, both CISTAR and NSBE SEEK are designing and implementing programs that (i) help students grow their engineering identities, (ii) increase their feeling of inclusion and belonging in engineering, and (iii) support their altruistic cultural values as part of being a competent, good engineer.

Growing Engineering Identities. Given the historical barriers to entry into engineering and STEM fields for many groups currently underrepresented in engineering, how to increase student identification with engineering and engender a sense of belonging have been key in recruitment, retention, and graduation efforts. The Identity-Based Motivation model uses a culturally attuned framework to positively affect motivation [1]. At the root of the model is that behaviors congruent with one's identities are preferred and motivating, whereas behaviors incongruent are not preferred and viewed as unimportant and meaningless. Moreover, what children and young adults perceive as congruent for them is heavily influenced by what they see and experience. As such, role models (teachers, mentors, peers) who reinforce and share in a given identity make it feel congruent. It can then be more readily adopted as a part of their identity – who they are. This is why having caring, dedicated and multiple mentors, for example, is at the heart of both the CISTAR and NSBE SEEK parts of the REM program and is so critical for changing the demographics of fields such as engineering.

Feeling a Sense of Inclusion and Belonging. Similarly, traditions in a field can make it not as relevant or motivating for some cultures or groups. In a study already a decade old looking at why engineering students leave [2], which is still largely true today, the research shows that "a significant proportion of engineering students leave because the engineering educational system has failed to show them that the engineering endeavor is profoundly human" and "has failed to capture their imagination and fascination and has failed to provide a welcoming atmosphere to

them" (p. 920). Again, both parts of the REM program, their experiences as CISTAR researchers and as NSBE SEEK mentors, is designed to be culturally relevant and to promote inclusion and belonging.

Altruistic Cultural Values. Individuals with altruistic cultural values operate within a framework that prioritizes helping others (e.g., giving back to their communities; solving problems that benefit people; tackling inequity). There is a burgeoning literature on the effectiveness of such altruistic appeals to grow interest and motivate students to achieve [3]. Additionally, there is evidence that when you highlight how your program or research team is working to solve a societal problem, it attracts students from groups that are higher in altruistic cultural values, such as women, Blacks, Native Americans, and Latino/Hispanics [4, 5, 6]. Thus, incorporating programmatic elements that support and inspire students by aligning with their altruistic cultural values is critical.

As we describe more about the CISTAR and NSBE SEEK partnership over time, we will point out these common design elements and show how they contribute to successful program outcomes. In summary, NSBE's grand challenge is "to increase the number of culturally responsible Black engineers who excel academically, succeed professionally and positively impact the community" (https://www.nsbe.org/About-Us-). The CISTAR program echoes these values with its emphasis on creating a diverse, inclusive center and by its focus on altruistic cultural values being at the heart of becoming a competent, good engineer. After describing the timeline of the partnership and giving a sense of how the REM program has adapted to changing circumstances due to COVID, we will elaborate more on how these commonalities were embedded into the REM program design.

Timeline of the Partnership

There was a lot of adapting from the first pilot of the REM program in 2019 to its present form in 2023 (see Figure 1). The original pilot in 2019 had only 3 REM students and 3 REM teachers.

Figure 1: A timeline of the CISTAR – NSBE SEEK partnership.

After the successful pilot in summer of 2019, the next year had COVID shutting down all in-person summer programs. NSBE SEEK was able to pivot to virtual programs in 2020. With university laboratories closed and having predominantly experimental research projects, it took longer for CISTAR to pivot and offer the program virtually. Thus, in the summer of 2020, we decided to support a few of the 2019 REM students to work virtually to create a prototype of a chemistry unit to share with NSBE SEEK.

