

Exploration of the role and needs of high school counselors in supporting broader participation within engineering fields

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Abstract

The Engineering 4 Us All (e4usa) is broadening participation within engineering through implementation of a high school curriculum which emphasizes that engineering is for everyone. The program works with students and teachers, while seeking to engage additional stakeholders in the discussion of how to support *all* learners in engineering. One such stakeholder group is high school counselors. The purpose of engaging school counselors was to introduce this stakeholder group to the tenets of the project and to create a bigger network to support students at the schools in which the project curriculum is being taught. A small focus group was conducted with two school counselors from two different e4usa schools in Spring 2022. Participants reported constraints in how the counseling process occurs as a barrier to informing students and others about the course. This suggests a need for further support of counselors to effect systemic change and to address common barriers within counseling systems. These findings suggest that enhancing the understanding of engineering careers and capacity building of school counselors could be an effective approach towards broader participation. The engineering education community needs to recognize the often-neglected stakeholder group of school counselors and the pivotal role counselors play in students' career pathways.

Introduction

There are several Interventions aimed at counselors in supporting STEM broader participation (Falco & Summers, 2019; reference redacted; Shillingford et al. 2017). Such efforts are complemented by studies that document the need to broaden participation and identify a role for or place an emphasis on school counselor interactions with students in shaping their future decisions within STEM, particularly a desire to persist within STEM (Aschbacher et al. 2010; Grossman & Porsche, 2014).

A five-week, online professional development (PD) was conducted in Summer of 2020 to educate counselors about engineering. The PD was run as part of e4usa (Ross et al., 2021), a National Science Foundation funded program with the goal of demystifying engineering and democratizing engineering education. An introductory engineering curriculum was developed with an eye toward providing students with college credit for completion of the course. The curriculum emphasizes connecting with engineering, engineering in society, engineering professional skills, and engineering design (Reid et al., 2020). Counselors who support teachers within the e4usa program were invited to participate in the online PD in an effort to better prepare school counselors for guidance about engineering. A total of 15 counselors completed the PD. The PD involved synchronous sessions with collaborative, hands-on, engineering design activities and asynchronous sessions that included readings and simple design projects (e.g., spaghetti tower, building a rain shelter out of newspaper, and constructing a robotic arm). The design activities aimed to educate counselors about the broad nature of engineering, and to

show that engineering can be for anyone. Synchronous sessions also included discussions about stereotypes, implicit bias, and dialoguing with university representatives about different engineering majors. Each activity required the counselors to use engineering-oriented skills, such as problem-solving, creativity, and critical thinking, to display that engineering is much more than just math and science. The PD also allowed counselors to work cooperatively in teams as well as to share useful information with each other. Overall, counselors were provided with the tools they needed to effectively engage students in conversations about engineering. The presented findings come from a follow-up with a subset of the e4usa counselors to further explore school counselor perspectives toward broadening participation in engineering

Background

A counselor serves many roles on a high school campus, and several lines of research have explored how these individuals might influence students' experience with STEM. Aschbacher et al. (2010) conducted a longitudinal study which documents factors influencing students' decisions to continue in STEM career trajectories or to leave STEM career trajectories. Their findings suggest that counselors had multiple forms of influence on the long-term decision-making of students. Counselors could support or hinder student long-term interest and participation in STEM through class programming. They also provide encouragement or discouragement during the counseling process. The authors suggest that counselors balance the need to maximize student graduation, and therefore aimed to minimize projected failure in STEM courses. Students who had an initial interest in STEM early in their high school career and then lost interest reported different counseling experiences than those who remained interested in STEM at the end of high school. Grossman and Porsche (2014) similarly explored influences on student STEM success using a mixed methods approach. They found high school students reported their school counselors could play a supportive role in STEM engagement through encouragement to pursue STEM and help in recognizing microaggressions. An association between perceived support and STEM aspirations for girls was also revealed but not for underrepresented minorities. Together, these studies identify the importance of school counselors in influencing STEM career trajectories and suggests a potential mechanism by which this influence can be a positive impact on future intent. However, they also indicate that there may be differences in the influence that counselors have for underrepresented minorities and girls in STEM.

