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Gender Perspectives on Role Models: Insights from STEM Students and Professionals

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Abstract

Qualified professionals in science, technology, engineering, and mathematics (STEM) and STEM education are in increasingly short supply globally. Role models can help increase women's representation in STEM, both at entry and senior levels. The study objectives were to identify the characteristics of role models in STEM higher education and careers and to investigate the differences in role model characteristics between career stages and between genders. We used a mixed-methods methodology involving a questionnaire and interviews. The participants, 788 alumni and final-year undergraduate and graduate students from a STEM research university, responded to the questionnaire, and ten leading women in STEM professions were interviewed. The questionnaire results indicated that a higher proportion of women than men reported being influenced by a role model during their studies. Seven key characteristics of role models were identified from the open-ended responses and the interviews: *ambitious*, *charismatic*, *empathic and encouraging*, *inspiring*, *knowledgeable, gifted*, and *professional*. The most frequent characteristics women mentioned were *empathic and encouraging*. The research findings support and align with the social cognitive career theory (SCCT), demonstrating how role modeling, which is part of the environmental theme, boosts intrinsic motivation—part of the personal theme, for individuals in STEM, especially women. These processes impact women's determination and professional performance—part of the behavioral theme. Based on our findings, to advance toward a STEM workforce characterized by greater fairness, we recommend designing and deploying structured mentoring programs and forums in STEM departments that can provide young women with more role models for success and thus with more hope for success in these fields.

Keywords Role model · Science, technology, engineering, and mathematics (STEM) · Gender · Career · STEM professionals · Women

Introduction

The ongoing acute shortage of scientists and engineers in the workforce hinders global sustainable economic development. Science, technology, engineering, and mathematics (STEM) professionals—scientists and engineers—are in great demand but in short supply, especially, skilled individuals that can be the backbone of tomorrow's workforce (World Economic Forum, 2020).

Both researchers and organizations have been calling for more qualified professionals in STEM and in STEM education, emphasizing underrepresented groups (Lent et al., 2008). The STEM occupational labor force shortage necessitates greater research into educational and career paths leading to these professions (Nugent et al., 2015). Due to the facts that the STEM workforce is aging and minority populations are growing, there is a need to recruit and retain underrepresented populations in STEM (Briggs, 2017). Increasing and diversifying participation in STEM in general and in higher education in particular therefore remains a key concern for policy makers in STEM education (Burt et al., 2023; Moote et al., 2021). Many national economies depend on their hi-tech sector and is currently impeded by a labor shortage, particularly in STEM fields (Atkinson, 2022; Avargil et al., 2020).

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Shortage of STEM Professionals Among Women

During the twenty-first century, science and engineering professions have become less popular among teenagers, especially females (Moote et al., 2021). The USA and Israel face a persistent challenge of attracting and retaining women in STEM fields, a crucial issue for innovation and economic growth. Despite many initiatives, there is still a gender gap in STEM, as men are still hired to senior positions across various sectors much more than women, even in nations with gender equality (World Economic Forum, 2017; Kot & Yemini, 2023). At the same time, STEM occupations match many women's interests and abilities (Cannady et al., 2017; Rocker Yoel & Dori, 2023). Furthermore, the potential contributions of women to STEM sectors are consequential, as they possess unique insights into ways that scientific innovations can meet the needs of other women (Harding, 2016). A prevalent barrier, identified across cultures, is gender gaps in self-efficacy for STEM achievement (Avargil et al., 2020; Stewart et al., 2020), and in career in STEM (Chomphuphra et al., 2019; Avargil et al., 2023).

Female role models in STEM are vital for inspiring positive attitudes among young girls towards STEM careers. The lack of female mentors and peers in these fields can deter women from pursuing them, perpetuating underrepresentation. Introducing girls to STEM role models in elementary and middle school can foster their interest in math and science. It can be done by increasing exposure to successful female STEM professionals through initiatives like school visits or media projects about women scientists. These can help challenge stereotypes and encourage the participation of young women in STEM. Moreover, universities should offer networking opportunities to help undergraduate women in STEM establish supportive relationships and networks with diverse role models (Wang & Degol, 2017).

In the job market, both at entry and senior levels, role models have strong potential to promote women's STEM representation (Curtin et al., 2016). According to social cognitive theory (SCT), role models can increase individual' self-efficacy, an important motivational factor (Bandura, 2001). Researchers claim that observing and emulating the behavior of role models tend to increase motivation for performing the same behavior, which facilitates the acquisition of new skills (Sahin & Ozerdogan, 2014). More specifically, Miller and colleagues (2015) examined women stereotypes. Chen and colleagues (2020) asked the question whether a strong sense of identity in science domains during college was associated with gender-matching between students and their high school science teachers. They found that the gender role model effect was strongest when the gender role models aligned with the overall gender representation in the school or society.