In 2021, both parts of the REM program – CISTAR and NSBE SEEK -- were virtual. One positive aspect of being virtual is that we were able to offer opportunities to students who may not have been able to attend in person. For example, CISTAR accepted a U.S. student who was on an army base in Japan; NSBE had kids attending virtually from Africa. It was not feasible, however, for CISTAR to try and offer a virtual curriculum to teachers, especially after the year most teachers had. Thus, the REM program moved forward with students and no teachers.

In 2022, due to continuing concerns over children's health with COVID, NSBE SEEK continued with only virtual SEEK camps, whereas universities were fully operational again in the summer of 2022. Thus, the CISTAR part of the REM program was able to be in person. In 2023, CISTAR was in person and NSBE SEEK offered both virtual and in person programs. It was challenging for both staff at CISTAR and at NSBE SEEK to coordinate a common program with so many changes over the years, but it also challenged us to work cohesively together and be more adaptable. As of the writing of this article, we are already working on the Summer 2024 program and, finally, we decided it makes sense to reintroduce teachers back into the REM program.

Heart of the Program

In other papers, the positive outcomes of CISTAR's part of the REM program have been well documented based on external evaluation reports that include a host of pre- and post-surveys; interviews, and behavioral observations [7, 8]. Similarly, NSBE SEEK's program outcomes have been described in papers and document the positive outcomes for SEEK kids, mentors, parents, and other stakeholders [9, 10].

In this paper, we focus on the success of *the partnership* by turning the lens only on the REM students - first as CISTAR researchers and then as NSBE SEEK mentors – and capture the synergies across the two parts of the REM program. It should be noted that typically when talking about the NSBE SEEK program, the focus is on the SEEK kids and their experiences and outcomes, whereas in this paper, our focus is on the experience of the REM students as SEEK mentors. That is, they are now the one who is teaching and mentoring versus being taught and mentored. It is coming "full circle" as one of the students said about this unique experience of a summer where they get to do both: Be mentored as researchers and then be a mentor to kids.

Thus, at the heart of the REM program, and why mentoring is a part of the title of the program, is the important role that mentoring plays in a successful research outcome and in contributing to the development of an engineering identity. Given the evidence on how assigned mentor-mentee pairings occasionally fail, and the importance of having role models from groups important to one's own identities, both CISTAR and NSBE SEEK have multiple, and diverse, mentors for each REM student (see Figure 2).

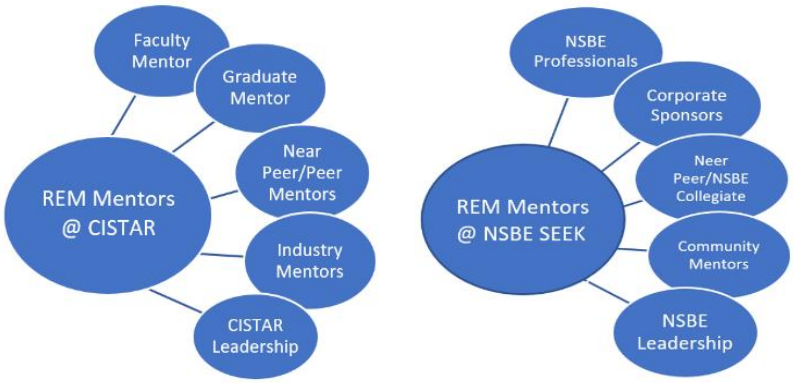

Figure 2: Each part of the REM program has multiple mentors.

Overview of Mentoring in CISTAR. REM students make a commitment to apply themselves to a full-time research project, meet critical program milestones, and participate in a final presentation of a scientific poster (see Figure 3). They are given a summer stipend; further, housing and travel are provided. For those 6-weeks, REM students are professionally mentored by a diverse group of faculty, graduate students, near peers, and center leadership.

All parties adhere to a mentorship model to help the REM students grow into their research and other professional skills, as well as to build their confidence as engineers. The mentors know that for many of these students, and consistent with NSF REM goals, it is often the REM student's first research experience, making it vitally important to nurture their emerging identities as engineering researchers.