There is some additional work which identifies mechanisms by which school counselors impact student trajectory through STEM career development specifically (Byars-Winston, 2014; Cabell et al., 2021; Falco, 2017). Both Byars-Winston (2014) and Cabell and colleagues (2021) found that counselor knowledge of the need to promote diversity in STEM could influence counselor professional activity, in particular how they discuss and communicate STEM to students. Cabell et al. (2021) also found that these counselors spoke of the need to increase representation for both girls and underrepresented minorities in STEM. Falco (2017) summarized research on counselor STEM career support and identified specific activities in which high school counselors engage with students (e.g., one-on-one advising sessions and larger group informational sessions). Such interactions could be leveraged to better support student self-efficacy and interest in STEM. Enacting such approaches requires that counselors

be supported as important stakeholders in the STEM education system, specifically the engineering education ecosystem which has been strongly criticized for its lack of diversity and inclusion at all levels (Roarty et al., 2021).

Guiding Framework

We explore school counselor perspectives toward broadening participation in engineering using the multicultural STEM-focused career development framework (Byars-Winston, 2014). The multicultural STEM-focused career development framework suggests that school counselors can play a pivotal role in promoting equity within STEM. There are three stages of capacity building against which counselor skill development efforts and practices could be examined: 1) counselors' awareness and knowledge of the professional STEM landscape and career pathways, 2) counselors' communication about STEM fields with students, and 3) counselors' skill development toward cultivating more diverse STEM talent considering individual factors and sociocultural contexts. Together the three stages suggest that school counselors must consider factors which might lead to inequities in STEM by gaining an awareness of STEM specific equity issues. Such awareness will allow school counselors to engage in communication and gain the requisite skills and practices in counseling that will create supportive conditions for diverse learners to consider enrolling in STEM courses. Counselors who engage in the necessary equity work, demanded by the STEM-focused career development framework, will need to consider their own biases as they become more aware of issues which represent barriers for underrepresented learners in STEM (Falco, 2017). They may need to develop practices which specifically support marginalized learners with targeted attention, such as support in applying to specific scholarships. We used this framework to answer the following research questions:

1. *How do experienced high school counselors describe their understanding of, and activities in efforts to support broadening participation in engineering?*
2. *What barriers or supports do experienced high school counselors identify that influence enrollment in engineering courses?*

Methodology

Counselors who support teachers within the e4usa program were contacted in Spring 2022 to gauge their e4usa program. Two school counselors (pseudonyms Ann and Tina) participated in the first focus group and provided data for this paper. The first case study counselor, *Ann (pseudonym)*, is an experienced counselor at a public high school in the Northeast and is new to working with the e4usa program. This counselor mentioned specific interactions with the teacher regarding the program and stated that the school also had a strong STEM department with multiple opportunities for students to engage with STEM programming. Ann did not specifically mention efforts to broaden participation with engineering, but did mention that this was an area of interest for her. Ann discussed that her work with students involves both individual meetings as well as group presentations. Additionally, the counseling department sends out information in advance to students.

The second case study counselor, *Tina (pseudonym)*, is also an experienced counselor at a public high school in the Mid-Atlantic region who has worked with the program for several years. She participated in an initial professional development workshop during the summer of 2020 and continued work with the same teacher for the last two years. Tina reports that the school they work at has several STEM programs, including an extensive engineering program. Students in the e4usa course have the opportunity to engage with extracurricular activities related to STEM or business and that many of these extracurricular activities begin in middle school. Tina mentioned decisions that were made at the school site with regard to the curriculum placement within the engineering course sequence and course prerequisites that were established for the course and how that influences the conversations the counselor has with prospective students. No specific activities to broaden participation were reported, but it was noted that the counseling department met specifically with the teachers who teach various courses within engineering, including product design, coding engineering, robotics, and architecture. The counselors attended presentations within each of the classes so that the counselors felt better prepared to work with students.

The insights provided by these counselors regarding their role as counselors in the e4usa program are shared as case studies. The focus group was coded using inductive coding (Thomas, 2006). An inductive approach was taken to enable any differences or similarities found between participants with disparate experiences within the program to emerge from the raw data rather than through application of a priori codes. The focus group was coded by a single rater, who then collaborated with raters from the previously offered counselor professional development team (Roarty et al., 2021) to ensure validity of the codes that were determined during the coding process. The rater identified codes from the transcript during the first round of coding. The second round involved placing initial codes into relationships or groups to begin identifying themes, which were discussed with the additional raters. These themes were then considered using the multicultural STEM-focused career development theory to begin to describe how the e4usa program impacts counselor awareness, communication, and practice and to better contextualize further needs for these counselors.