However, few studies have explored the effects of role models on STEM higher education achievement or explored alumni's perspectives on role models (Bettinger & Long, 2005; Fuesting & Diekman, 2017; Shin et al., 2016). To the best of the authors' knowledge, no studies have been published on role models of early career and senior professionals as a potential source of motivation to succeed in STEM careers. There are a few studies on career choice in higher education which are based on the social cognitive career theory (SCCT) with emphasis on women (Avargil et al., 2020, 2023). However, characteristics of STEM role models, especially women, were investigated neither in a diverse population in terms of age and career experience nor in the context of a hi-tech-oriented country. In our study, we aim to highlight the need for identifying role model characteristics to enable empowering girls and women in STEM and ensure competitiveness and economic prosperity, especially in hi-tech industry (Houston, 2020; Women in Hi-Tech Report, 2022). In light of the potential significance of role models and gender gap of prior research about them, the study objectives were (a) to identify the characteristics of role models that motivated STEM professionals at diverse career stages to choose and remain in their careers and (b) to investigate the differences in the identified characteristics between the professionals' career stages and genders.

Theoretical Background and Literature Review

The study is grounded in two theoretical frameworks: SCCT (Lent et al., 1994, 2008) and motivation theories. We begin with presenting well-established theories of motivation that have direct implications for the characteristics of motivational role models. We then present the social cognitive theory and the social cognitive career theory. We follow with an overview of role models in STEM higher education. Finally, we focus on women students and professionals and on the characteristics of teachers or mentors that make them role models.

Theory of Motivation

Gladstone and Cimpian (2021) provide a systematic review of four well-established theories of role models that elucidate specific role model characteristics that motivate others. These theories included expectancy-value theory, mindset theory, attribution theory, and SCT.

Expectancy-value theory (Eccles & Wigfield, 2002, 2020) states that a person's motivation to engage in a particular behavior is determined by their expectations of success (expectancy) and the value they attach to the outcome (value). The researchers (Morgenroth et al., 2015) introduced into the construct of role modeling the idea of role ambitions and their effect on motivational processes by presenting a theoretical framework for better understanding not only when, but also how, role models can effectively influence motivation and goals of others.

Mindset theory (Dweck, 2006) stated that people's beliefs about their abilities and potential for growth (a fixed mindset versus a growth mindset) can greatly impact their motivation and success. Those with a growth mindset believe that their abilities can be developed through hard work and dedication, while those with a fixed mindset believe that their abilities are set and cannot be changed. Attribution theory (Graham, 2020; Weiner, 1988) suggests that people seek to understand the causes of events and behavior, and they will attribute causes to either internal factors or external ones. In summary, expectancy-value theory focuses on a person's expectations and values as motivators, mindset theory looks at a person's belief about their abilities, and attribution theory examines how people attribute the causes of events and behaviors. SCT (Bandura, 1977(and SCCT, along with motivation theories constitute the theoretical framework for our study.

Gender Differences in STEM-Specific Self-Efficacy

Self-efficacy and interest were identified as key mediators in choosing one's academic major and in making career decisions. Women in STEM fields tend to show lower self-efficacy compared with men. Stewart and colleagues (2020) emphasized gender disparities in STEM self-efficacy, particularly in math and science classes. Sakellariou and Fang (2021) studied the role of math and science self-efficacy in predicting college STEM enrollment while considering factors such as academic achievement and gender differences. They found a consistent STEM self-efficacy gender gap despite occasional instances of girls reporting higher self-efficacy, especially in science. Simpson and Maltese (2017), who studied the role of success and failure in STEM career persistence, noted that women frequently attributed their success to luck rather than to strong abilities or hard work. The researchers also indicated that among women, failure sometimes stems from low self-confidence, potentially affecting women's outcomes in STEM. In STEM fields, gender disparities in self-confidence are particularly pronounced in chemistry, computer science, and engineering (Wilson et al., 2015). Investigating gender differences in engineering, Seron and colleagues (2016) found that women often lack self-efficacy, assertiveness, and confidence in fitting into the engineering culture. With respect to engineering students' self-efficacy and course grades in foundational courses, Whitcomb and colleagues (2020) highlighted the importance of self-efficacy in student learning. They found that men demonstrated significantly higher confidence levels despite minimal or reverse disparities in grades in engineering, physics, and mathematics courses.

Social Cognitive Theory

Bandura (1977), in his social cognitive theory—SCT, claimed that the person or people, their behaviour, and their social environment interact with each other to affect self-efficacy. SCT specified that self-efficacy for distinct tasks grows upon observing a role model who performs the same or similar tasks. According to the SCT, individuals who serve as role models can have a significant impact on those around them, especially youngsters during the process of developing their sense of self. By observing the actions and behaviors of a role model, students can learn what is acceptable and what is not. For example, a child who has a positive role model who consistently demonstrates behaviors, such as determination and kindness, is more likely to adopt these values themselves.