Figure 3: CISTAR mentors with their REM mentees by their research posters.

Overview of Mentoring in NSBE SEEK. The REM students serve as SEEK mentors for four weeks and receive a stipend that is the equivalent of what they would receive for an entry-level summer job. They are trained to help NSBE SEEK kids see themselves as future engineers or scientists. Mentors are trained in Week 1 to accomplish this by delivering carefully developed engineering modules that they learn during week 1 of their 4-weeks at a NSBE SEEK camp.

As a mentor to NSBE SEEK kids, the REM students reinforce their own engineering identities and rediscover their excitement as they watch the kids explore the curriculum. Throughout the program, the REM students pick up transferrable skills related to professionalism, public speaking, and leadership. Also, many of the other SEEK mentors were NSBE Jr. members who attended a SEEK camp, or they have been mentors before, which further reinforces their engineering identity.

It is particularly encouraging for kids, and their parents, to see mentors and teachers who are in engineering who 'look like them' in terms of being similar in race and/or gender (see Figure 4).

Figure 4: Having mentors, such as these three REM students, introduce engineering-related projects to SEEK kids, helps these kids imagine themselves as engineering professionals when they grow up.

In SEEK, REM students are exposed to the larger NSBE ecosystem through returning staff, teachers, and industry professionals that reinforce the message of Black engineers as normative and successful. In addition, the REM students have many mentors and opportunities to grow professionally during their time as SEEK mentors. As will be discussed later in the mentoring and learning stage, they interact with other peers who are often engineers, STEM teachers and business professionals, as well as NSBE members, all of whom mentor the REM students in the course of engaging with the SEEK kids.

In-depth Program Descriptions

Each of the two parts of the REM program involve: 1. an initial onboarding and training stage, 2. a mentoring and learning stage, and 3. a final culminating and continuing engagement stage. Below these stages are described along with important programmatic features designed to grow engineering identities, increase feelings of inclusion and belonging in engineering, and support altruistic cultural values.

1. **Initial Onboarding and Training Stage**

CISTAR. The REM students meet one another and their graduate mentors prior to the start of the program in a virtual orientation meeting where program goals and their 6-week schedule are outlined. When they arrive, we have an orientation and celebratory lunch gathering with all their academic mentors; in 2023, our NSBE SEEK partners visited Purdue University to meet each REM students and to explain their second part of the summer at NSBE SEEK (see Figure 5).

Figure 5: NSBE SEEK Leaders Thomas Harris and Shernari Council (standing) come to visit CISTAR at Purdue University on Day 1 to greet the 2023 cohort of REM students.

This initial meeting is followed a few days later by a Diversity and Culture of Inclusion interactive talk that lays out CISTAR's goals about broadening representation – why we care and how we are achieving it – as well as what we mean by our center striving for an inclusive culture and why it is *everyone's responsibility*.

Each of the REM research projects is tied to the center wide theme of *Energy for our Growing World: How a wide range of energy sources serve the needs of people, and how we balance those needs against the impact these energy source differentially have on communities.* This common theme appeals to altruistic cultural values and helps the REM students better understand how all of their different research projects are contributing toward a more sustainable and equitable energy future. We further taught the REM studenets via an Energy Justice workshop about the new tool mapping disadvantaged communities (DACs), as well as the Department of Energy's priorities for the energy sector (e.g., increase energy democracy, decrease energy burden in DACs). Post-program assessments of the value of the theme and equity workshop were well-received by the REM students.

NSBE SEEK. The initial training process for SEEK mentors introduces staff to the goals and mission of NSBE while establishing their place as problem-solvers within the NSBE ecosystem. The NSBE SEEK mentors, including our REM students, are educated by the SEEK staff about the importance of racial identity and the disparities and prejudice that exist in the engineering space. Next, we stress the importance of having a strong STEM background from a young age and how the SEEK program enables young SEEK students to see themselves as future engineers (https://gems.education.purdue.edu/wp-content/uploads/2019/02/STEM_in_Schools_v1-2.pdf).