Results & Discussion

The *in vivo* codes aligning with the theoretical framework were first categorized to identify emergent themes and then placed within the constructs of *counselor awareness, counselor communication, and counselor skills and practice* (Byars-Winston, 2014). Each theme that emerged related to at least one construct within the framework, which enabled an identification as to how the program is currently supporting the practice of high school counselors and pointing to potential future interventions. The emergent themes and representative quotes found within each section of the framework are presented in Tables 1-3. Ann and Tina did have different experiences within the program, but tended to provide similar thoughts within the presented themes. Representative quotes from each counselor are provided to capture each individual's specific thoughts within a theme.

Counselor awareness

Two themes emerged relating to counselor awareness of broadening participation. The first was *gender imbalances within engineering courses*. Counselors identified a need to broaden participation for girls through engineering courses. The following quote from Ann encapsulates the conversation the counselors had about the students within their course.

But as I'm looking at the class list now, I'm very disappointed that there are no girls. We had 15 take it first semester and 11 second semester to do the engineering too. But they're all boys and you know, I'm not sure what that's about because our STEM program at [school name] definitely has a lot of girls interested in who attend.

The discussion of gender imbalance was often framed by what was occurring in other STEM programs on campus. Tina's mentioned a computer science effort, "So we have several girls in our computer science classes too, so they're doing better advertising to the girls." Such comparisons extended beyond internal programs to include those offered by local, external collaborators. Tina described a program offered by a nearby university, "Well, the [local university] does a girls in engineering program that our girls get invited to every year. So that's one thing that's been helping. We have a local engineering firm that also does a girls in engineering day for the last oh gosh probably 8 to 10 years. So those things I think have helped a little bit too."

The second theme was *identifying and addressing barriers to participation*. The key barrier was course access. Tina shared

So part of the barrier is the fact that it's you know it's considered an honors class, so that scares some kids off. Now, most of those you know if they're qualified then I think we you know, get them over the fear of the engineering and just tell them it's a reward for it being an engineering class, but the barrier sometimes is that [engineering teacher] has a prerequisite, being that they have to be an honors math. And not all the, some kids can be a really strong academic math student so, but [engineering teacher] is always really good if the kid has a real interest and is a hard working good math student, then [e4usa teacher] has been good about you know, taking that student instead, but that's the only barrier I can think of that I that I know has been an issue in the past in our school.

The sum of these themes and quotes highlight the counselor's awareness of who is and is not participating in engineering programs and what barriers must be overcome to broaden participation in engineering offerings at their schools and beyond.

Counselor communication

The counselors also discussed with each other how the counseling system worked and the specific ways in which they communicate with the students they work with regarding STEM. The first theme that emerged was that the counselors often *broadly situated the initial conversation about engineering within STEM and student interests*. Many of the statements made about communication regarding STEM fields are also closely tied with the counselor skills and practices. In some cases, counselors spoke of the type of student that might be attracted to, or

successful in, an engineering course. For instance, in the quote below from Tina, she discusses the students skills and interests and how she then relates this to engineering.

Oftentimes, you know it happened probably three times in the last two weeks, students said, you know, they're not sure exactly what they want to do in the future, but we talk about things they like, things they're good at, and engineering comes up when they talk about. You know I met with a girl today she likes art, but she's also a straight A student and she said I'm good at everything, but I don't really have a passion or anything and we started talking about you know her art and her interest in math and science and her abilities in it and engineering was one of the things that we talked about and she agreed to take the class

Ann also reported that her conversations with students often began with connections to student interest, and would begin with broad connections to STEM fields and then narrow to engineering, saying she starts with “what are your career plans for the future, and we'll guide them and we might make some changes.”

Another theme that emerged was *an evolution in their thinking of the field of engineering* that was reported by both counselor's. While Ann did not identify specific factors influencing this evolution, Tina's quote below identifies specifically the summer PD offered by e4usa influenced this evolution in thinking.

