2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #39270

Inspiring and Including Diverse Students with an Industry Energy Program Embedded into a Summer Research Experience

Dr. Denise M. Driscoll, Purdue University

Dr. Denise M. Driscoll is currently the Director of Diversity and Inclusion at a National Science Foundation Engineering Research Center called CISTAR (Center for Innovative and Strategic Transformation of Alkane Resources) in Purdue's School of Chemical Engineering and an Adjunct Assistant Professor of Psychological Sciences in Purdue's College of Health and Human Sciences. Her experiences as an academic, diversity consultant, and administrator over the last +30 years has helped her integrate broadening participation and inclusion practices across research, workforce development, and community engagement initiatives.

Maeve Drummond Oakes, Purdue University College of Engineering

Maeve Drummond Oakes is the Associate Director of Education for the NSF Engineering Research Center, CISTAR. She has extensive experience in academic program management at Purdue University, successfully leading programs at undergraduate and graduate education in the School of Civil of Engineering. In Biomedical Engineering she led the creation of new experiential activities for students with industry and through study abroad. As the university coordinator for the Purdue EPICS program she was responsible for the development of a consortium of more than 40 universities, globally. At CISTAR she oversees all of the programming for CISTAR's engineering workforce development pillar.

Inspiring and Including Diverse Students with an Industry Energy Program Embedded into a Summer Research Experience

Introduction and Rationale

This *evidence-based practice* paper focuses on how we added an *Industry Energy Program* to complement a 6-week research experience to inspire engineering and science undergraduate students from predominantly underrepresented backgrounds in STEM and make them feel included in a wider community of not only academic, but industry professionals.

Our findings are based on two cohorts of students participating in an NSF-funded Research Experience and Mentoring (REM) combined summer program in Summer 2021 (a virtual program because of COVID restrictions) and in Summer 2022 (an in-person program). Both cohorts spent their first six weeks doing research with the *Center for Innovative and Strategic Transformation of Alkane Resources* (CISTAR), a National Science Foundation Engineering Research Center, before spending their last four weeks of summer mentoring kids at the National Society for Black Engineers Summer Engineering Experience for Kids (NSBE SEEK) camps.

Our focus in this paper is on the *CISTAR Industry Energy Program* that we added to their six-week research experience, and how it contributed to their professional and personal development. The design of the REM program—to be both inspirational and inclusive for the population of students who apply to be a part of CISTAR's REM program—has been described at length already in an earlier paper [1]. Important to reiterate here, however, is that the 6-week program is specifically designed as a first-research experience (approximately 70% of our participants). Further, the REM student participants over the last two years have reflected our applicant pool as follows: an estimated 80% Black/African American, 10% Hispanic/Latinx, 10% White, 50% female; and one-third of the students are first-generation college. Thus, the students belong to several groups that are underrepresented in STEM fields, as well as underrepresented in the energy sector.

Theory and Rationale for the Program The theory and research considered in designing the wider REM program, where the *Industry Energy Program* is embedded, is based on social identity theory and the innate need for social connectedness rooted in decades of research in social psychology (similar to the belonging literature), as well as research from engineering education on Identity-Based Motivation that has been linked to persistence, career choices, student academic success, and other outcomes [2,3,4]. Further, how their social identity as engineers and scientists is shaped is explained by their understanding of the context they are in (the REM program) and how well they are supported in their identities within the program. For a full consideration of all the concepts considered when designing inclusive programs for predominantly underrepresented students, see the two-factor culture of inclusion model and survey described by Driscoll and Everett, 2022 [5]. In addition to the above literatures informing our program design, we incorporate feedback from our program participants collected by an external evaluator (Everett Evaluations, LLC), which helps us to re-design and improve our program each year.