The SEEK mentors are from a wide variety of educational backgrounds, both HBCUs and PWIs, as well as from diverse ethnic backgrounds. They are encouraged to share their experiences and work together to build their classroom culture, customize lesson plans, and make the 3-week program tailored to the SEEK students in their classes (see Figure 6).

In addition, each of the teaching modules have a social justice component that challenges the SEEK students to imagine ways they can solve problems in their community through technologies like drones, coding, and robotics. SEEK Engineering Design Challenges incorporate elements of social justice by allowing the SEEK students to reimagine these engineering kits on drones, coding, and robotics as vehicles of change and means of problem-solving. Throughout, SEEK mentors ask the SEEK students to think of issues or problems facing their communities and then help the students apply their newfound knowledge and imagination to tackle these challenges and present real-world solutions.

Figure 6: NSBE SEEK students watch what their NSBE SEEK mentor is building in preparation for doing it themselves next.

For example, SEEK students have used drones to address package delivery theft, and have thought to use the robots that they code to help complete tasks such as medicine delivery to the elderly. Additionally, the SEEK mentors provide the SEEK students with background on important historical figures within specific branches of engineering to inspire them and build their engineering identity.

During the training, there may also be opportunities for REM students to connect with the broader NSBE ecosystem (i.e. Professional members, Corporate Sponsors or Community Partners). By sharing all this information, we establish during the training week the NSBE vision in which "Engineering is a mainstream word in homes and communities of color; All black students can envision themselves as engineers; Blacks exceed parity in entering engineering fields, earning degrees and succeeding professionally." Lastly, we share a high-level impact report that speaks to SEEK's longstanding history of having impacted thousands of students and mentors since 2007, which gives the SEEK mentors a better understanding of the desired end outcomes.

2. Mentoring and Learning Stage

CISTAR. In addition to having an academic faculty and graduate student(s) mentoring the REM students on their research project, CISTAR leverages two Purdue engineering programs that introduce students to research: Summer Undergraduate Research Fellowship program (https://engineering.purdue.edu/Engr/Research/EURO/students/about-SURF) and the Pathways Scholar program (how a graduate degree can prepare you for different career pathways). Thus, the REM students are part of a wider research program with other undergraduates from across the U.S. and from different countries. CISTAR hires, as well, several near peers who are engineering graduate students to help the REM students be successful in their research projects. This near peer also helps build a cohort that has fun together, often including in social activities CISTAR's 10-week Research Experience for Undergraduate (REU) program participants.

What is also attractive to students is that CISTAR has as part of their summer programs an *Industry Energy Program* that includes (i) industry weekly mentoring sessions, (ii) industry talks that are interactive, and (iii) field trips to different industry energy sites (i.e., solar, nuclear, wind, oil and gas) where professionals talk about various sources of energy and/or about their company. This broad spectrum of mentoring is designed to inspire and include the REM students in the program and wider field of engineering, as well as specifically grow their interest in the energy field.

NSBE SEEK. As engineering/science students, many of the first-time REM mentors have minimal experience outside their respective fields, especially when it comes to a lot of the skills required to manage a class of grade 3-5 students. Our Site Directors (SDs) are teaching professionals, or veteran SEEK mentors, who serve as their primary mentors. The SDs oversee daily operations, assist with training, and facilitate the flow of the programs to ensure SEEK mentors can effectively impact their SEEK students. In particular, SDs host daily debriefs to ensure that SEEK mentors can confidently serve their SEEK students through class management, conflict resolution, communication, facilitation strategies, and other skills.