I describe it to students a little differently than I used to before I did that summer program two years ago. I know it's more about design and not just you like science and math, so you might be good at this. Uhm, I talk about problem solving and working with a team and everything that we have is designed by some engineer and group of people and and that it isn't strictly for kids who are good at math

Counselor skills and practices

In addition to speaking about how they communicate with students about engineering specifically and STEM broadly, the counselors also described specific aspects of their counseling practice that impact participation within the e4usa course and engineering. The first theme that emerged from these statements identified *constraints within the system* that detailed mechanistic aspects of programming students into courses, which includes communicating about course options to students. The mechanisms of informing students of the course itself was seen as a potential barrier by both counselors in part because it requires student efforts outside of counseling interactions. For instance, in this quote from ANn she describes how students are overlooking the program details that are sent out to the students as a counseling practice and that it is the counselor pushing students to consider courses that results in them changing their minds.

Yeah, I think it's more that they're not paying attention to it [*program details sent via email*] and when you have that conversation and you start talking about the e4usa course. You know, I said to a kid today “I don't want to tell you what to take, but I really

think this would be a good idea.” He's like “that's a good idea for me.. you know, so take that other class out and put e4usa in” and so I think if we take it seriously they will too.

The counselors agreed that while these mechanisms must be in place to support the large number of students they must process, their practice of counseling individually was more likely to inform students about a program with sufficient detail for the students to make an informed decision. Additionally, the counselors identified ways in which they had connected with the e4usa program that impacted their practice or ways in which they would like to be provided with additional details from the program. At least one counselor mentioned a wishlist tool to speak with students about engineering programs, and then mentioned that she hadn't opened a recent email from the program which contained just such a tool. Ann also specifically described how her interactions with the teacher in the e4usa program provided her with additional details to share with other students, which is an important note to consider as Ann is a new teacher that did not attend the initial counselor PD offered by e4usa.

So without me talking to him, I wouldn't have known what types of experiments or projects they were doing and that certainly helps us to explain and recruit other students in the future to classes when we know a little bit more about specific things that they're doing

Conclusions and Implications

The counselor multicultural STEM-focused career development framework (Byars-Winston, 2014) enabled analysis of this small case study to identify how to support systemic change outside of the classroom and curriculum through working with additional stakeholders. The counselors themselves identified many similarities in the process by which they engaged with learners to promote participation with engineering (e.g., counselors identified issues related to the need to broaden participation in the specific courses on their campus, which aligns to counselor awareness within the framework). Their statements did not extend beyond gender to consider other underrepresented groups in STEM, but did indicate that counselors are aware that there is a need to support broader participation in this particular course on their campus. The counselors made comparisons to other programs on campus, which suggests that these counselors are reflecting on how the system could be changed to support broader participation and might indicate that the counselors recognize a need to develop their skills or practices as counselors. This might represent a future source of support designed to build reflective pieces that enable counselors to leverage strengths that already exist on campus to broaden participation for additional STEM courses (Dalal & Carberry, 2021).

Both counselors mentioned the need to support girls in engineering, while recognizing the importance of broadening participation. They did not report specific activities they engaged in to broaden participation for other marginalized groups when prompted, which was meant to address counselor practices. The counselors mentioned supportive conversations that would likely result in broader participation according to prior work (Cabell et al., 2021) when discussing their counseling conversations and communication about STEM. This may point to a need to increase counselor's sense of self-efficacy in supporting diverse students as they seem to have

the knowledge by not reporting that knowledge when prompted. These findings are important to consider given that Grossman and Porche (2014) reported differences in association between perceived support and STEM aspirations for girls and underrepresented minorities. Future work might continue to explore counselor awareness of the unique needs of underrepresented minorities and girls within engineering at a finer level of detail.

The counselors noted that their understanding of engineering has changed over time which further indicates that these individuals are open to changing how they communicate and explain engineering specifically. They also identified barriers that exist which might prevent access to engineering for students (Dalal et al., 2021). In particular, the counselors noted that the systems in which students learn about the courses require students to pay attention to printed/advertised materials before engaging with counselors or students might hear about the courses from friends. This further suggests that counselors may need additional support to change their practices.

The current study is a small-scale analysis of counselor interactions within a specific engineering program. It was not possible with this small sample size to determine whether the different experiences of the teachers within the program led to differences in professional practice. It is possible that future interventions might further target the needs of these counselors.

Overall, the findings suggest that enhancing the understanding of engineering careers and capacity building of school counselors could be an effective approach towards broader participation. The counselor multicultural STEM-focused career development framework can be used to guide interventions to support broadening participation within engineering. The engineering education community needs to recognize school counselors as an important stakeholder group that plays a pivotal role in students' career choices and pathways.

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