"We Were on the Same Level": Young Engineering Researchers Taking Up Agentive Positions in a Diverse Learning Community

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Abstract: This study reports on the design and enactment of a summer engineering research experience for high school students focused on increasing interest and knowledge and removing barriers to participation and preparedness for underrepresented students through expansive framing of program experiences and opportunities for consequential engagement. A cadre of twelve outgoing eighth-grade students drawn from one Title 1 district learning to participate in photovoltaics engineering research and collaboratively designing a community solar engineering project over a period of six full-days. These Youth Scholars were intentionally embedded within a larger cohort of summer research participants including undergraduates, teachers, and international graduate students. Though all participants were novice in solar energy engineering, all were positioned as both learner and contributor. This design-based research study addressed the question: What were the affordances and constraints of being positioned as a learner and a contributor in a diverse cohort of novice engineering researchers?

Introduction

This study reports on the design and enactment of a model of a summer engineering research experience for high school students focused on increasing interest and knowledge and removing barriers to participation and preparedness for underrepresented students in engineering. Specifically, the project aimed to support a cohort of outgoing eighth-grade students drawn from a Title 1 district with high proportions of Hispanic students, a population historically marginalized in engineering (Gibbons, 2009). Twelve students participated in the program two days a week over three weeks (six full-day sessions), learning to participate in PV engineering and collaboratively designing a community solar engineering project that was the core activity of the program.

By design, and taking a situative approach to fostering learning (Greeno & Engestrom, 2014), these Youth Scholars (YS) were embedded within a larger cohort of summer research participants that included undergraduate students trying to become engineers, local teachers developing learning to do research and create curriculum for their classrooms, older high school students exploring engineering as a possible major, and international graduate students taking on responsibilities in new labs, along with the YS working on their community solar project. Though all these sub-groups had different goals for their program participation, they all shared an interest in solar energy engineering as well as the experience of working on solar energy projects while being mentored by established graduate student-mentors from photovoltaic engineering research labs. The summer research experience participants represent differing levels of professional competence, but each participant must navigate as a learner and a contributor to the cohort and to the field, negotiating meaningful involvement in the PV engineering community while being supported by like and diverse peers and mentors.

For each of these sub-groups, three focal activities organized their program experience: working on their own meaningful projects, receiving feedback from other cohort members, and giving feedback to others. Through these activities, all cohort members, including the YS, were positioned as both learners and contributors, not only as consumers of knowledge, but also as producers of knowledge (Ito et al., 2014) with the moral position, rights and responsibilities, to discursively produce their engineering selves (Davies & Harre, 1990). The purpose of this intentional positioning was to facilitate a support system where participants could draw on the affordances of their own and others' diverse perspectives and backgrounds in order to help one another move forward the consequential work with which they were engaged (Page, 2010). Although many learning scientists investigate the affordances for learning of fostering communities of learners in relatively homogenous groups (e.g., Engle & Conant, 2002), there is little research exploring the possible benefits of fostering learning relationships in such diverse cohorts.

The current study was part of a larger research project investigating the designed-for and emergent patterns of relationships among participants and their influence on trajectories on engineering pathways. Here we focus specifically on the YS sub-cadre of this diverse cohort. Taking a design-based research approach, we examine the meaning the YS made of their participation in the program, particularly of their interactions with their older cohort members, and of their consequential engagement (Gresalfi, Barab, Siyahhan, & Christensen, 2009) in a variety of PV engineering activities. In particular, we were interested in the following research question:

What were the affordances and constraints of being positioned as a learner and a contributor in a diverse cohort of novice engineering researchers?

Membership in a diverse cohort as an innovation to address barriers to engineering

Through a consideration of the complex interaction of factors that often inhibit STEM trajectories, the project components provide a sustained cohort-based network that we anticipate is needed to broaden the participation of underrepresented students in engineering. Despite increasing emphasis on the importance of STEM-related fields by the National Science Foundation and other national organizations, the number of U.S. students pursuing STEM college degrees and careers has declined in recent decades (National Center for Education Statistics, 2015), especially for underrepresented demographic groups who have historically been excluded within STEM, namely, women and minorities (Joyce & Farenga, 2000). These disparities carry over to post-secondary education, where Hispanic students' college entrance SAT math scores and their persistence rates in STEM fall well below that of their White counterparts (Landivar, 2013). Multiple barriers contribute to Hispanic students' underperformance and underrepresentation in STEM domains. Inadequate K-12 academic preparation is a major factor (Museus, Palmer, Davis, & Maramba, 2011). A large proportion of K-12 ethnic minority students are raised in low income areas and do not get exposure in underserved schools to rigorous educational experiences or adequate math and science courses that comprise preparation needed for college STEM degree paths (e.g., Adelman, 2006).

