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Abstract

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Keywords

role models, engineering education, outreach, elementary, career planning

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Challenging the Notion of Role Models in Engineering Outreach Programs for Youth

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Abstract

Engineering outreach programs often portray outreach educators as role models for youth. It is widely believed that introducing youth, especially girls, to potential engineering role models will broaden participation in engineering majors and careers. Based on interviews with and surveys of fourth- and fifth-grade girls participating in an engineering outreach program, we question whether youth are looking for career role models, and we challenge the assumption that youth will take up an adult as a role model simply because the adult is presented as such. We question what role these "models" play in the minds and lives of youth and argue that it may differ from what we expect. To be clear, we are not arguing that engineering role models are not important or not influential. Rather, we think it is important to gain a better understanding of how youth, particularly girls, view these potential engineering role models, which will allow us to optimize the significance of these adults to the youth participating in engineering outreach.

Keywords: role models, engineering education, outreach, elementary, career planning

Introduction

In this paper, we use data from a three-year study of an engineering outreach program to challenge the notion that youth engaged in engineering outreach programming readily take up near-age peers or adults as role models. This is not to say that this does *not* occur *in certain cases*, but we do not think that it occurs as readily nor at the magnitude that we and others in the field believe that it does.

Outreach programs for youth often attempt to position adults as role models, usually with the goal of inspiring youth by messaging that they, too, can be like the role model or do what they do (Farland-Smith, 2014; Kekelis & Joyce, 2014; National Inventors Hall of Fame, n.d.). In engineering, the use of role models has been recommended as one way to increase the number of girls pursuing engineering majors and careers (e.g., Hughes et al., 2013, Kekelis & Joyce, 2014). However, based on findings from fourth- and fifth-grade girls participating in an engineering outreach program, we question whether youth in this age group are looking for engineering role models, and we challenge the assumption that youth take up an individual as a role model simply because a program provides these potential connections. This led us to question what role these "models" play in the minds and lives of youth, and we argue that it may differ from what we previously thought. In this study, we seek to answer the following:

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1) Are elementary-aged girls looking for role models?
2) How do girls perceive adults presented as potential engineering role models within outreach?

To be clear, we are *not* arguing that engineering role models are *not* important or *not* influential. Rather, we think it is important to gain a better understanding of how girls view the individuals presented as engineering role models as it will help us think more critically about methods for achieving key goals of engineering outreach with adolescent youth.

Background

Defining Role Models

Throughout this paper we will use key terms repeatedly, including: *role model*, *mentor*, and *outreach*. Here, we define these terms so that readers understand how we conceptualize these roles and ideas. We define *role model* as "a person you respect, follow, look up to or want to be like" (Bricheno & Thornton, 2007, p. 385). In contrast, a *mentor* is "someone who has relevant knowledge and experience and works on a short- or long-term basis with a mentee to give advice, guidance and support to assist the mentee's career, well-being, learning and professional development" (Durbin et al., 2020, p. 218). A person can be both, but a mentor is not necessarily a role model and vice versa. In the context of motivating youth to pursue engineering, we focus on role models for a practical reason: one person can serve as a role model for many children but can mentor only a limited number of children. We do not see these terms as interchangeable and feel that we all need to be more cautious in how we use them. For *outreach*, we use the *Oxford English Dictionary*'s definition: "the activity of an organization in making contact and fostering relations with people unconnected with it, especially for the purpose of support or education and for increasing awareness of the organization's aims or message" (Oxford University Press, n.d.).

Role Models in Engineering Outreach

Broadly, engineering outreach to youth may take the form of facilitated engineering design activities, presentations about engineering careers, or demonstrations of engineering activities or technologies. The goals of PK-12 engineering outreach programs may include facilitating engineering learning, encouraging interest in engineering, informing youth about engineering careers, increasing participation in engineering study and careers, and recruitment to a particular university (Gartland, 2021). University-led outreach programs frequently employ undergraduate or graduate engineering students as outreach educators (OEs); these OEs are considered to be well-positioned both to facilitate participation in engineering practices and to model enthusiasm for engineering study and careers (Bers & Portsmore, 2005; Bledsoe et al., 2004; Cunningham & Lachapelle, 2016; Higgins & Hertel, 2013; Portsmore et al., 2003). Often, outreach programs expect that their OEs will serve as role models for youth who participate in the outreach activities (Gartland, 2015). This expectation is based on a belief that when youth interact with prospective role models, youth will be inspired to emulate them and pursue engineering study and careers (e.g., Drury et al., 2011). Studies support this belief; interacting with someone who is perceived as a role model has been found to positively influence self-efficacy and interest in content areas with which the role model is affiliated (Rosenberg-Kima et al., 2008; Stout et al., 2011).

Research suggests role models can serve three functions for youth: demonstrating specific goal-oriented behaviors, embodying possible futures, and sparking dreams. Morgenroth and colleagues (2015, p. 467) describe these three functions as *behavioral models*, who show how to perform skills and achieve goals; *representations of the possible*, who show that a goal is attainable; and *inspirations*, who make a goal seem desirable. Engineering OEs, particularly OEs who are themselves engineering students or engineers, could show how to do engineering and become an engineer, could show that becoming or being an engineer is possible, and could make engineering appealing—any of which could promote increased participation in engineering.

It is important to keep in mind that potential role models are just that: potential role models or *role model prospects*. The individual who may be seeking a role model, the *role aspirant* (Morgenroth et al., 2015), ultimately determines whether a role model prospect attains this status. As such, we consider OEs to be role model prospects until a child identifies them as a role model.