The rationale for adding an *Industry Energy Program* was discussed after our first REM pilot program in 2019. In interviews by our external evaluators, several REM students reported wanting more interactions with industry. Given that a majority of chemical engineers in the U.S. go into industry after they graduate, we agreed there would be advantages to finding ways for them to interact meaningfully with industry professionals. A recent paper on the advantages of Educational Intensification strengthens the rationale for creating such a program: "*... increasing the interaction*

intensity between industrial practitioners and students better prepares the students for professional careers in many ways, including exposing them to the corporate work environment, teaching them various communication styles, and introducing them to practical technical approaches with commercial components" [6].

A second reason for adding an *Industry Energy Program* is that REM students are typically earlier in the process of exploring their career paths as young engineers and scientists than are students taking part in traditional research experiences. It is purposely designed for those wanting to have a first research experience as a chance to "dip their toe" into exploring whether research is for them, and it only requires them to engage in research for part versus all of their summer. They already had a community of supportive peers along with their faculty, graduate, and near-peer mentors. We also wanted them to build their network with industry professionals to help inform them of their various career path options. Having both academic and industry professionals, together, creates a strong support system for these students in both the short term (during the six weeks) as well as in the longer term, as all industry professionals gave their contact information and invited students to get in touch with them.

Further, an *Industry Energy Program* is their chance to also connect with, and get inspired by, what industry professionals are doing around energy. We had as an overall theme to the REM program *Energy for Our Growing World*: How a wide range of energy sources (renewables, emerging energy technologies—biofuels, solar, nuclear, wind—and fossil fuels and shale) serve the needs of people, and how we balance those needs against the impact these energy sources differentially have on communities and our world. We made sure that all industry professionals understood this theme and would try to integrate it into their interaction with the students. These industry sessions, therefore, provided a general, real-world contrast while students were also doing a deep dive into one specific area to complete a laboratory research project in six weeks.

A third reason, as we discussed in a previous paper [1], is consistent with some general design elements known to inspire and increase inclusion. For example, an *Industry Energy Program* will help deepen the REM student's understanding between theory, research, and application; of how what they learn in class relates to what companies may be doing. For students with more community-minded orientations (i.e., altruistic cultural values), this bigger picture of what is happening in the different energy sectors, and learning about real-world implementation of technologies, may be critical for motivating and retaining their interest [7,8].

Logic for our Assessment

In 2021, the first year we introduced the *Industry Energy Program*, it was entirely virtual due to COVID-restrictions. However, we did have an external evaluator include this new component in our REM logic model to help us keep in mind our goals and evaluate progress made toward the outcomes. The left column of the logic model lists the REM participant activities (see Table 1). Each row identifies the short-term, mid-term, and long-term outcomes related to the activity.

Table 1: Logic Model for REM Participants

REM Participant Activities	Short-term outcomes	Mid-term outcomes	Long-term outcomes
Exposure to industry professionals (through mentoring, tours, and presentations)	Increase knowledge about future career options and the connection between research and community impacts	REM participants understand the interrelationship between research, theory, and real-world applications in industry	REM participants make informed choices about their career/future education. Participants develop professional network and engage past time of program

Three major goals motivate the evaluation work for the program as a whole: (1) to provide formative and summative feedback to the CISTAR leadership team so the program can be developed to meet the participants' needs and refined for future participants, (2) provide evaluation data that can guide the development of future mentoring programs and guide assessment of mentor pair data, and (3) provide information that will help NSF determine the value of these types of experiences, one of which was the industry energy program.

Type of Industry Energy Program

Given the REM program is primarily a research program where they are spending ~30-35 hours a week doing research, often in a laboratory setting, we didn't want to over-tax them with too many non-research demands. Therefore, we had no more than two industry-related events per week. Also, we approached primarily companies who were already members in CISTAR, mostly individuals from large energy companies.

Before we had a conversation with a potential industry member that we wanted to invite, we wrote to them and explained the purpose of our program, the goal of broadening representation, and our desire to create a safe and supportive environment where the students could feel free to ask questions and explore their interests. Once informed, they could get in touch with us, if interested. It was designed by us to be a fairly diverse group of industry professionals with respect to their professional background, work experience, age, gender, race/ethnicity, and nationality. Finally, before the industry professional interacted with the students, we sent them a reminder of our program purpose and goal, as well as sent individuating information about each student (a picture, their university, and hobbies/interests). There were three types of industry interactions: weekly industry mentoring session, interactive talks with industry professionals, and industry tours of energy sites.