Broadening underrepresented students' participation in engineering requires effective K-12 innovations because many such students self-select out of engineering-related learning opportunities and career trajectories before entering college (Museus et al., 2011). More broadly, the majority of college students who major in STEM fields make that choice during high school. That choice is related to a growing interest in mathematics and science that develops as early as middle school (Maltese & Tai, 2011). Thus, K-12 formal and informal education experiences need to provide equitable opportunities and outcomes in three key ways: increase interest in engineering, promote knowledge in STEM content areas and opportunities for participation in engineering practices, and develop awareness of career pathways to engineering fields (Svihla & Petrosino, 2008). It is critical that learning-teaching designs aimed at broadening participation begin in high school in order to nurture learners' initial interest and support their commitment to pursuing STEM learning and STEM careers.

We argue that current educational approaches to developing historically underrepresented students' interest and preparation in engineering through informal learning experiences are limited in at least three ways. First, most programs consist of one-day workshops (e.g., Molina-Gaudo, Baldassarri, Villarroya, & Cerezo, 2010) or short-term afterschool club experiences (e.g., Nugent, Barker, Grandgenett, & Adamchuk, 2010). Second, current diffuse approaches introduce multiple engineering fields in surface fashion with few opportunities for rigorous preparation or deep, sustained connection to a single field. Finally, programs targeted at demographics that relate to risk or underrepresentation frequently fail to recognize that engineering cultures are characterized by particular ways of doing and "being an engineer" (Godfrey & Parker, 2010, p. 9) that may be at odds with the cultural practices and identities of historically underrepresented learners (Wilson-Lopez, Mejia, Hasbun, & Kasun, 2016). Thus, they fail to consider cultural connections that facilitate meaningful bridge-building. For example, many Hispanic groups are characterized by collectivistic orientation, familism, and an emphasis on community (vs. individual) outcomes (Knight et al., 2009). Accordingly, "helping" professions may provide more salient career pathways for many Hispanic students compared to science and technology. Yet, engineering programs for youth rarely offer experiences that highlight these aspects of students' identities and experiences.

Given the above, there is a need for studies that test sustained educational models aimed at fostering adolescents' interest in engineering and other STEM disciplines, participation in STEM opportunities, and preparedness to pursue engineering career trajectories. Moreover, there is a need to understand the impacts of longer-term, after school education experiences that take a focused approach, promoting deep knowledge through consequential engagement in meaningful projects, and rich social relationships within a single field (e.g., PV), while also creating a culture of support among familiar and like peers. Finally, there is a need to examine the impacts of extending this culture of support and build a community of learners that includes those with a diverse range of backgrounds, experiences, interests, and ages. This type of cohort not only approximates the collective, familial orientation of many of these students, but also positions everyone as a learner, everyone as a contributor.

Designing for consequential engagement in a diverse cohort

Here we explore the affordances and constraints of a summer youth program that attempted to systematically address the aforementioned barriers and limitations by situating incoming high school students in a diverse cohort of summer research participants, widely varying in their age, education level, and goals for the program, yet all with limited prior knowledge of PV, all interested in solar energy engineering, and all consequentially engaged (Gresalfi, Barab, Siyahhan, & Christensen, 2009) with authentic engineering research. Our designed innovation of consequential engagement in PV engineering differs greatly from the broad, exploratory overviews of the engineering field common in other engineering education models, and is designed to foster deeper knowledge of disciplinary core ideas, crosscutting concepts, and engineering practices, skills, and habits of mind as well as to position students to learn and contribute in meaningful ways within a diverse cohort (National Academies Press, 2009). Further, through expansive framing (Engle, 2006), we sought to help students see themselves as connected to the past, present, and future of PV and its impact on broader social and environmental issues. We also framed the students' project and their participation in the summer program in terms of potentially contributing to the field, providing opportunities to engage with their local communities and other engineers, and as products they could share digitally with a much wider audience. It was our belief that integrating this team of young scholars into a diverse cohort of summer engineering researchers would further forward the same goals we were aiming for through consequential engagement and expansive framing, to support engineering identities, which we believe are a discursive production (Davies & Harre, 1990), a joint accomplishment between individuals and their social environments (Hand & Gresalfi, 2015).