Although the idea of introducing youth to role model prospects sounds reasonable, research does not overwhelmingly support the effectiveness of these potential role models. Despite claims that role models are one answer to increasing underrepresentation in engineering, the addition of role model prospects to outreach programs does not necessarily improve student outcomes (Armour & Duncombe, 2012; Gartland, 2021; Morgenroth et al., 2015). Worse, interactions with role model prospects may negatively influence youth or discourage them from pursuing engineering study and careers. Not only are youth less likely to identify with or aspire to emulate a potential role model whom they perceive to be too different from themselves, unattainably successful, or as representing an unpopular stereotype, studies suggest that when youth view a

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potential role model in any of these ways, their aspirations toward and interest in engineering study and careers actually diminish (Betz & Sekaquaptewa, 2012; Cheryan et al., 2011; Gartland, 2014, 2021; Lockwood & Kunda, 1997).

Much of the research on role models and their impact is conducted with university students or those already in engineering careers (e.g., junior engineers looking to senior engineers). There is a dearth of research that examines how youth identify role models, especially for elementary-aged students. Although researchers started to identify the various people youth look to as role models, there is a wide breadth of definitions of role model and range of functions that these individuals fill. In particular, the terms *role model* and *mentor* are often conflated (Armour & Duncombe, 2012). Further, it is not clear if role models serve the same purpose across different age groups and contexts. For example, adults looking for a role model may be more specific in whom they look to (such as a parenting role model or a career role model), while youth may be more diverse as they continue to actively develop their identities across multiple domains (including academic, athletic, social, and personal interests). The extent to which youth perceive role model prospects as actual role models is unknown; it may be that well-meaning adults see these prospects as role models for youth but that the youth themselves do not view them as such (MacCallum & Beltman, 2002).

Methods

Researcher Positionality and Motivation for the Current Study

We are engineering education researchers and educators. Two of us have worked in engineering and science education outreach for 15 or more years as OEs and outreach program directors. Authors engaged in varied roles in this study, including training OEs, collecting data, and analyzing data. As educators and researchers who have been involved in engineering and science outreach programs for many years, we believe that the relationships youth develop with OEs are meaningful and have impact. Further, consistent with existing research, we believe that youths' relationships with and uptake of engineering role models can spark and sustain youths' interest in, affinities toward, and identification with engineering (e.g., Rosenberg-Kima et al., 2008; Stout et al., 2011). As educators and researchers, we wanted to better understand how youth identified and took up OEs as role models. In light of the suggestion that a paucity of role models impedes girls' interest in engineering and the corollary that girls will pursue engineering study and careers if they encounter engineering role models (Drury et al., 2011; Hughes et al., 2013; Stout et al., 2011), we were particularly interested in unpacking girls' relationships with engineering role model prospects. Therefore, we sought to answer the following questions:

1) Are elementary-aged girls looking for role models?
2) How do girls view adults presented as engineering role model prospects within outreach?

Creating Opportunities for Youth to Interact with Potential Role Models

We conducted our study within the context of an existing engineering outreach program that had several elements that research suggested would support youth to perceive the OEs as role models. We modified the program and incorporated additional elements to increase the likelihood of role model uptake (Miel et al., 2019). To design these modifications, we drew on studies suggesting that role aspirants (i.e., youth in the program) would be more likely to take up role model prospects (i.e., OEs) as role models when they perceived the role model prospects as competent, successful, appealing, emulable, attainable, and sufficiently similar to themselves (Gartland, 2014, 2021; Gladstone & Cimpian, 2021; Morgenroth et al., 2015).

The mission of the engineering outreach program in this study was to provide elementary school-aged youth with extended opportunities to engage in authentic, developmentally appropriate engineering learning experiences. The program was driven by a belief that all young people deserve opportunities to engage in engineering ways of thinking and doing. A secondary goal was to support youth in learning more about engineering and what it means to be an engineer. Undergraduate and graduate engineering students (the OEs) facilitated outreach activities, visiting local classrooms for one class session each week for 16 weeks during the school year. The OEs were predominantly women (approximately 60%) at various stages of study and across a variety of engineering disciplines. Our NSF-funded study, *Role Models in Elementary Engineering Education*, sought to investigate the interactions between OEs and youth to determine whether these youth, particularly girls, viewed the OEs as role models. We postulated that since the majority of the OEs were women, seeing more women in engineering roles would increase the likelihood that girls would want to emulate them.

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Positioning Outreach Educators as Role Models

We initially hypothesized that youth who participated in the focal outreach program would identify the OEs as role models. We based this conjecture on four factors. First, we believed that the OEs' status as emerging engineers and as college students would make them admirable and appealing to youth. Second, based on prior observations of youths' interactions with the OEs, we believed that youth would see the OEs' status as emerging engineers and as college students as attainable. Third, the program provided time for youth and OEs to build relationships and learn about one another. The youth and OEs interacted for approximately one hour each week for 16 weeks across the academic year, providing roughly 16 hours of contact. Throughout the study, we encouraged the OEs to get to know the elementary students and to let themselves be known by the students. Finally, the large proportion of female OEs was quite different from the gender representation imbalance found across engineering in the United States. Thus, this program provided girls the opportunity to interact with young women in engineering and potentially see these young women as representations of the possible. We believed that girls would identify similarities between themselves and the OEs and come to recognize engineering as a pursuit for a future possible self (Markus & Nurius, 1986; Morgenroth et al., 2015; Oyserman et al., 2006) or increase their sense of belonging by countering stereotypes of who can and cannot be an engineer (Dasgupta & Stout, 2014). Given these factors, we conjectured that the context of this outreach program would be conducive for youth, particularly girls, to take up the OEs as engineering role models.