Weekly Industry Mentoring Sessions. The REM students had the same industry mentor(s) over time so that they could build a relationship with the mentor(s) and feel comfortable enough to ask questions on any range of topics. These sessions, moreover, were designed such that mentor(s) responded to the interests and needs of the REM students in what we called a "Mr. Roger's" fashion – inviting a friend of theirs to talk with the students for a little while about an interest they expressed (i.e., Engineers Without Borders).

Interactive Talks with Industry Professionals. The purpose was to give the REM students insight into the daily life of an engineer working in the energy sector and hear what they are doing around all the different energy sources (e.g., gas, oil, wind, solar), and how their companies are innovating based upon new research and technological advancements. All of our speakers gave the REM students their contact information and were very open to continued contact with them, thus helping the students grow their industry network.

Industry tours of energy sites. To give the REM students an opportunity to learn about different sources of energy, we wanted to give them a better understanding of different kinds of energy sources. In 2021, the tours were virtual; in 2022, we toured several different energy sites in-person.

2021 Industry Energy Program

Program Design. When COVID restrictions had everyone working from home, we had industry professionals from such companies as Chevron, ExxonMobil, Corteva, Dow, and Shell give virtual interactive talks or virtual tours, as tallied in Table 2.

Table 2: Description of Industry Energy Program

Type of session	# Sessions	Number of Presenters
Mentoring	6	3 sessions had a guest join in
Interactive Talks	6	2 sessions had 2 or more presenters
Tours	2	3 presenters; 6 presenters

Program Findings. Assessment was both formative and summative. Immediately after each session, we had a short evaluation survey. We found that having a QR code added to the speaker's last slide or including the link to the survey in the chat, increased responding. We also sent the students a survey link/QR code after each mentoring session or tour. They were asked to rate the quality of the event and the quality of the presenter on a 1 (awful) to 5 (excellent) scale. For most sessions, the majority of responses were either "good" (4) or "excellent" (5) with an occasional "average" (3). The most valuable information, however, came from asking open-ended comments about 1. What did you like? 2. What did you dislike or would suggest to improve? 3. What was a valuable takeaway? 4. Would you recommend this session? (yes, no, maybe) and 5. Please explain your response (optional). The comments helped us to understand what students learned from each session and how to improve each session.

After their NSBE SEEK experience, half of the 14 REM participants were randomly selected by our external evaluator for a post-program interview. Participants were asked four questions about the *Industry Energy Program* (see Table 3).

Table 3: Summary of Findings on 4 Industry-related Questions

Industry-related Question	# of Yes Responses out of 7	Sample Quote(s)
Did you feel that you had enough points of connection with industry while at CISTAR?	7	*I felt like I had a connection. That was one of the reasons I applied for the program. Most experiences I have had in the past did not have this industrial aspect but were focused on research. I learned that there are multiple things people are doing in industry to reduce carbon emission.*
Did you feel industry representatives were available to mentor and connect with you?	7	*Every one that spoke gave out their email address to answer more questions or have a one-on-one talk. It was something they were all willing to do and they didn't seem to just do it because it was something they were required to do (2 students added that they needed to reach out still).*
Did they give you a better sense of different options for future career plans? If so, what did you learn?	7	*Helped me see if I wanted to work right after school or go to graduate school. I learned I would want to pursue graduate school. I learned this from the industry mentors and graduate mentors.*
Do you think the industry connections you made will be helpful in future? If so, how?	7	*I do believe it will be helpful as I can seek their advice when time goes on about making a change from one job to another or trying to learn about opportunities and also seek their advice in general when it comes to changes academically or career wise.*

In conclusion, students were well-pleased with the *Industry Energy Program* in 2021. If interested in further gauging the effects of the *Industry Energy Program*, students from 2021 were interviewed and some of their responses compiled in a video: https://www.youtube.com/watch?v=mCYDbtRp3GU.