Method

Design research begins with the belief that research must attend carefully to the context of learning in order to produce knowledge that can have a positive, and potentially transformative impact (Barab, Dodge, Thomas, Jackson, & Tuzun, 2007). Thus, design researchers attempt to "engineer" learning and teaching processes and systematically studies these processes to iteratively illuminate and refine how a designed educational innovation influences learning and teaching systems (Brown, 1992). Rather than "fixed packages of strategies with readily measurable outcomes," design research tends towards "open-ended social or socially embedded experiments that involve ongoing mutual engagement" (Gutiérrez & Penuel, 2014, p. 20). Such was the stance we took in trying to ascertain the meaning these youth scholars made of their participation in a diverse cohort and the affordances and constraints of being positioned as both learners and contributors. Design-based studies take a variety of methodological turns. Here, we took an ethnographic approach much in the style of learning scientists concerned with fostering STEM pathways for youth (e.g. Calabrese Barton et al., 2013, Rahm & Moore, 2016).

Context and participants

The context of this study was a summer research experience program at an engineering research center embedded in a university in the southwestern US. Within this context, twelve outgoing eighth-grade students (6 boys and 6 girls) participated as Youth Scholars, traveling to the university twice a week for three weeks. These youth scholars had recently completed eighth-grade in one of two middle schools in a large urban district serving a majority Hispanic student population (94% non-Caucasian; 93% low SES, 17% English language learners). The majority of YS participants were Hispanic; half the cadre reported their primary home language as other-than English. Attendance at the six full-day sessions was high (89%). YS participants were recruited based on their demonstrated academic proficiency and interest in STEM. All three authors, one research faculty member, one middle school teacher, and one graduate student, participated as facilitators in the program and also contributed to the program's design.

The central activity of the YS program was designing a community solar energy engineering project. Facilitated by a local middle school science teacher, the YS participants scoped and framed a problem of interest to them: promoting solar energy in their community through a co-op membership model, with energy drawn from a field of solar panels that would simultaneously provide shade structures in five local parks. Participants collected survey data from members of their local community and the PV engineering community, and conducted interviews with PV experts. Their project culminated in a video project sharable with wider audiences. Through these activities, we intentionally sought to recognize and honor strengths these Hispanic adolescents brought to the summer program, including, family, community, peer, and popular culture funds of knowledge (Wilson-Lopez et al., 2016).

The YS program was embedded in a larger summer research cohort that included 11 undergraduate students, 2 older high school students, 3 international graduate students, and 7 local K-12 teachers. These older cohort members worked on 9 different photovoltaics research projects, guided by graduate student mentors for 5 to 9 weeks. Working with engineering program facilitators, we purposefully designed the summer research program to take advantage of the diversity in this larger cohort (Page, 2010), foster a sense of belonging and develop interest and identify that sustain engineering pathways for underrepresented students (Packard, 2015). Thus, we intentionally created participation structures aimed at decreasing potential social hierarchies (e.g., those due to age, experience, SES status) and level the playing field among members. In so doing, we hoped to foster reciprocal relationships among diverse cohort members, thus positioning YS participants as contributing members, consequentially engaged in meaningful work in order to foster these engineering identities. For instance, each project group presented their work in a weekly cohort lab meeting; all participants presented their work-in-program and all were taught to take up audience roles (Herrenkohl & Guerra, 1998) in order to offer helpful peer critique (Dannels, 2005). Other activities that were intentionally designed to jointly position the YS as learners and contributors, and to scaffold their consequential engagement as members of their larger heterogeneous cohort are listed in Table 1.