Context and Participants

The study focused on a university-led outreach program in the northeastern United States. A total of 25 fourth- and fifth-grade classrooms across five public schools in two suburban school districts participated in this study. The university Institutional Review Board approved the study, and we obtained assent from students and consent from caregivers for students to participate in the research. OEs and teachers also consented to participate in the research. All students, teachers, and OEs engaged in the outreach activities regardless of their participation in the research study.

Pairs or trios of engineering undergraduate and graduate students facilitated engineering design activities in elementary classrooms during the school day for one hour each week for approximately 16 weeks over the school year. Of the OEs working in the classrooms represented in this study, 35 were female and 22 were male, which was consistent with the gender proportion of OEs in the larger outreach program.

The gender of participating students was identified by their caregivers on study intake forms. The numbers of participants (total and for girls) are listed in Table 1. Because we focus on the fourth- and fifth-grade girls who participated and because we do not have large enough numbers to disaggregate by race or ethnicity, we do not report race or ethnicity information for the sample of participants in this study. However, we want to note that the students who participated in the research reflected the race distributions of their schools and school districts. Across the three years of this study, the student populations of the larger study and in the focal schools were 2% American Indian or Alaskan Native, 8% Asian, 15% Black or African American, 21% Hispanic or Latinx, 0% Native Hawaiian or Pacific Islander, 49% White, and 5% Multiracial students.

Data Collection

We collected data from participating youth using surveys and individual interviews in Year 1 (2017–2018), Year 2 (2018–2019), and part of Year 3 (fall 2019) of the project. No data were collected in the spring of 2020 due to COVID-19. Over the course of the three-year project, we attempted to examine girls' perceptions of OEs as role models in

Table 1
Numbers of student participants by data collection method and semester.

	Survey		Interview	
	Total	**Girls**	**Total**	**Girls**
Fall 2017	–	–	38	23
Spring 2018	68	33	88	42
Fall 2018	73	38	74	39
Spring 2019	90	47	76	39
Fall 2019	84	43	36	18

a variety of ways. We collected data at the end of each academic semester, reviewed participants' responses, and modified the interview protocols and survey instruments when preliminary analyses of student responses suggested additional or modified questions might elicit more nuanced or detailed participant responses. Figure 1 depicts the progression in how we shifted our questioning across the project. The progression reflects our efforts to understand how girls perceived their OEs and who they selected as role models. We began by asking girls about role models in a general sense. We asked them "Do you have a role model?", and if so, we asked them to identify their role model(s) and explain why they chose the individual(s) as a role model(s). We then shifted our questioning to focus more specifically on perceptions of the OEs by asking girls, "*Would* any of your OEs be a role model for you?" We followed this up the next semester by asking, "*Could* any of your OEs be a role model for you?" Next, we directly asked girls, "*Are* any of your OEs a role model for you?" and asked them to explain why or why not. Because we were not convinced that girls viewed their OEs as role models, we wanted to understand how girls viewed their OEs. So, our final shift involved asking girls how they perceived their OE ("What *are* your OEs to you?") and what "role" or function they served. Note that although we write "OE" here for simplicity, in the interviews and surveys we used either an OE's name (e.g., Helena or Fatima) or a program-wide nickname derived from the program name, STOMP (i.e., STOMPers).

We conducted surveys during three semesters: fall 2018, spring 2019, and fall 2019. All surveys were administered online via the Qualtrics survey platform. Surveys in the fall included questions that asked if girls had, needed, or were role models as well as how important certain characteristics were for a role model to have (e.g., be inspiring or be someone to look up to). While we received survey responses from between 33 and 47 girls depending on the semester, sample sizes reported in the results below may differ based on missing data on a given item.

We conducted semi-structured interviews across each of five semesters, beginning in fall 2017 and ending in fall 2019. We video-recorded and audio-recorded the interviews. We interviewed between 18 and 42 girls each semester; for this paper, we analyzed a subset of those interviews. In the initial interview set, some girls were interviewed twice (once in each of two semesters) and some classrooms were overrepresented. To avoid double-counting and to balance representation across classrooms, schools, and OEs, we reduced the interview set to 50 interviews. We selected 10 girls from each time point using the following criteria: (a) each girl completed a survey during the respective time period; (b) there was no overlap in girls selected across time points; and (c) the girls were spread across all the participating classes as much as possible. This permitted us to include a wider range of voices across the classrooms and time periods. Interview questions included: "Do you have role models?", "Could your OE be a role model for you?", "Would your OE be a role model for you?", "Are your OEs role models for you?", and "Which of these (kinds of people) are your OEs most like?" In Year 1, we prefaced questions about role models by stating, "A role model is a person you respect, look up to, want to be like, or try to be like. It can be a person who inspires or encourages you." In Years 2 and 3, rather than telling girls a definition of a role model, we asked girls to tell us why someone was or would be a role model to them.

While the main goal of the interview questions at each time point followed the progression presented in Figure 1, we included a variety of additional questions to better understand girls' perceptions of role models and their OEs. For example,

Figure 1. Progression of interview and survey questions.

in addition to asking girls whether their OEs could be role models, we also asked girls what they liked or admired about their OEs, whether they were similar to or liked any of the same things as their OEs, how they might want to be like their OEs, and what they liked about working with their OEs. We intentionally included a mixture of direct and indirect questions to gain a more holistic understanding of girls' perceptions of their OEs.