2022 Industry Energy Program

Program design. In 2022, the challenge was to turn the *Industry Energy Program* into a successful hybrid program with in-person tours and as many in-person industry speaker interactions as possible. Unfortunately, it was difficult to schedule in-person interactive talks, so all but one was virtual.

We also added an additional mentor, so there was a total of two. As the mentoring session is weekly and mentors are at companies, these sessions had to remain virtual; however, as research has shown, trust does develop in virtual mentoring relationships; it just takes longer, typically, to form than an in-person mentoring relationship. Reminding students of the need to work on their virtual skills, even

in the absence of COVID because of the many ways they will continue to work and form virtual relationships with people around the world, was a good way to put it in perspective. Further, we encouraged all students to have their cameras on unless there was some unusual reason why they couldn't. We did take note from the near-peer attending these sessions that a lot of discussion topics were covered, as shown in Table 4.

Table 4: Example of Discussion Topics from Mentoring Sessions

Environmental justice	Sustainable materials
MBA after an engineering degree	How to get your first job
Going back to school after an industry job	What is an average week at work
Climate change	How to find your passion
Work life balance	Why get a PhD
Importance of coding	What factored into your job process
Greenhouse gas emissions	How to help with energy problems

We had three in-person tours:

1. Purdue University's Reactor Number One
2. zEDGE Tiny House, a laboratory designed and engineered for testing the energy efficiency of structures on a small scale (see Figure 1)
3. Agronomy Center for Research and Education, where students learned about the integration of photovoltaics and agriculture (see Figure 2)

Figure 1. zero-Energy Design Guidance for Engineers (z-EDGE) tiny house at

Figure 2. REM students learn about the integration of photovoltaics and agriculture at the Agronomy Center for Research and Education

Program Findings. There were five speakers from industry who were rated by the students on the same 1 to 5 scale as before. Again, the percentages of students who rated the quality of the content and the quality of the presenter(s) as "good" (4) or "excellent" (5) was typically in the 90-100% range. We had an additional rating of the speakers on the same scale, and all were rated as "excellent" by students. Thus, students were pleased with all of the speakers. As one student said in an interview with our external evaluator:

"I really like the industry speakers; I enjoyed the diversity of them. Hearing a different perspective that isn't in your lab and hearing about different paths you can take. Also hearing a different point of view with other students in CISTAR and hearing their questions and working through them together has been interesting."

At the end of the 6-weeks, we asked for REM student feedback via a survey about the mentor sessions held for an hour each week. Consensual responses were that the two mentors were engaging and enjoyable and the students appreciated the industry mentors letting the students drive the content/topics to discuss. Examples of two students' comments were as follows:

"I like the continuous meeting to build connection rather than seeing them once and potentially never again. I also liked that they let us shape the topics we would discuss, and they encouraged us to be engaged."

"I just learned so much and it was truly very personalized to me and my needs (and the needs of the cohort) which I loved and appreciated so much."

Also, at the end of summer, our external evaluators reported interviewing 9 of the 10 REM students (one student did not respond to their request for an interview). It was found that:

- 100% of the REM students recommended the mentoring sessions and
- 78% of the REM students felt they would connect with the industry mentors in the future.

The quote our external evaluator reported to demonstrate this favorable response to the mentors was:

"My favorite part of CISTAR's REM program was the industry mentors we had each Friday. I liked the first session we had with them. I liked hearing the diverse ways they got to their jobs. When you think about post-grad, you think there is one way for your path, but that's not everyone's journey."