Table 1: How youth scholars were positioned as learners and contributors across the six-day program*

	Positioned as Learners	Positioned as Contributors
Day 1	-Lunch with undergraduates -began scoping their community solar project, facilitated by teacher	-Audience for teacher lesson ideas -Learned how to collect & record data for teacher research project to prepare for substituting when teachers on a field trip
Day 2	-Lunch talk by PV graduate student on applications of solar	-Lab meeting: presenter & audience roles -Learned how to collect data for teachers' research project
Day 3	-Lunch talk by PV grad on options of solar panels for YS project - Kinesthetic astronomy led by teacher participant	-Learned how to collect & record data for teacher research project
Day 4	-Lunch talk by older high school student on how to find STEM opportunities beyond the program	-Friday Lab meeting: presenter and audience roles -Gave feedback on teachers' lesson pilot test, short feedback training, critique form, paired with teachers 2 to 1 for increased confidence and peer support -Learned how to collect & record data for teacher project
Day 5	-Lunch talk by PV grad student on his project similar to YS project	-Collected and recorded data for teacher research project while teachers were on a field trip
Day 6	-Lunch talk by older high school students about how to succeed as entering freshmen	-Lab meeting: presenter and audience roles -Feedback to undergraduates on writing project, scaffolded by close reading, critique form, and paired 2 to 1 paired with undergrads 2 to 1 for increased confidence and peer support

*At the end of summer, the YS presented their research to PV engineering scholars and solar energy industry leaders, alongside the older cohort members.

Data collection and analysis

This study was part of a larger program of research aimed at interrogating and informing further iterations of the design of the summer research program. Data collection took place throughout implementation of the summer program and across all cohort members who consented to the study. Data sources included daily survey responses, audio-video recordings and ethnographic field notes of cohort members' participation in core activities, semi-structured interviews to elicit participants' perspectives (Bogdan & Biklen, 2007; 20-30 minutes), and participant-generated artifacts (e.g., written feedback, project videos/posters, Google Classroom posts). Initial data analysis progressed along with data collection, as study team members wrote extended memos and met regularly in order to capture independent insights about participants and program activities, and to analyze broad patterns across persons, types of cohort members, and events.

As the current study focused on the meaning YS participants made of their positioning as learners and contributors in the larger cohort, closer analysis focused on YSs' survey responses and transcribed interviews, and data logs of video recordings related to networking activities with the larger cohort. Data from other cohort members were used as secondary sources. All three members of the research team iteratively examined data individually and met for collective work sessions to interpret the meaning these youth scholars made of their experience in this diverse cohort. The team met frequently (and as soon as possible after core events) to compare field notes and negotiate interpretations of observational and interview data, to analyze and interpret survey data, and to synthesize our understandings relative to project goals. Using constant comparative methods, we sought to determine patterns across data sources through multiple iterations of examination (Corbin & Strauss, 2014). Using interactional analysis (Jordan & Henderson, 1995), we identified participation structures and patterns of activity among diverse participants, paying particular attention to how activities for expansively framed (or not) and to how YS participants were positioned relative to their older cohort members and to PV engineering. We tried to follow the means and consequences (affordances and constraints) of social actions through multiple rounds of listening and viewing audio-video recordings in which YS were engaged with their older cohort members, coupled with examination of relevant artifacts. Our interpretations of the meanings that youth participants made of these social actions were informed largely through content analyses of their pre and post program interviews.

Findings

Through our analytic process, we surmised that the young engineering researchers in this study made much meaning of their experience in this diverse cohort in which they, along with all members, were positioned as learners and contributors, all consequentially engaging in important engineering work. Specifically, we surmised that these scholars came to understand that there is important work to be done in PV engineering, I am capable of contributing to that work, and we are all in this together. Furthermore, due to the expansive framing of time and participation (Engle, 2006) intentionally designed into this program, the youth participants came to see the program simply as a vehicle for the diverse members of the summer cohort to do their work, work that will continue past the program. These insights were generated through the confluence of three themes that emerged through analysis: authentic membership, difficulty in giving feedback, and developing engineering identities by consequentially engaging in real, high stakes work, using PV engineering processes and concepts to achieve meaningful goals.

On the same level: Authentic membership

The YS in this study revealed through their participation, interviews, and reflections, that they saw themselves as legitimate members of this diverse cohort where all participants were explicitly positioned by the program as learners and contributors. This was especially apparent in an interview segment in which Ryan shared her experience giving feedback to a teacher, demonstrating how it had given her a new positionality relative to teachers:

> It was like, they weren't doing the whole superiority complex. I know - it's not exactly that, you need control in a classroom. But it was like we were on the same level – because we <u>were</u>! We were learning about the same thing. So, it was pretty cool.

Another YS, Mikki, related her first experience with one of the teachers in the program, saying, "He helped me…At first, he introduced himself to me…when we did the research or data collection… he made me feel more confident about being here…he was one of my favorite people here."