Data Analysis

To answer our main research questions, we explored the following sub-questions in the context of the focal outreach program:

1. Do girls have role models?
2. Which characteristics are important to girls when identifying a role model?
3. Could the OEs be role models to girls?
4. Are the OEs role models to girls?
5. What roles do OEs play in the lives and minds of girls?

Survey data were analyzed using descriptive statistics, calculating frequencies of responses to each survey item. Interview data were analyzed thematically. The research team transcribed the interviews. One researcher read through all student responses, tagging words and phrases that related to the sub-questions listed above. These tagged utterances were grouped into themes related to girls' perceptions of role models in general and specific to their OEs.

Across the years of data collection, the survey and interview questions aligned with the progression of the sub-questions as we sought to better understand how girls view potential role models within outreach. Below, we present our findings in alignment with the progression of these sub-questions.

Findings

Do Girls Have Role Models?

During the interviews in both fall 2017 and spring 2018, we asked girls if they had any role models, how they chose these role models, and what made a person a role model to them. In the 20 interviews that were coded, 15 girls indicated that they had role models, with girls identifying a total of 35 individuals as role models. Almost half ($n = 16$) of the role models mentioned were family members (e.g., parents, grandparents, cousins, or siblings) or friends, followed by celebrities ($n = 7$; singers, gymnasts, and Michelle Obama), teachers or classmates ($n = 6$), and their OEs ($n = 6$).

Unlike the interview results which indicated that the majority of girls (75%) had role models, on the survey fewer girls (approximately 40%) stated that they had at least one role model. Additionally, approximately 25% of girls indicated that they did not think much about role models with another 25% indicating they did not need role models (this percentage is much smaller in fall 2018 as girls could only select one option, while in 2019 they could select all options that applied). Finally, 30–45% of girls said that they were a role model for others (see Table 2).

Which Characteristics Are Important to Girls When Identifying a Role Model?

We sought to understand what girls looked for in role models, so we asked girls how important various characteristics were for a role model. Almost all girls identified that the personal attributes of a person were important in being a role model. Girls said a role model should treat people with respect, be kind, and/or be a hard worker. Additionally, most girls said that it was important that a role model be someone you look up to, who inspires you, you admire, and you want to be

Table 2
Girls' perceptions of having and needing role models.

Item	Fall 2018 (%)	Combined spring 2019 and fall 2019 (%)
I have one or more role models.	41	38
I don't think about role models that much.	28	25
I rely on myself and do not need role models.	3	24
I am a role model for others.	28	45

Note. In the fall 2018 survey ($N = 29$), girls were asked to select only one option, so percentages add up to 100%. In both the spring and fall of 2019 surveys ($N = 95$), girls could choose all options that applied, so the percentages add up to more than 100%.

Table 3
Girls' perceptions of characteristics of role models.

	Combined fall 2018 and fall 2019		
"How important is it that a role model is someone who…"	**Total (*N*)**	**Not at all/a little (%)**	**Somewhat/very (%)**
You can look up to.	73	6	95
Inspires you.	74	18	82
You want to be like.	71	23	78
You admire.	74	31	69
Treats people with respect.	75	3	97
Is kind.	73	4	96
Is a hard worker.	73	6	95
Works through things that are hard.	70	13	87
Is good at what she/he does.	73	18	82

Note. Items were rated on a 4-point scale (1 = not at all important; 2 = a little important; 3 = somewhat important; 4 = very important).

Table 4
Outreach educators as possible role models.

Could/would your OEs be a role model for you?	**%**
Yes…they *are* a role model to me.	45
Yes, but…they are *not my* role model.	33
No.	22

Note. $n = 18$.

like (see Table 3). These findings suggest that girls envision role models as people they admire, are inspired by, or want to emulate; and who treat others with respect, are kind, and are hard workers.

Could Outreach Educators Be a Role Model to Girls?

In the spring and fall of 2018, we shifted from asking girls about role models in general to asking specifically about their OEs as role models. In spring 2018, we asked girls, "*Could* your OEs be a role model for you?" and in fall 2018 we changed the wording slightly to ask, "*Would* your OEs be a role model for you?" Even though we selected interviews from 20 girls (10 in each semester), only 18 girls answered these questions (see Table 4). Fourteen girls indicated that their OEs "could" or "would" be role models, though six of these girls (33%) indicated that they did not actually view their OEs as their role model ("Yes, but…"). For example, one girl who expressed interest in becoming an engineer said, "They [the OEs] do engineering and they could teach me how to engineer," but she did not say that she looked to her OEs to do so. Another girl described her OEs using characteristics often associated with role models but did not identify any of the OEs specifically as her role model, saying, "So that's like what *would* make them a role model for me" (italics added). Another girl thought her OEs could be role models because they worked hard and had achieved appealing milestones, such as getting into a highly selective college. Eight girls (45%) explicitly said that their OEs could be role models, citing reasons such as their OEs being kind, helpful, funny, patient, good engineers and teachers; being persistent through failure; and having similar interests (e.g., building). However, not all girls felt that their OEs could or would be role models for them ($n = 4$, 22%). One girl suggested that the OEs could be role models for other people, while another girl said OEs could be a role model "If I wanted to be a scientist or an engineer [but I don't]." Similarly, another girl stated that she already had other female role models from the university's other outreach programs, so she did not really consider these OEs as role models.

Are Outreach Educators Role Models to Girls?