Three aspects of role models determine whether they can cultivate students' self-efficacy, and thereby, their performance (Bandura & Walters, 1963; Kenneth Jones & Hite, 2020; Schunk & DiBenedetto, 2020). The three aspects are (a) the role model's perceived competence, (b) the perceived similarity of the role model to his/her students, and (c) the attainability of the role model's success. In short, SCT posits that self-efficacy is promoted by role models.

A role model's ability to foster the subjective value of STEM may depend on their identity and demographic characteristics similar to the ones of the students and may underline the STEM profession as a good fit with the students' long-term goals and aspirations (Gladstone & Cimpian, 2021). The three aforementioned aspects of role models informed our assessment of characteristics of effective role models.

Social Cognitive Career Theory

Lent et al. (1994) based their SCCT on Bandura and Cervone's SCT (1986). In SCT, the person, their behaviour, and their social environment all interact with each other to affect that person's self-efficacy. SCCT uses the SCT model to explain people's behaviour in three stages of career choice: (1) the creation of academic and professional interests, (2) selection and attainment of career-related goals, and (3) performance and persistence in educational and occupational initiatives. SCCT comprises three dynamic, mutually reinforcing themes: (a) personal factors, entailing an individual's cognitive and emotional strengths, self-regulatory processes, and personal preferences; (b) environmental factors, such as parental or spousal support, mentors, and role models; (c) behavioural factors, which are actions that ultimately shape whether individuals attain their goals. SCCT has been applied for researching STEM career choice (Alshahrani et al., 2018; Avargil et al., 2020; Mau, 2003; Schnoes et al., 2018). According to SCCT, a person's educational experiences affect their self-efficacy and expectations of the consequences of their own behaviour, which, in turn, affect their career choice (Lent et al., 2000). Individuals are most likely to select occupations that they believe they will succeed at (Le et al., 2014). There are also environmental factors which affect career choice, such as ethnic background, gender-related norms, cultural and familial expectations, availability of educational and occupational opportunities, work-related challenges, and relevant to this study, role models (Lent et al., 2008; Sjaastad, 2012). Lent and colleagues (2000) suggested to divide the social environment in Bandura and Cervone's model (1986) into two: immediate and close versus broad and cultural.

Gender Differences in STEM Career Selection

Israeli society is mostly Western in nature (Smooha, 2023). Despite gender gap in Israel's hi-tech sector, particular potential is demonstrated by females from diverse social-economic backgrounds. These girls outperform or perform on par with boys in programs for gifted students (Dori et al., 2018). According to Zohar (2006), there are several factors which distinguish between the experiences of boys and girls when it comes to STEM. First, boys tend to have more experiences related to STEM. Second, at times, parents and society at large communicate different messages to boys and girls regarding the need to achieve and gain independence, and girls tend to feel less confident and have lower self-esteem when tackling scientific subjects. Zohar (2006) has also claimed that the way scientific subjects are taught at school may be less suitable for girls.

Fouad et al. (2010) found that girls' selection in a science or mathematics career was most influenced by their teachers' expectations of them—be they low or high—while boys were also highly influenced by their peers' level of interest in these subjects. Negative stereotypes of female abilities ascribed to by faculty members may also contribute to the underrepresentation of females in STEM undergraduate majors (Leslie et al., 2015). Stereotypes can impede math and science-related recreational interests and career aspirations (Szymanowicz & Furnham, 2013).

Role Models in STEM Higher Education

Role models provide several key advantages. The following research findings illustrate the theories described above. Role models can provide encouragement and promote a sense of belonging and self-efficacy for STEM educational attainment, particularly for individuals who feel connected to the role model (Bandura, 2006; Shin et al., 2016). Role models motivate students by demonstrating that goals are attainable. They are directly involved in an individual's life, providing encouragement, as well as access to professional information, skills, and social networks (Saltiel, 1985; Soltovets et al., 2020). The researchers (Shin et al., 2016) drafted biographies of STEM professionals that challenged the view of STEM professionals as innately talented individuals who do not need to work hard to succeed. The researchers reported that students who read these biographies, as compared with students who did not read them, exhibited a higher level of interest in STEM careers and identified more with the professionals. For example, women reported an increase in perceived fit in STEM after reading biographies of successful STEM role models who were also women. Wilson and colleagues (2012) showed that STEM undergraduate students benefitted from mentors who cultivated their metacognitive abilities and higher order thinking skills. Studies of scientists, physicians, and science and engineering higher education students found that social support, including role models, had promoted their aspirations (Fuesting & Diekman, 2017) and achievements (Hazari et al., 2010; Kang & Kaplan, 2019).