The SEEK program has tried to build a culture of support and intentionality for all its participants, which is seen in the personal relationships this program develops and sustains (see Figure 7). During the program, SEEK mentors can connect with program stakeholders, such as corporate sponsors, community members, or NSBE members, who all very much want to see them succeed. Our diverse corporate sponsors frequently belong to Employee Resource Groups in large companies. They can reflect and give insight to the SEEK mentors on their professional experiences and help shape their engineering identity.

Figure 7: The comradery between the SEEK students and their SEEK mentor is evident.

Additionally, community members, such as the principals and parents, connect with SEEK mentors and offer their support. Although the main focus, once again, is on NSBE SEEK kids and mentoring them, the benefits to the SEEK mentors, our REM students, is invaluable and long-lasting as they become more involved in the NSBE organization and meet more of its leadership, staff, and members. In this way, too, NSBE SEEK strengthens REM students' engineering identities.

3. Final Culminating and Continuing Engagement Stage

CISTAR. As part of the CISTAR REM's culminating event, there is a poster session and celebration attended by CISTAR faculty, graduate students, and staff, as well as invited guests interested in their research topics. Certificates are presented to each REM student. Throughout the summer, the students are given contact information by their academic and industry mentors and invited to stay in touch.

As part of CISTAR receiving an NSF grant, the REM students and their graduate student mentors are invited to attend a two-day Emerging Researcher's National Conference in Washington D.C. REM students gained critical skills with: (1) talks about the experience of being underrepresented in STEM by a host of successful academics and businesspeople, (2) professional development workshops (e.g., communication, preparing for graduate school) and 3) career pathway learning opportunities. Students were thrilled to present their research projects to academics, peers (~1,000, >80% UR), industry professionals, as well as individuals representing non-profits and government agencies (see Figure 8). The cohorts of REM students and their mentors attending the conference enjoyed re-affirming their friendships in person after only communicating virtually the last six months, as well as meeting others from similar types of programs who came to Washington D.C. from all across the country. These experiences are well known from research to support feelings of belonging and identifying as an engineer.

Figure 8: In addition to students presenting their research and winning awards at the ERN conference, they also took a night tour of the Washington D.C. monuments, including the Martin Luther King, Jr. Monument with its haunting quote: "Out of the Mountain of Despair, A Stone of Hope."

NSBE SEEK. The SEEK mentors are busy wrapping up challenges and reflecting on the learning process in the final few days. They reflect on their accomplishments in making a difference with the NSBE SEEK students and the positive influence these young students had on their lives and future career paths. The NSBE mentors realize not only the positive impact they have had on the kids and their communities, but also, they report having grown to appreciate the expanded network of Black business professionals and peers in engineering/STEM that they have gained through their NSBE SEEK experience.

While the focus of the NSBE SEEK program is largely concerned with how to keep in touch with the NSBE SEEK students, many of whom will return to participate in the camp the following summer, we've had several of the SEEK mentors already saying that they will return as mentors or leaders next year (see Figure 9)! At the end of the 4-weeks, too, there are several SEEK staff/mentor appreciation events. Each site director holds a fun event to send off, celebrate, and thank everyone; often the parents or corporate sponsors throw a party, as well. As with the above CISTAR culminating experience, all of these NSBE SEEK culminating experiences serve to reinforce the REM students' sense of belonging and identifying as an engineer, as well as support their altruistic cultural values, which is why many of them choose the REM program in the first place.

Figure 9: NSBE mentors get to know each other well, and many come back the following summer.

Success of the Partnership

Each year, we hear back from our evaluators that the REM students enjoyed the combined summer program – doing research at CISTAR and then mentoring kids at NSBE SEEK. For

many, it was a transformative experience; as one REM student said, "It was an opportunity to see engineering from both sides – research and education." There are several reports that already document these outcomes for CISTAR and NSBE SEEK, separately [6, 7, 8, 9, 10]. What we are trying to capture in this paper are the reasons that combining these two parts into one combined summer program makes a lot of sense and has consistently led to such positive outcomes for the REM students. Below we reiterate a few of the more important benefits.