We again shifted our question (spring 2019) to directly ask the girls, "*Are* any of your OEs a role model for you?" Eight of the 10 girls identified their OEs as role models. However, the girls described their OEs in different ways. First, some girls described their OEs as engineering role models, but not necessarily *their* role models. For example, one girl stated:

> I think [OE] is a role model because she shows that girls can be engineers too and not just like normal, like a cook or someone who cleans. She's—they're both—excellent role models of you can be an engineer, you can be whatever you want to be. (Participant)

Table 5
Girls' perceptions of their outreach educators.

"My OE is someone that…"	Total (*N*)	Not at all/a little (%)	Somewhat/very (%)
Treats people with respect.	49	6	94
Is kind.	48	4	96
Is a hard worker.	47	6	94
Is good at what she/he does.	47	4	96
I can look up to.	42	19	81
Inspires me.	45	40	60
I want to be like.	41	63	37
I admire.	40	45	55
Is a role model to me.	43	40	61

Note. Survey results from spring 2019.

She went on to say that despite her OEs modeling that girls can be engineers, she did not want to be like her OEs because, "I want to be my own person and like not the same [as OE]." Another girl went one step further, noting that her OEs were good engineering role models; however, she wanted to be a doctor, not an engineer. She explained that the OEs were only helpful to her as role models in the sense that some of the coding and work with Chromebooks that they did might be related to the technology she would use one day as a doctor. Second, some girls described their OEs as role models in terms of personal characteristics that the OEs demonstrated. For example, girls said OEs were role models because they were kind, nice, and good at teaching people. Similarly, some girls described their OEs as role models for how to behave. One girl stated that the OEs were good examples of the behavior expected of students during certain aspects of the project, saying that the OEs stood quietly while students tested their rockets. Another girl described her OE as a role model because the OE showed everyone how to do parts of a project (e.g., how to connect the 3D printers), so that when the girl did it herself, she knew which exact steps to follow, saying, "I would do that since she did that" (e.g., plugging it in the same way). Finally, one girl identified the OEs as her *actual* role models. This girl indicated that she had some interest in engineering and stated that her OEs were role models because they also were interested in and currently doing engineering.

The spring 2019 survey data provided similar findings to the interviews. We asked girls about their perceptions of their OEs using the same characteristics of role models that we had asked about on the fall 2018 and 2019 surveys. These questions focused on indirect indicators of the girls' perceptions of their OEs as role models. Additionally, we added a question that directly asked if their OE was a role model to them. Over 90% of girls described their OEs as someone that has positive personal attributes, noting that their OE treats them with respect, is kind, is a hard worker, and is good at what she or he does (see Table 5). Girls agreed that their OEs were people they could look up to (80%), that inspired them (60%), and that they admired (55%). However, only one-third of girls responded that they wanted to be like their OE. Finally, the majority of girls (60%) stated that their OE was a role model to them.

What Roles do Outreach Educators Play in the Lives and Minds of Girls?

Previous surveys and interviews asked, both indirectly and directly, about role models in general and girls' perceptions of their OEs as role models. Because the results were inconsistent about whether OEs were perceived as role models, we wanted to understand how girls actually viewed their OEs. Thus, we shifted to asking girls how they perceived their OE ("What *are* your OEs to you?"), in essence asking them what "role" or function OEs served. Using a Bingo-type board with multiple options, we asked girls, "Which of these (kinds of people) are your OEs most like?" and allowed them to choose as many labels as needed to characterize their OE. Girls tended to describe each of their OEs individually, often viewing their OEs as playing different roles from each other. Table 6 presents a summary of girls' perceptions of the roles the OEs represented to them.

The majority of girls described their OEs as a teacher (80%) or a friend (70%). Girls often described their OEs as teachers because the OEs utilized behaviors in the classroom that were similar to those used by their teachers. For example, one girl described her OE as a teacher because "she does the loud talking and telling the students what we're going to do today." Another girl provided a similar reason saying:

> Because they taught us all the stuff and they always spoke in front of the class when they needed to get our attention…[if] they didn't tell us [something] before, they would ring the chime that we have and they would announce it to us. (Participant)

Girls described their OEs as being like friends, often stating that they were helpful, nice, and made the students feel good. For example, one girl said, "[OEs] would always help us with everything. And they would want to be with me. [When] we had trouble with our groups, they would always make us feel better." Another girl stated, "Because [OE is] really nice, and

Table 6
Students' perceptions of outreach educators' roles.

Perceived role	*n*	%
Teacher	8	80
Friend	7	70
Coach	4	40
Student	1	10
Camp counselor	1	10
Sitter	1	10
Role model	1	10
Afterschool club leader	0	0
Other	0	0

Note. Percentage is based on the number of girls ($N = 10$). Total exceeds 100% because respondents could choose multiple options.

she helps us do a lot of things. And if we feel discouraged, she can help bring our feelings." Another girl noted that OEs were like friends because they were close to her in age and could explain things in a way she could understand, stating:

> [OE] was like your friend two grades above you, that kind of friend. He's like, 'Oh, but if you're going to do division, divide by seven, then you should…[he's] teaching you how to do math in a harder but easier [way]. (Participant)

Finally, one girl described her OE as a teacher and a friend, saying, "Well, [OE is] sort of like a teacher but also like a friend. Sort of maybe a teacher that's not a teacher…like a teacher that's silly and stuff."