Rask (2010) reported that the gender of instructors influenced undergraduate students' choice of major. Similarly, Bettinger and Long (2005) investigated the influence of instructor gender on undergraduate females' choice of major. They reported mixed results regarding STEM subjects: while female students were less likely to major in biology or in physics when their initial courses had female instructors, the opposite effect was observed for geology, mathematics, and statistics. Other researchers (Drury et al., 2011) have argued that the influence of female role models on the career choice of younger females affects STEM career persistent. By contrast, role model's effects on career retention are less understood. To fill this research gap, the present study explores how role models influence professionals' motivation in STEM fields, especially among women.

According to the situated expectancy–value theory model (Eccles & Wigfield, 2020) people's identities can influence their motivational beliefs. Individuals gain a sense of belonging when they view themselves as matching the stereotypes or prototypes for a given group identity, such as people in STEM. Thus, if someone associates people belonging to STEM as being from a different gender or racial/ethnic group, they may become less likely to identify with STEM (Starr et al., 2019).

Starr and colleagues (2019) explored virtual reality as a space for a possible self-intervention to decrease stereotype threat and increase (physical) STEM motivation. Their study was among the first to explore whether a possible self-intervention supported by virtual reality, moderated by identification, could increase academic motivation in STEM domains among women.

Due to the importance of role models in STEM fields and in the absence of physical accessibility, digital technologies are being used to facilitate access to role models. Skov and Lykke (2023) presented a literature review on how digital technologies facilitate students' interactions with STEM role models. They discussed how role model visits enabled by digital technologies can be conveyed to young people across a broad diversity of role models, breaking stereotypical perceptions of STEM professions.

Women Role Models in STEM Higher Education

Women in STEM have been making great strides toward gender parity in higher education, but some key gaps of resources abide (Appiah-Castel et al., 2020). Men, scientists and engineers, are often thought of as pursing their career for a love of knowledge, intellectual challenge, and strong academic performance, and therefore the select of and retain a STEM major and career particularly in engineering. However, women are markedly underrepresented in STEM careers and are affected by social factors and sense of belonging. In particular, a study by Dennehy and Dasgupta (2017) found that women, but not men, mentors promoted women students' retention in engineering majors. Lacking women role models is linked to avoiding or leaving STEM majors. Women faculty also report a collective lack of mentoring and supportive policies (particularly for work–life balance) leading to burnout (Pololi & Jones, 2010). Specific support of mentors and role models include promoting students' self-efficacy, motivation, sense of belonging, and occupational aspirations. Furthermore, role models can introduce students to prospective employers and graduate degree advisors, and overall stewarding their professional advancement (Dasgupta & Stout, 2014).

Characteristics of a Role Model

Students accept people as role models when they are relevant and possess qualities they value in a role model. Aish and colleagues (2018) focused on developing the intrinsic motivation of STEM minorities and female students, calling for a larger pool of realistic STEM role models. They began their study by identifying the qualities valued by STEM higher education students' existing role models and defined five qualities.

Gladstone and Cimpian (2021) systematically reviewed the literature on the topic of inspiring students—particularly female and minority students—to pursue STEM by exposing them to role models. They discussed features of role models that might increase versus decrease students' STEM motivation, focusing in particular on the three features we discussed above: role models' competence, their similarity to the students, and the attainability of their STEM career. The authors claim that the relationship between the perceived competence of the role model and in-group students' motivation had an inverted-U shape: Describing the role model as competent increased student motivation and performance, but only up to a point.

Other researchers (Han et al., 2021) studied high school STEM teachers' role after attending summer training and teaching integrated STEM the next year. They found that teachers' confidence and expectations, along with students' attitudes towards STEM and awareness of STEM careers, influenced students' STEM knowledge. The researchers (Zhang et al., 2023) investigated the impact of a week-long Biotech in Action (BIA) program that emphasized role modeling and studying authentic science for high school students. The researchers showed that students can learn about jobs and career by interacting with STEM professionals from biotechnology companies.

When the role models belonged to groups that are underrepresented in STEM (e.g., women, people of color), they often had positive effects for all students, regardless of demographic similarity. In contrast, majority-group models did not motivate students from underrepresented groups and at times demotivated those students.

Methods

We used a mixed-methods methodology, including quantitative and qualitative elements. We used statistical analyses to compare close-ended item responses and content analysis (Creswell & Creswell, 2017) to identify categories in open-ended item responses.

We begin this section by presenting the research objectives and questions; after that, we describe our research participants and settings (see Table 1). Next, we describe the study's data collection tools and how we deployed them. We end this section with an explanation of the data analyses that we conducted.