Benefits of a Combined Program. While traditional summer research programs are for ten weeks, the CISTAR research experience is only for six weeks. This is particularly helpful for broadening representation in engineering as students from institutions where they may not have research opportunities can learn those skills. Importantly, too, students can learn whether research interests them; if they dislike it (which to find out early is already a benefit), then it is only for 6-weeks, and they still will have learned a lot, grown their network with industry professionals, and have NSBE SEEK to look forward to for the rest of the summer.

Similarly, a lot of summer experiences for undergraduates – summer camps and internships – are for the entire summer. NSBE SEEK provides flexibility, allowing REM students to be SEEK mentors for one of their last summer 4-week sessions so that the REM students can first have a research experience. This is a good opportunity, too, for SEEK mentors who haven't yet had a research opportunity.

Also, we know from former REM students that if they like the SEEK program, they will certainly return for a second summer, which benefits NSBE SEEK, as well. Overall, the REM students are overwhelmingly pleased to be able to follow their passion for teaching kids about engineering/STEM, while at the same time figuring out if they like research and are interested in energy research, specifically.

Broadening Representation of Blacks in Engineering. The common goal of broadening representation of Blacks in engineering is part of the mission of NSF ERCs, like CISTAR, and, of course, is a central part of NSBE's mission. CISTAR is but one partnership among many organizations and institutions across the country that partner with NSBE and NSBE SEEK, but it is through these partnerships that you can make a difference, one cohort of students at a time.

What we have achieved across four summers, and four cohorts, is 38 REM students successfully completing our combined summer program, the majority of whom are now interested in possibly going into a career in the energy field. Reflecting our applicant pool, ~ 75% of these students are Black, ~10% from other underrepresented racial/ethnic groups, and ~50% are female. During this period, too, we estimate that if each REM student had an impact on ~20 SEEK kids at in-person SEEK camps, and ~40 SEEK kids (two sections of 20) in virtual SEEK camps, then a conservative estimate over the four years is that approximately **2,000** 3rd-5th graders in SEEK were impacted by REM students serving as SEEK mentors.

Where are They Now? Given the REM program is designed to be a first research experience, the majority of these REM students are still finishing their undergraduate degrees. As can be seen in Figure 10, it is nice to see how many of these former REM students are spread all across the U.S., showing how wide the reach of the CISTAR and NSBE SEEK partnership has been.

The legend of the figure also shows the types of institutions that the REM students are from; specifically, 24% at HBCUs, 18% at Other MSIs, and 37% at PWIs, 14% now in a PhD program. In addition, 21% of these former REM students have graduated and have an industry job, and several of them are working in companies in the energy sector.