External evaluators also asked the REM students about the tours. They reported that 88% of the students enjoyed the tours, learned something new, and liked traveling with their fellow students. A reason why students may not have been so happy about the tours was that it was difficult to schedule them around sometimes required laboratory meetings. To illustrate the generally positive response, however, the following quote from one student was included in the evaluator report:

"I enjoyed the tours. Part of it was that they were face-to-face. It's easier to stay engaged when you're looking at the person speaking to you. I learned a lot more. It was cool we were looking at

different types of engineers (nuclear engineering)."

Energy in their future? Although we cannot determine the percentage of students who would have responded positively in the absence of the *Industry Energy Program*, comments made about their future suggest that it was an important part of getting the students excited about working in energy in their future. Our external evaluator concluded following interviews with the REM students: "Almost all of the participants (89% of the student respondents) thought that they would, or might be, working in the energy industry in the future. Most of the students came in with an interest in energy and left more confident in their abilities and more determined to be a part of solving the big energy-related problems facing our growing world." The following quote was given as an example:

"*Students learn how tackling "big problems, "such as transitioning to renewable energy, means working together with people from diverse backgrounds and disciplines to find solutions, and that it helps to have a wide, supportive community of engineers across both industry and academia."*

Several students seemed to better understand the many different career paths that were open to them as a consequence of not only doing research, but also being exposed to industry professionals. For example, one student said in an interview with the external evaluator:

"The program, in a good way, made what I want to do less clear. I wasn't considering research before this, and now I'm considering it more. Research is another avenue in my head. I don't like to plan ahead too much, because I know that plans can get derailed. When I graduate, I will consider research and industry. The program made research an option for me. I found I enjoy it."

Planning the 2023 Industry Energy Program

The Industry Energy Program will remain a hybrid program but, if possible, we will only have the industry mentors being virtual. Seeing the same individuals over the six weeks, and the informal and open nature of these mentoring sessions worked well.

However, while students enjoyed interacting with industry professionals, they really liked the in-person interactive speaker sessions. Thus, we are working to see if there are industry professionals visiting our university during those 6-weeks, and if so, whether they will agree to come and give an interactive talk to the REM students. If not, we will likely have fewer virtual talks and more in-person tours.

In a previous description of this combined experience program [1], we described how these students are more likely to be community-minded and care to have a better understanding of a company's stance and activities relevant to energy justice. Many REM students are passionate about energy sustainability, renewables, and energy justice goals: "achieving equity in social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system." (U.S. DOE). They want to be a part of the energy transition and make the world a better place and so enjoy thinking more complexly about energy justice issues.

With over $62 billion being invested in climate and clean energy in the U.S., we believe it will add value to have an energy justice emphasis to our upcoming 2023 *Industry Energy Program*. We would like students to learn more from industry professionals about what companies are doing with respect to the future of energy, energy justice, and the changing skill sets needed. We will also be inviting a speaker from an advocacy organization (i.e., Energy Efficiency for All; American Association of Blacks in Energy).

Conclusions

Recommendations. Individuals designing summer programs should embed an Industry Program into their summer research programs. Companies are more than willing to connect with undergraduate students by mentoring, talking with, or giving a tour of their company-related sites or laboratories. The only challenge is making sure you include design features, such as we discussed, that lead students to see themselves in future as an industry professional if they choose this career path. In addition, not every well-intentioned industry professional will be inspiring and appreciated by the undergraduate students; thus, including formative evaluation after each event will ensure your program improves over time.

End goals. The outcomes of the *CISTAR Industry Energy Program* from these past two years have been uniformly positive, with the cohorts of REM students reporting back that they learned a lot from, and felt supported by, a wide community of engineers and scientists from the different industry events. This is critical as the majority of the REM students are from groups underrepresented in STEM (African American, first-generation college, and/or women) and we need to continue to make sure that they feel included in a supportive network of not only academic, but industry, mentors and individuals who care about their success. By having a diverse and dynamic group of industry professionals that are available and willing to support and help these REM students succeed in both the short- and long-term, alongside the students' academic mentors who engage them in *Energy for Our Growing World* research projects, it will certainly help to make the field of energy more diverse in the future.