Research Objectives and Questions

The objectives of this study were (a) to identify the characteristics of role models that motivated STEM professionals at diverse career stages to choose and remain in their careers and (b) to investigate the differences in the identified characteristics between the professionals' career stages and genders.

The study involved three *research questions* (RQs).

RQ1: What characteristics of role models do STEM students and professionals describe?

Table 1 Research questions, tools, and data analysis

Research question		Research tool	Data analysis
RQ1	What characteristics of role models do STEM students and professionals describe?	Online questionnaire Interview	Qualitative research methodology Content analysis
RQ2	What are the differences, if such exist, in different career stages regarding the characteristics they describe in their role models?	Online questionnaire	Quantitative
RQ3	What are the differences, if such exist, between women and men regarding the characteristics they describe in their role models?	Online questionnaire	Quantitative

RQ2: What are the differences, if such exist, in different career stages regarding the characteristics they describe in their role models?
RQ3: What are the differences, if such exist, between women and men regarding the characteristics they describe in their role models?

Settings and Participants – The Israeli Context

The Israeli hi-tech sector shows a significant gender gap as presented in the report by the Innovation Authority and Women in hi-tech Report (2022). It revealed alarming figures: while women comprised 33% of the industry's workforce, they held just 28% of tech roles and only 9.4% of CEO positions in the past decade. They also secured only 4% of the industry's investment, with 96% going to men. This pattern persists as women advance, posing challenges for their integration into hi-tech as they age. For example, despite half of mathematics matriculation exam at the end of high school takers being girls, they make up only 23% of development and cybersecurity roles in the IDF and less than 31% of undergraduate students in hi-tech (Women in hi-tech Report, 2022). However, the potential to narrow the gender gap in engineering studies and hi-tech stems from the Israeli women scientists' blend of rational and emotional reasoning when balancing career and family. Many women marry and have children during their studies, seeing their careers as important as their family. For example, when considering post-doctoral research opportunities abroad, they weigh career prospects against emotional ties and commitment to their family at large (Yair, 2020).

Technion – Israeli Institute of Technology (the institute) is a top-tier STEM-centric higher education institute and research university with more than 15,000 enrolled students. For many decades, the institute's graduates have made major contributions to various sectors of Israel, especially to the hi-tech industry (Frenkel & Maital, 2012).

The research participants comprised two groups (see Fig. 1):

- Questionnaire respondents'—788 alumni and final-year students of a prestigious science and engineering research university.
- Interviewees—10 leading women in STEM professions, graduate from prestigious the same research university.

Questionnaire respondents included 533 alumni and 228 final-year students. Our selection of final-year students was based on their advanced stage of study and readiness to graduate, as these students are about to enter the work world. We split alumni into twentieth century alumni and twenty-first century alumni, based on the lowest degree obtained from the Institute—undergraduate or graduate. The participants' undergraduate degree completion year ranged from pre-1979 to 2018, presenting a wide range of ages. Table 2 summarizes participants' gender and the highest degree they obtained from the Institute.

The interviewees included ten leading STEM professional women. Their ages range from 26 to 61. All interviewees have a degree from the Institute. All of them have graduate degrees. During the interviews, we explored what made senior women's role models special. We interviewed women from a variety of STEM fields. Interviewees included Arab, religious, and immigrant women, as well as Jewish, secular, and native-born women.

The interviewees did not include undergraduate students since, in the open-ended questions, they only wrote very briefly and succinctly when describing the characteristics of their role models, assuming they had no prior career experience and lacked a broad retrospective view. Additionally, the students' future careers do not always focus on the field they studied. It was important from a research perspective to delve deeper and understand the impact of the role models on those who actually work and have a senior career. This enabled us to take a holistic view of the influence of the role model characteristics throughout their career trajectory.