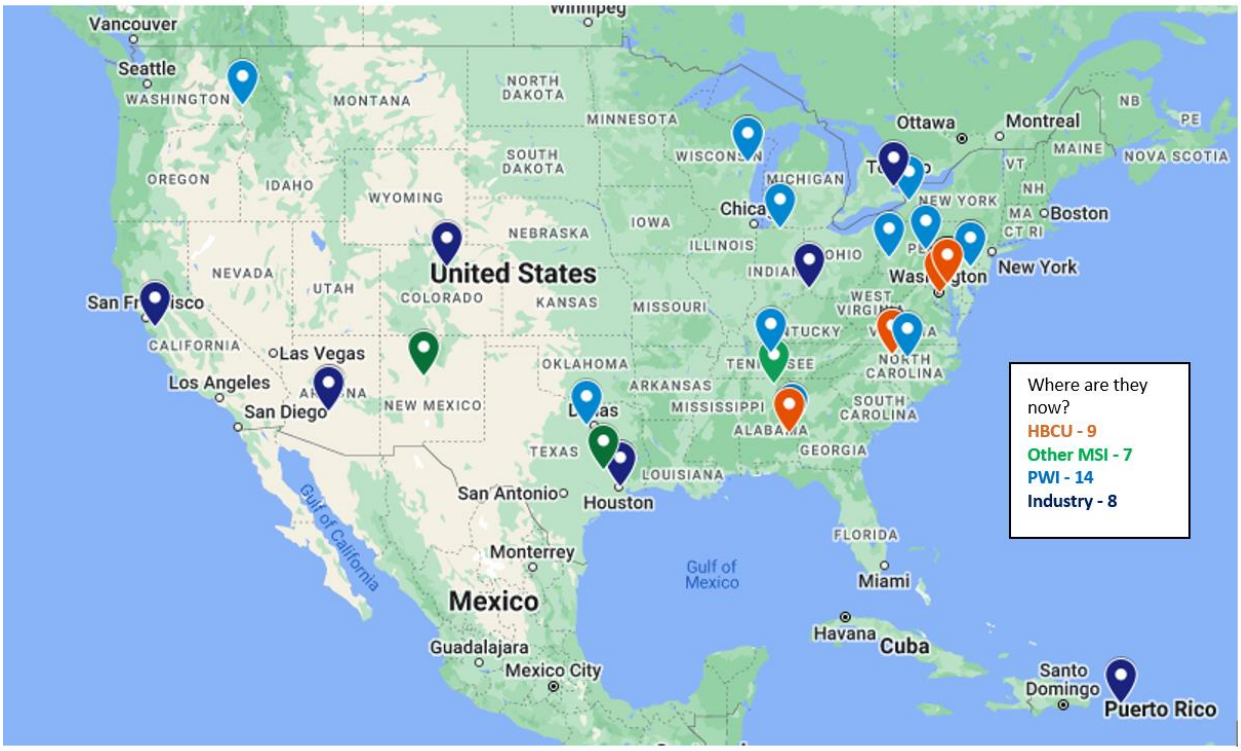

Figure 10: Representing the location of former REM students from across the country from the four years that CISTAR and NSBE SEEK have been partnering; see the legend for the color-coding details.

In a few more years, it will be interesting to see how these former REM students scatter across the country and the universities and companies they end up working for; we can't wait to see how they continue to achieve next as engineering and STEM professionals!

Growing Engineering Identities. As we have described both parts of the REM program, we have shown how fostering and growing the REM students' engineering identities is at the core of what both CISTAR and NSBE SEEK do. Using a multiple mentoring approach that builds skills and proficiencies alongside confidence and a growing, supportive network, the REM students have thrived. Both programs have well established these findings about growing skills and proficiencies and have already documented in other papers and reports the impact of their summer experience.

What is interesting in this paper is thinking about the synergies of our goals and methodologies; about the consensus across the two parts of the summer experience around what the REM students need to further inspire and grow their engineering identities. The emphasis on diversity—the need for representation—and the important role of feeling included and that one belongs, are core parts of what is critical to have alongside the learning of field-specific and technical competencies that are all too often the sole focus of programs and/or program assessments.

Consistent with altruistic cultural values, the REM students are also being reinforced by learning that a social justice and equity framework is valuable when thinking about solving engineering problems. Many of the REM students are motivated to join the program because they want to be role models to the kids and that they care about improving STEM education for kids, especially for those kids living in underserved neighborhoods.

Further, they are even more motivated after their summer experience at SEEK to work to increase the representation of Blacks in engineering. As they go through the program, the different modules reinforce how the social justice framework can help them think more wisely about implementing new technologies to serve the good of the people. CISTAR is similarly working to model caring about engineering means caring to make the world a better place by being better stewards of our energy resources.

Evolution of a Partnership

When forming a partnership, in the early stages, success is simply being able to handle the extra work involved in coordinating programs. As the partnership grows, each part of the partnership becomes more invested in the other partners' successes, goals, and needs. As such, it transforms the partnership from simply coordinating calendars and logistics to better understanding and caring to clarify the higher-level goals and to ensure the message about the value of each part of the program is consistently conveyed to the REM students.