An additional 40% of girls described their OEs as a coach, saying that OEs told them what to do but also helped them, the way a coach would. One girl said, "[OE] was like giving us clues and stuff where a teacher would be a bit more like, she'd be a bit more explanatory…but he was giving us a bit more freedom of what to do." Only 10% of students viewed their OEs as a role model, camp counselor, sitter, or student. One girl described her OE as a student because she knew her OE was currently a student at the university. Another girl described her OE as a camp counselor, saying, "He just looks like he would run a camp. He said he likes basketball. He looks like he would be a coach." Finally, only one girl described her OE as a role model, with her reasons related more to the appearance of the OE saying, "Every time she comes…her clothes are all so nice and she has these clothes, heels or something, and then her hair is done so nice."

Limitations

We found differing patterns of responses between survey and interview data, such that girls tended to identify their OEs as role models more often in interviews than they did in surveys. While we would prefer closer alignment in findings between the two data sources, we were not surprised by the differences. Differing goals guide surveys and interviews, resulting in distinct questions and contexts that can cue different responses. The interview format allows for follow-up questions and probing to gain a deeper understanding, allowing respondents the opportunity to consider their initial response and elaborate further as needed. Closed-ended survey items only allow respondents the opportunity to check the box or option that most closely matches their feelings or beliefs. Although surveys cue respondents to answer and move to the next question—typically with few options for elaboration—interviews have an interviewer who can prompt for more information in order to capture greater nuance in an individual's response.

In the present study, our primary interest was understanding whether girls viewed their OEs as engineering role models. However, we typically asked girls about role models in a more general sense and did not ask them specifically about career role models. As a result, we may have inadvertently cued girls to think in terms of a more general definition of role model. That is, when our questions defined a role model as "a person you admire, look up to or want to be like," we may have prompted girls to think more about character role models than about engineering role models. Relatedly, while our interest was to better understand what girls look for in role models and how they perceive adults presented to them as engineering role models within outreach, we did not specifically ask girls about their preconceptions about role models. For example, we did not ask the girls about their perceptions of the importance of or the necessity of role models either in general, to them personally, or in relation to a future career. These preconceptions may have influenced girls' responses and could have provided additional explanation for why girls indicated that they did not need role models or for when they indicated OEs could be a role model for someone, yet not for them.

In this study, we focused on how girls who participated in the focal program perceived the OEs. Although we might expect similar findings for all youth in the program, given that they are the same age, we are not able to generalize our findings for boys or nonbinary youth.

Finally, this work cannot speak to the role of race or ethnicity in role model selection. Our data did not support studying the possible connection between the race or ethnicity of the girls and that of their OEs, and subsequent role model uptake. There is research that suggests that youth are more likely to take up role models who they see as racially or ethnically similar to them (for a review, see Gladstone & Cimpian, 2021). Our findings should not be used to make claims about the utility or effectiveness of programs that introduce youth to racially or ethnically matched role models as a means for encouraging youth to engage in and aspire to engineering activities or careers.

Discussion

Our purpose in this paper is to challenge the assumption that youth identify an engineering role model simply because an outreach program attempts to position an adult as such. We questioned whether youth are looking for role models and what role these "models" play in the minds and lives of youth, asking:

1) Are elementary-aged girls looking for role models?
2) How do girls perceive adults presented as potential engineering role models within outreach?

We believe the answer to both questions differs from what we expected, and below, we explore several reasons for why youth may not readily identify potential role models as engineering role models.

Elementary-Aged Youth May Not Be Looking for Role Models

Despite the common practice of introducing youth to potential engineering role models based on the assumptions that doing so will broaden participation in engineering majors and careers, our results caused us to step back and ask, "Are elementary-aged girls looking for role models?" Our data suggest that the answer is yes…and no. In this study, some girls indicated having role models, while others said that they did not need role models. In fact, some girls perceived themselves to be role models for others. When girls mentioned having role models, they most often named family members or friends, followed by celebrities, teachers, and classmates—consistent with previous literature (Bricheno & Thornton, 2007). Some girls across the years did identify their OEs as role models.

Girls Perceive Outreach Educators as Admirable, Appealing, and Emulable—But Not Necessarily Role Models

In this and prior work (Miel et al., 2019), we found that youth see OEs as admirable, appealing, and emulable people—evidence that indicates OEs could be role models to these youth (Gartland, 2014, 2021; Gladstone & Cimpian, 2021; Morgenroth et al., 2015); however, our data suggest that the youth are not necessarily taking up the OEs as role models. Girls described their OEs as someone they could look up to and as someone who inspired them. Some girls directly identified their OEs as a role model, and some girls stated that they wanted to be like their OEs, indicating that their OEs might be a role model to them. Yet, many girls did not explicitly identify their OEs as role models, even if they perceived the OEs as having role model-like qualities. It may be that perceiving an OE as admirable or inspiring is necessary for a girl to take up an OE as a role model, but not sufficient.

Factors Youth Consider When Selecting Role Models

Girls considered multiple factors when selecting role models. The most common reasons girls cited for choosing someone as their role model were perceived personal characteristics and attributes (e.g., being a hard worker or being kind) or because they looked up to someone and wanted to be like them. In fact, the majority of girls said that it is important for a role model to be someone who treats you with respect, is kind, is a hard worker, or is good at what they do. Additionally, girls said a role model should be someone you can look up to, who inspires you, and who you want to be like. The emphasis on personal characteristics as a factor in role model identification suggests that children at younger ages may think of role models purely in the frame of behavioral models that demonstrate things like fairness, patience, friendliness, and how to be a good person.