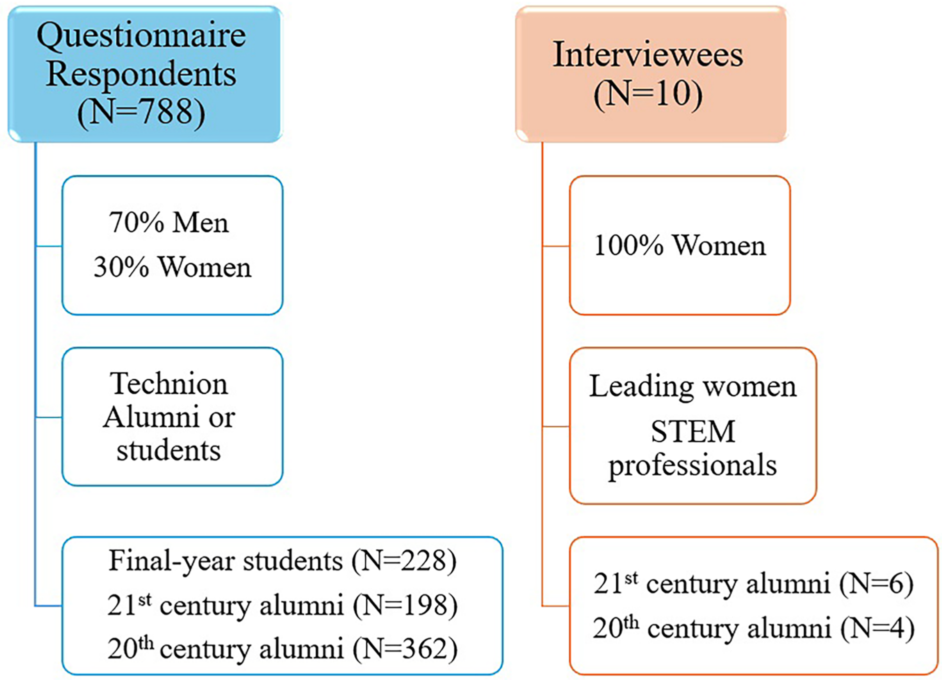


Fig. 1 An overview of the research participants and tools

Research Tools

The research tools included online questionnaires and interview protocol.

Online Questionnaire

We developed two versions of an online questionnaire in Hebrew—one for students and another for alumni—in which we asked respondents to provide information about role models they encountered, if any, during their studies at the Institute. The questionnaire was distributed by email via the Institute alumni association and the faculty secretariat as well as through social media. The questionnaire also included other items unrelated to role models. Further details regarding the development and deployment of the questionnaire can be found in Lavi and colleagues (2021). Aside from items concerning the demographic variables described in Table 2 above, the questionnaire contained an open-ended item which read as follows: "If you found role models during your studies at [Institute name], please describe one or two such people and describe two salient characteristics about each of them" (translated from Hebrew). We purposely did not provide a definition of "role model," so that respondents were free to interpret this term as they wished, based on their own subjective experience. Respondents were asked to describe the role model's characteristics according to their subjective perception, regardless of the role model's role.

See "Data analyses" below for an explanation of how we identified particular characteristics based on responses to this item.

Table 2 Gender and highest degree obtained from the Institute

Variable		Final-year students ($N=228$)	Twenty-first century alumni ($N=198$)	Twentieth century alumni ($N=362$)	All ($N=788$)
Gender	Men	63%	61%	75%	70%
	Women	37%	39%	25%	30%
Highest degree from the Institute	Undergraduate only	51%	60%	50%	53%
	Graduate[a]	49%	40%	50%	47%

[a]With or without an undergraduate degree from the Institute

Interview

We conducted short semi-structured interviews with 10 participants. For the interviews, we selected senior STEM women from different disciplines and positions who consented to be interviewed and provided their email addresses in the questionnaire. The interviews lasted from 15–30 min. During the interview, we asked questions about role models the women had, the characteristics of the people who influenced and motivated them along the way, as well as their career path. In most cases, interviews were conducted in the participants' offices.

Data Analyses

We used SPSS version 24 for statistical analysis and a confidence level of 95% for every statistical test we carried out. In what follows, we describe the data analysis as it relates to each of the three research questions.

In assessing the open-ended answers and in analyzing the interviews, we employed a qualitative research methodology, which is interpretative in nature (Erickson, 2012). To discern characteristics of the role models, the participants' answers were coded and categorized via open-ended content analysis (Creswell & Creswell, 2017), identifying categories with open-ended item data.

Content analysis began with initial semantic coding (Terry et al., 2017) conducted separately by two of the co-authors on 100 randomly selected responses—50 of alumni and 50 of students. This coding was reviewed by three of the authors of this paper, leading to a revised coding scheme agreed upon by all three of them, with clearly defined themes. To ensure that the category classification was correct, three judges ranked about 10% of the statements for each category separately. The inter-judge agreement ranged from 84.1 to 95.6%, with Cohen's kappa ranging from 0.831 to 0.947. Using the revised coding scheme, one of the authors coded the remaining.

Analysis of the Questionnaire Open-Ended Questions – Role Model Characteristics (RQ1)

In assessing responses to the open-ended items, we employed a qualitative research methodology, which is interpretative in nature (Erickson, 2012). Our analysis process included four main steps: first, to discern characteristics of the role models, the participants' answers were coded and categorized via open-ended content analysis (Creswell & Creswell, 2017). Content analysis began with initial semantic coding (Terry et al., 2017) conducted separately by three of the co-authors on 100 randomly selected responses—50 by alumni and 50 by students. Second, the participants' answers were read thoroughly by the same authors, who coded them into categories in an open-ended manner. This coding was reviewed again, leading to a revised coding scheme agreed upon with clearly defined themes. Third, to ensure that the category classification was correct, then each of the three authors independently coded a new un-coded sample and reached agreement, after deliberating on the appropriate categorization of each answer.