Growing Our Partnership. NSBE SEEK is a program affecting thousands of kids. Mentors and teachers are inspiring a next generation of more diverse engineering/STEM professionals who understand the benefits of both being mentored and mentoring. After all, many of them were NSBE kids or belonged to NSBE Junior, then became NSBE mentors, and now have long-term affiliations with NSBE as professional members or community volunteers. We hope to continue to grow the NSBE community by offering NSBE SEEK camps across the U.S.

In addition, in the spirit of returning to our original 2019 REM model, in 2024 we plan to re-introduce teachers in the REM program. In 2019, we learned of the positive influence the teachers had on the REM students, and vice versa. Having a cohort of teachers and students working together during the 6-week CISTAR part of the program before coming to NSBE SEEK had unique benefits; the REM teachers were, at times, mentoring the REM students, and other times the REM students were mentoring the REM teachers (some who had been away from college and research laboratories for quite a few years).

Further, several of the teachers come from school districts that serve large numbers of Black or African American students. Part of the program outcomes will be for teachers to return to their school to implement an energy learning module in their classrooms based on what they learned. This should have a cascading and positive influence on the students in their classrooms, hopefully encouraging more interest in engineering.

Although the partnership between CISTAR and NSBE SEEK has been mutually beneficial and continues to grow[1], the partnership has gone beyond these benefits because of the shared values we have in creating more socially responsible leaders. Similar to service-learning programs [11], experiences that help students meet the new demands being placed on engineers to not only be technically skilled, but cognizant of the societal impact of new technologies, will be the ones that contribute to a better future for us all. We hope that reading about the CISTAR-NSBE SEEK partnership inspires similar types of programs to develop.

Captured in Testimonials

Testimonials, while not so easy to measure, can cumulatively and powerfully demonstrate the points we have been making about how the REM students are building strong engineering identities, feeling a sense of belonging, and, as one student said, "feel like a part of something bigger than myself that will make the world a better place."

Likewise, when reporting on programs, we often talk about what is self-reported that students learn (leadership skills, research skills), and while that is important, we somewhat neglect measuring the impact of who REM students meet during their summer. As can be seen from describing the programs, the REM students grow in both their professional and personal networks; they now know leaders and administrators of organizations, centers, colleges and universities, teachers, peers and friends also in engineering/STEM, many who will remember them, be open to being contacted, will help them, and even a few who will continue to mentor them through their formative early professional years. As the focus of NSBE SEEK is on the SEEK kids, the events they hold, the volunteers from businesses, universities, neighborhoods, parents, and community centers, all of those interactions that involve engaging the SEEK kids also have a secondary, but positive impact on the REM students as SEEK mentors. What they might not realize until later are the benefits of having had so many mentors and being part of a larger organization such as NSBE.

In conclusion, we would like to let the video testimonials have the last say. CISTAR and NSBE SEEK have worked together to develop videos that capture the enthusiasm of several cohorts of students as they talk about their summer experience. We still enjoy watching the first video that we made together about the 2019 cohort (https://www.youtube.com/watch?v=us0nnQtAsNM), but the one we produced based on the 2023 cohort includes some of the new program elements (https://www.youtube.com/watch?v=2G5L6qL4g0Q). Regardless, across the four cohorts, what remains the same is the student's enthusiasm for the REM program, and how personally and professionally rewarding they report it being.

[1] Currently, the REM program is seeking additional financial support to expand its reach and offer this opportunity to more students and teachers each summer. We are also interested in growing the industry component of both the CISTAR and NSBE SEEK parts of the program. This two-fold expansion presents a unique opportunity for industry partners and private donors to get involved. For those interested in partnering with CISTAR and NSBE SEEK's REM program to shape a more diverse, inclusive, and innovative energy sector, please e-mail us at either cistar@purdue.edu or seek@nsbe.org.

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