Uptake of Role Model Prospects as Actual Role Models

Some girls in our study viewed the OEs as role models. However, two things stand out: (a) only a small number of girls saw their OEs as role models and (b) OEs were not necessarily seen as *engineering* role models. While a few girls mentioned having similar interests (e.g., building or engineering) or that their OEs were good engineers, most girls cited

personal attributes (e.g., being nice, kind, funny, patient, or hard workers) or behavioral characteristics (e.g., standing quietly while watching projects being tested) as reasons for choosing their OEs as role models. Additionally, while some girls saw their OEs as possible role models, they noted the OEs just were not role models for them personally. Finally, a few girls stated directly that their OEs were not their role models because these girls did not want to be engineers or simply did not need role models.

Mind the Gap: Reasons for Lack of Role Model Uptake

There are a few possible reasons why girls generally did not take up these OEs as engineering role models. First, simply interacting with a role model prospect may not be sufficient for a youth to identify that person as a role model. Second, the amount and nature of the interactions may not be enough to establish a meaningful connection, which may be a prerequisite condition for identifying someone as a role model. Finally, rather than seeing an OE as an engineering role model, youth may instead see them as a character role model, if they saw a role model at all.

Seeing May Not Be Believing

Meeting a role model prospect is only part of the role-modeling process. In their motivational theory of role modeling, Morgenroth et al. (2015) posit the mechanisms by which a role aspirant takes up an individual as a role model. Youth interact with potential role models and "see" these influential others. However, seeing is not enough. Keeping in mind their own interests and abilities, youth also evaluate the extent to which the possible role model is like them, whether they demonstrate a shared goal, and whether they represent something that is desirable and attainable for them. If the potential role model matches these criteria, then they might be taken up as a role model. We saw evidence of this in our study when girls described their OEs using typical characteristics of role models but indicated that they were "not a role model for me." While girls viewed OEs as kind, hard workers, and good at engineering, the lack of shared interests in engineering ("I want to be a doctor") may have prevented girls from taking up OEs as role models.

Additionally, seeing may not be believing *right now*. Many of the girls in our study described OEs as people of good character. It is possible that role model prospects may not be taken up as *career* role models, but rather as *character* role models, when children are younger (i.e., 9–11 years old). However, as children get older (i.e., 16–18 years old), they may begin looking for career role models, leading them to recall memories of their OEs as good people who were enthusiastic and knowledgeable about engineering. As youth begin to align their developing identities with compatible careers, they may look back to their interactions with their OEs and begin to convert these earlier career role model prospects into actual career role models. It is not known if youth readily convert character role models or career role model prospects into career role models. However, research with undergraduate students suggests that interactions with role model prospects may lay the groundwork for them to function as role models in the future and inspire future persistence in science, technology, engineering, and mathematics (STEM) careers (Stout et al., 2011). This suggests it might be possible for youth to look back and reclassify and be inspired by their OEs as engineering role models at a later time (e.g., when a role model is sought or needed).

Length and Content of Interactions

Second, we question if it is realistic for an individual to be considered a role model after short interactions with children. In spending approximately 16 hours in classrooms over the course of the school year, our program is at the middle or upper end of the amount of interaction between adults and youth that many outreach programs provide. It should be noted, however, that the 16 hours was total time in the classroom and may not reflect the actual amount of one-to-one interaction between youth and adults. Despite this extended period of contact, the fact that many of the youth in this study did not take up OEs as role models makes us question why this was the case. It is possible that the type of interactions did not lead students to connect to the OEs in such a way that they took them up as role models. Alternatively, it may have been that the interactions were not intensive enough to build relationships or establish personal connections that could lead to youth perceiving the OEs as role models.

We think it is realistic that even during short interactions students get some exposure to ideas or areas of engineering, including potential engineering careers, which they had not previously encountered. However, we doubt that in short interactions students are able to gain a sufficient depth of understanding of particular engineering careers, at least not at a level to determine whether the career aligns with personal interests or at a level to disrupt currently held stereotypes of engineering. Additionally, the manner in which content is delivered during interactions with outreach providers may be an important determinant in whether and how they are taken up by youth as role models. Not only do elementary school students rarely identify teachers as role models (Bricheno & Thornton, 2007), but the more "teacher-like" the interactions are, the more likely it is that OEs will be seen as teachers rather than role models (Bricheno & Thornton, 2007; Gartland,

2014, 2015). However, when interactions are more informal in nature, highlight OEs' enthusiasm for a discipline, and focus on developing personal connections, youth are more likely to identify these providers as role models (Gartland, 2014, 2015; Kekelis & Wei, 2010).

Seeking a Role Model?

Finally, we cannot overlook the possibility that students may not view adults as engineering role models because they simply are not looking for this type of connection or relationship. While our findings suggest that girls in fourth and fifth grade do identify role models, they typically are not the role model prospects we presented to them. This suggests that youth this age might be looking for role models to develop their personal identities and character more than for exploring and identifying possible future careers. It could be possible that these elementary-aged youth were not thinking about careers in too serious a manner, and therefore would not be looking for career role models. However, in prior work (Miel et al., 2019), we asked these and similarly situated students about their future career plans, and many of them had future careers in mind. Thus, we believed that students at this age had begun to consider future careers. In the current study, few of the girls were planning careers in engineering, so it may also be that even if these girls had been looking for career role models, they may not have been looking for engineering role models.