Fourth, to ensure consistency, a sample of 15% of the participants' responses and their codification was assessed for inter-coder agreement (Weber, 1990). The inter-rater was calculated using Cohen's kappa analysis, indicating a good reliability ranged from 84.1 to 95.6%, with Cohen's kappa ranging from 0.831 to 0.947 (Landis & Koch, 1977).

Analysis of the Interviews – Role Model Characteristics (RQ1)

As explained in the Research tools and data collection section, the interviewees were asked about their role model characteristics. The authors coded interview transcripts according to the list of role model characteristics identified from the responses of the questionnaire respondents (Table 3).

Analysis of the Questionnaire – Differences Between Research Populations by Career Stage (RQ2) and Gender (RQ3)

We classified the participants into career stages into final-year students (career selection), twenty-first century alumni (firmly in career retention), and twentieth century alumni (at the end, or already past, career retention). Participants were divided so that the twenty-first century alumni were those who graduated since 2007, which means that they started studying at the institution after the beginning of the twenty-first century. We checked for differences between participants in different career stages for (a) mentioning they had found a role model during their studies and (b) the characteristics they had identified in their role models. These characteristics were identified via open-ended content analysis of participants' responses to the open-ended item "If you found role models during your studies at the [Institute name], please describe one or two such people and describe two outstanding characteristics about each one of them." We performed Pearson's chi-square tests with 95% confidence interval for (a) percentage of those who found a role model and (b) for each role model characteristic. For significant results ($p < 0.05$), we performed post-hoc Bonferroni tests to ascertain the order of frequencies for each group.

Table 3 Example statements from questionnaire about characteristics of role models

Category	Distribution	Respondent statement in the questionnaire
Ambitious	19%	"Ambitious innovation" [#60114—21st A]
		"Undergraduate lecturer […] said that to know software you had to work Thanks to him, I understood what hard work in learning is from the first semester" [#94008—S]
Charismatic	4%	"Great charisma combined with an extensive knowledge in all areas" [#13060—S]
Empathic and encouraging	41%	"One of the best lecturers […] with incredible humanity" [#33522—S]
		"My advisor instilled in me the belief that I can also do things by myself" [#31802—21st A]
Gifted	24%	"The capital market lecturer […], he is a decent person and a gifted lecturer [#19275—S]
Inspiring	19%	During the undergraduate studies there were a number of fascinating and inspiring lecturers" [#34290 – 20th A]
		"*An amazing, smart, and feminist woman who inspires me a lot. Neither recoil nor scared, still able to teach warmly and elegantly everything in the best atmosphere*" [68621- Student]
Knowledgeable	26%	"There was one lecturer who stood out for the knowledge and skill he had acquired in the industry" [#24211–20 th A]
Professional	40%	"A great lecturer and a pleasant person. Took his position as an instructor very seriously" [#54904—21st A]

S student, *21st A* twenty-first century alumni, *20th A* twentieth century alumni

To investigate gender differences, we compared women and men with respect to (a) mentioning a role model during their studies and (b) characteristics they had identified in their role models. Here too, we performed Pearson's chi-square tests with 95% confidence interval for (a) percentage of respondents who found a role model and (b) for each role model characteristic.

Results

Our findings are presented according to the study's research questions (RQs).

Characteristics of STEM Students' and Professionals' Role Models (RQ1)

Out of the 787 questionnaire respondents, about 80% identified role models they had found during their studies at the Institute and described them. Firstly, we will refer to the relation between career stage and finding a role model. Among final year students, 25% reported that they did not find a role model, while among twenty-first century and twentieth century alumni, 16% and 19% reported it, respectively. Pearson's chi-square test did not show a significant relation between career stages and finding a role model. Secondly, we will refer to the relation between gender and finding a role model. Of all female respondents, 87% reported finding role models while studying at the Institute, compared to 77% among males. Pearson's chi-square test showed a significant relation between gender and finding a role model, $\chi^2(1) = 9.417$, $p < 0.05$.

As part of the questionnaire, students and alumni were asked to identify role models they encountered during their studies at the Institute. Out of the 629 respondents who declared that they found a role model during their studies at the Institute, 519 described a role model with salient characteristics. Table 3 presents the role models' characteristics we identified along with example statements from questionnaire responses.

According to respondents, the most important role models' characteristics are *empathic and encouraging* (41%), *professional* (40%), *knowledgeable* (26%), and *gifted* (24%).

These characteristics were mentioned by at least a quarter of participants we could classify.

We defined a category only for characteristics mentioned by at least about 5% of respondents. The only unusual category was *charismatic*. Despite only 4% of respondents mentioning this category, we decided to define it as a separate category since the interviewees mentioned it several times in their interviews.