Analysis also indicated that being positioned as sources of critique and feedback, thereby contributing to the adult cohort members' learning, was particularly meaningful to these young scholars. Many responded in surveys that providing feedback to the teachers' instructional plans and the undergraduates' writing projects was their favorite activity on the days that these activities occurred. Audio-video analysis indicated that the students were meaningfully engaged in these activities. Not only did video show students participating in the teachers' lessons and attending to instruction, positioned in the traditional learner role, but also giving suggestions, positioning themselves in the contributor role as well. For example, a teacher demonstrated his model for a solar powered drone, and then asked what the students thought. One student responded that it would be even better if the drone could be steered in some way, and then posited a possible design for a steering mechanism. The teacher, intrigued by the idea, positioned himself as a learner to discover more about the student's ideas. Throughout the remainder of the interaction, the student and teacher flexibly moved between learner and contributor roles, focusing on the goal of improving the lesson in general and design of the drone specifically.

Further, through analysis of interviews, we garnered deeper insights about how these young learners saw themselves as potentially re-positioned relative to their prior positioning to teachers. Ryan connected her experience to one she might have with a peer her own age:

> They did a lot of stuff that was easy to understand because they're used to talking to less [knowledgeable] kids…. But at the same time, it was like talking to a peer about wearing the wrong clothes or something. So it was pretty awesome.

In this example, Ryan felt that, while the teachers did well presenting their lessons and making them comprehensible, as they were used to talking to students, there were things about the lessons that did need to be critiqued. This had the potential to be awkward, and generally would not be something she mentioned to a teacher. However, because of her positioning and being "on the same level" as the teachers, she felt it her duty to point it out, as she would for a peer she felt was in need of her help. It was this re-positioning that she found "pretty awesome." This was even more evident in another part of her interview. She talked about how she wanted to help the teachers improve their lessons, as she recognized that they actually would be implemented with the students in these teachers' classes. Ryan's view extended past this task as just an assignment for the program, to the expansive and consequential implications of her work. Mikki shared a similar perspective, "It felt cool. I liked being heard... I liked how they asked my opinion in it. I liked how they were like, 'Okay let's ask for a student's perspective, not just our own.'" Through being positioned as a contributor and her growing engineering identity, as well as her established identity as a student, Mikki felt confident that she had something important to say and to contribute to the teachers' work that would be of worth. She noted the difference in this program, where the teachers did not just rely on their own opinion or the opinion of the other teachers, from other learning environments in which she more frequently participated. Being "on the same level" as the other cohort members allowed her to actually "[be] heard."

Level with me: Difficulty in giving feedback

The youth scholars' positioning as contributors of feedback in this diverse cohort was not without its challenges, however. As Linehan and McCarthy (2000) explained, in relation to the positioning of students and teachers, "both students and teachers have a degree of agency in how they position themselves in interactions, but this agency is interlaced with the expectations and history of the community, the sense of 'oughtness'" (p. 442). Anticipating students' possible difficulties with going against this sense of "oughtness" when giving feedback to those who, in situations outside the program, were generally positioned authority figures, we paired up the youth scholars for these feedback activities. Still, in addition to sharing their positive experiences as peer critiquers for the teachers and undergraduates in their cohort, many YS also reported the difficulties. Mikki described it as "hard" and Ryan noted, as mentioned previously, that it could be awkward, "like talking to a peer about wearing the wrong clothes or something." This seemed to be especially true of the process of reviewing the undergraduates' writing project, and then meeting with them to give feedback. In the audio recording of the Ryan, Mikki, and Jaxon's meeting to give feedback to an undergraduate on her online article, Ryan began with saying that the article was engaging, but complicated and that the "big words were threatening." Ryan further suggested that the abundance of these words could discourage the readers who might "scroll down instead of getting into it." Jaxon agreed, suggesting adding a glossary to explain the words. However, when the undergraduate then explained that her article was not really targeting a younger audience, Ryan responded with "It seems very professional. It's perfect." Similarly, other youth scholars, who made many annotations of possible improvements or changes on the written copies, did not share their written comments in their discussion with the undergraduate to whom they were offering feedback. Further investigation is needed to determine the specific factors involved in this reluctance to give feedback face to face with the undergraduates, and whether, as "older college students" they either positioned themselves or were positioned in a way that discouraged feedback from "young high school students."