Our results suggest that girls viewed engineering role model prospects in two primary ways, in terms of either their function (described using nouns) or their attributes (described using adjectives). When described in terms of their function, girls most often viewed their engineering role model prospects as *teachers*, noting that the behaviors and practices OEs used were similar to those used by their classroom teachers. This identification of the OEs as teachers may have contributed in two ways to girls not seeing OEs as engineering role models. First, as discussed above, youth rarely view teachers as role models (Bricheno & Thornton, 2007; Gartland, 2014, 2015). Second, although someone could be both an engineer and a teacher, if these youth perceived the OEs as primarily teachers, and not as engineers, it is unlikely that these girls would identify the OEs as *engineering* role models. Research on the influence of academic and career role models suggests that it is important for the role model to provide not just inspiration and modeling, but also support and guidance specific to the discipline or career (Nauta & Kokaly, 2001). These girls may have interpreted the OEs to be models of teaching, not engineering, and thus may not have seen the OEs as engineering role models.

In addition, there may be a disconnect between what outreach programs think should be presented to youth and what youth are actually looking for. Prior research has suggested that girls may envision a general role model as different from a career role model (Buck et al., 2008). Specifically, Buck and colleagues found that eighth-grade girls perceived *role models* and *science role models* differently, often describing general role models positively in terms of the personal connection made with them but describing science role models as unappealing and as reflecting negative stereotypes of scientists. In our data, we do not see evidence that suggests elementary students are seeking role models to give them ideas or more information about what it is like to be an adult in certain disciplines. We do, however, see evidence that suggests youth see adults as models of character. Our data and Buck et al.'s work support the conjecture that differing expectations for varied types of role models could have supported the girls in this study to perceive the OEs as *character* role models but not *career* role models.

It is possible that elementary students who develop positive relationships with OEs could, at later dates, look back at these adults not just as admirable people but as admirable representatives of engineering. Additionally, we see evidence that suggests elementary students look to OEs as sources of encouragement and support. OEs could serve to provide youth with recognition and to strengthen their sense of self-efficacy in engineering, thus bolstering their identities as engineers (Godwin, 2016) and supporting students to see "engineer" as a possible and desirable future self (Markus & Nurius, 1986). Finally, although elementary school-aged youth may not be currently and consciously searching for career role models, it is possible that in the future, as they do begin to seek career role models, they could invoke memories of OEs and look to them as engineering role models.

Conclusion and Implications

Our goal was to better understand how youth view potential engineering role models. We found that young girls do not conceptualize role models in similar ways as do adults nor do they automatically take up a potential role model as an actual role model. This suggests that we need to *mind the gap* in engineering outreach. Many outreach efforts showcase engineering professionals in hopes that children will see future possible selves in these professionals and be motivated to pursue pathways leading to similar professions. Therefore, we recommend carefully considering the benefits that youth may derive from interactions with engineering OEs.

While the OEs from our program may not serve as engineering career role models as we originally thought, we have considered various analogies related to the possible beneficial roles they play. First, and consistent with how potential role

models often are presented, OEs may play an **energizing role**, serving to spark and sustain students' interest in engineering. In this case, the OEs could be envisioned as fanning the flames of engineering interest. A second way to think of OEs is as **doorstops**. We often think of youth as having endless possibilities open to them, but as they age, more and more of these doors begin to close as youth begin to narrow down possible career choices (Auger et al., 2005; Gottfredson, 1981; Hartung et al., 2005). By providing youth with opportunities to engage in engineering activities, OEs prevent the door to engineering futures from closing before youth have begun to explore and choose career pathways. Consistent with Stout and colleagues' (2011) stereotype inoculation model, OEs may serve as **vaccines**, such that in-group peers and experts help to protect or shield individuals against stereotypes, thus increasing their sense of belonging in a domain in which they tend to be underrepresented. A final option sees OEs as providing **fertilizer** that provides necessary encouragement or support (e.g., nutrients) to grow youths' interest (e.g., seeds) in engineering. Similar to some seeds that can remain dormant for extended periods before conditions are ripe for sprouting, youths' interest in engineering may emerge as they get older, at which point they could draw on their previous interactions with OEs as they decide whether to further pursue an engineering pathway.

As outreach providers seek to *mind the gap* and optimize the significance of adults to youth participating in engineering outreach, we should design with the particular goals of our programs in mind. Program directors who intend to spark and sustain youth's interest in engineering may wish to position OEs as energizing facilitators of intriguing, memorable engineering activities. Program directors who wish to keep open the doors to engineering may choose to leverage the OEs' disciplinary expertise to support youth to develop technical skills or to leverage OEs' pedagogical skills to support youth to participate in hands-on engineering design challenges. Directors who want to encourage resilience and persistence in the face of systemic obstacles may wish to utilize in-group educators and to design programs in ways that support OEs to serve as vaccines against stereotypes (e.g., Bailey et al., 2023). Directors who wish to cultivate affective resilience might encourage OEs to act as fertilizer by facilitating engaging activities and nurturing students through setbacks, frustration, or failure. Our findings suggest that outreach programs should carefully consider the positioning of OEs as part of purposeful design toward desired outcomes.

Although OEs may not be taken up as role models, we want to be very clear that we are *not* arguing that these educators are not important or lack influence. Adults can play meaningful roles in outreach, but we must think more critically about what these roles are and how they support the goals of engineering outreach with youth at this age. A variety of factors may influence youths' perceptions of OEs, all of which highlight areas in which we need to *mind the gap* between our assumptions about the process of role modeling and what actually takes place. Future work should build a more nuanced understanding of the influences of engineering OEs on elementary-aged youth. A better understanding of what these relationships mean to youth will help outreach providers to more effectively utilize adults to achieve key goals of engineering outreach with students at this age.

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