Leveling up: Consequentially engaging in real, high stakes work

In addition to the youth scholars' feelings of being authentic cohort members, we found much evidence that they saw their involvement as real, high stakes work, and that they saw themselves as consequential contributors to that work. Returning to Ryan's comment that the youth and teachers in the program were "on the same level", we assert that this did not indicate that the teachers in the program talked down to the youth's level. Rather, Ryan indicated in her comment that they were all scholars together, and "all learning the same things". Therefore, when embedded in this summer program environment in which everyone was positioned as a learner and a contributor to the important work of engineering research and its consequential implications, the level and rigor of engagement ramped up and many of these youth scholars responded by also "leveling up."

As further evidence of this, in their final interviews, all youth scholars identified specific, critical contributions they had personally made to their collective project of creating a viable design for using solar energy in their community and developing a short video to explain it. For instance, Mikki discussed her work on the PowerPoint, and noted that it "took me hours. I was up at 2 in the morning." Similarly, Jaxon shared that he had done all the math - for the financial and energy information in their video - at home, "so it took until one o'clock [in the morning]." There was no programmatic expectation that the YS work outside the hours they participated in the program. Many of the students simply undertook intentional action, interrogating the usefulness of engineering concepts and processes to move forward a project they believed in. As Jaxon reasoned,

> "I just persevered...because I knew that if I kept doing it, eventually I would get it right. Like if I gave up on the math, we wouldn't have the statistics and our presentation wouldn't be as strong. Now we know how much it is going to cost and how much energy it is going to save…[and] it makes our presentation much more powerful."

Each time Jaxon discussed the group's video presentation during the interview, he did so in the context of what it would be used for *after* the program. In this case, he was referring to the importance of making it "much more powerful" for the people they would be sharing it with in the future: families, community members and leaders, other students and school leaders, and an online audience.

By the end of the program, Ryan demonstrated "leveling up" and owning the responsibility of working with others to develop solutions to consequential problems. She also demonstrated growing acceptance of her engineering identity. During her interview, she explained:

> My definition of an engineering is someone who improves a solution or creates a solution - working with others to create a solution that benefits a large number of others, or even a small number of others, so yeah. So yeah, I guess *I do [think of myself as an engineer]*.

In their interviews at the beginning of the program, most students identified engineering as something that you did after going to school to become an engineer and choosing that as your career. However, Ryan is an example of how that perception changed for many of the YS in the time they were in the summer program. Her focus on improving or creating solutions to benefit either large or small groups of people demonstrates her acceptance of our expansive framing of photovoltaics. Further, she felt that the activities she and the other YS were engaged in were consequential and allowed them the chance to participate in a way that would benefit others.

Significance

This study sought to interpret what meaning the members of a YS cadre made of their experiences in a summer PV engineering research experience designed to support underrepresented youths' trajectories on engineering pathways through expansive framing of program experiences and opportunities for consequential engagement consequential engagement in a diverse cohort. Of the emergent themes, two of them are positive, while one has room for growth. The authors found this innovation to be powerful in the way of developing engineering identity; the YS participants felt a strong sense of belonging to their cohort as learners and contributors. The examples presented are just a small representation of the many participants who demonstrated their ability to expansively frame their contributions. Several YS recognized that their engagement was consequential not only for their older cohort members, but potentially for a wider audience in the world, the students who would encounter the teachers' lessons, the public audience who would read the undergraduate's projects, members of their own community who might benefit from their community solar engineering research project. Another significant finding was the YS participants' decision to level up, and accept their roles as both learners and contributors, rather than shrinking away or freezing in the face of uncertainty elicited from being positioned by program participation structures as not only students and learners, but also as key contributors through their own work and feedback on others' work. Coupled with their explicit expressions of feeling like engineers or future engineers, we take this leveling up as evidence of these young scholars' developing sense of belonging to the field of PV engineering as contributing members.

However, our findings also reveal the need to provide more scaffolding when asking the YS to give feedback to adults. This task turned out to be more intimidating than the authors expected, even though the YS participants gave feedback in assigned pairs or groups in our attempt to provide added support and bolster confidence in this activity. These findings provide us with a both a foundation to build on for future iterations of this designed summer research experience in our efforts to further engage learners from populations historically underrepresented in the consequential work of engineering. They further contribute to theoretical understandings of consequential engagement and expansive framing by showing how these principles are applicable to examining the affordances and constraints of positioning underrepresented youth in a diverse cohort of novice engineering learners.

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