Among the interviewees, nine of ten reported to have found a role model during their academic studies or early career.

Some examples of statements from the interviews are cited below, to demonstrate the importance of role models for senior women in STEM.

> *The career of a scientist entails guiding students, training the next generation of scientists. "I've admired faculty members who encourage their students to succeed, by collaborating with and guiding them. Consequentially, their support helps the students to advance. Indeed, their own students have become faculty members or are trailblazers in their own right"* [SLB_19].
> *"Some women who couldn't find a role model confessed that they wanted one desperately.*
> *Even top scientists want to be mentored when they take on a new challenge"* [NT_51].

Another example from an interview with a senior faculty member presents the inspiration she received from her advisor, a woman with a strong personality.

> *"My Ph.D. advisor had a strong female personality. She was and still is a role model for me. It is important to emphasize that she was a mother of four children. To me, that really speaks to her strengths. I learned a lot from her, much of which I implemented when I became a mother myself. I held her in high esteem as a woman and as a mother and as a successful academic. She was from a past generation, and endured many obstacles because she's a woman"* [AR_12].

All of the characteristics listed in Table 2 were also mentioned in the interviews. Table 4 in Appendix A provides a complete list of examples for statements from each category.

Characteristics of STEM Students' and Professionals' Role Models by Career Stage (RQ2)

Out of the 629 respondents who claimed to have found a role model during their studies at the Institute, 111 gave responses that could not be classified into any characteristic. Unclassified responses were either too short or too vague to be classified into a characteristic.

Figure 2 shows the percentage of participants in each career stage who identified a particular characteristic in their role model, out of the total number of participants who described role model(s) with salient characteristics.

Following each Pearson's chi-square test, a *post-hoc* test was conducted using Bonferroni adjustment for multiple pairwise comparisons (see Appendix B Tables 5 and 6). The analysis shows that the students mentioned *ambitious* significantly more (about twice as much) than alumni, students mentioned *empathic and encouraging* significantly more than twenty-first century alumni, and students and twenty-first century alumni mentioned *inspiring* significantly more than twentieth century alumni. Conversely, both alumni groups mentioned *knowledgeable* significantly more than the students.

Characteristics of STEM Students' and Professionals' Role Models by Gender (RQ3)

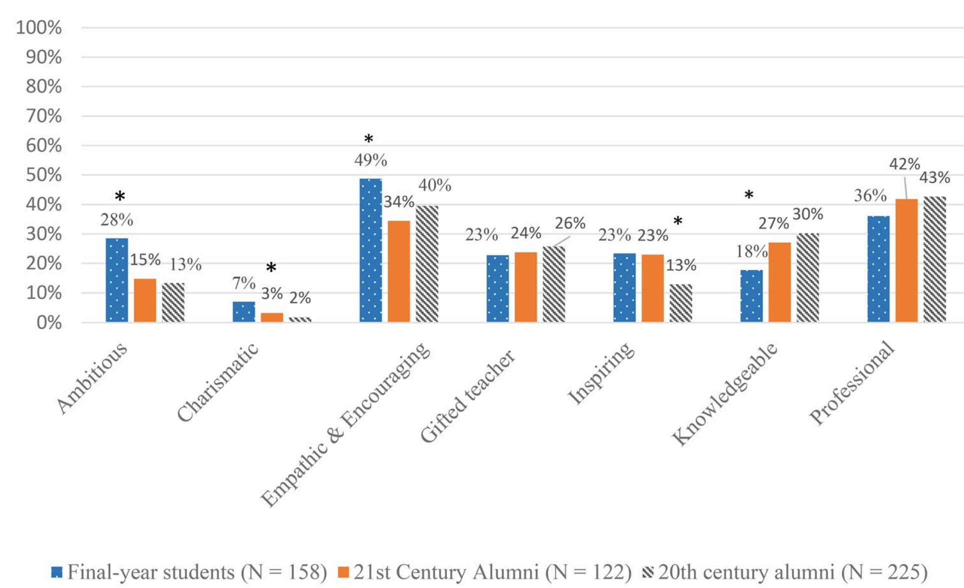
We first address the differences between women and men when it comes to finding and describing a role model. As mentioned before, among 786 questionnaire respondents, 629 said they found role models during their study at the Institute. The majority (519) described a role model with salient characteristics as described in Table 2.

Figure 3 shows the percentage of men and women divided to three categories: (a) did not have any role model, (b) mentioned name(s) of role model, and (c) defined salient characteristics.

As shown in Fig. 3, role models were found more by women (87%) than men (77%), and more women defined salient characteristics in their role models than men (77% and 61%, respectively). In addition, there were significantly more men that only mentioned the name of the role model they found (or its professional role), rather than mentioning any salient characteristic their role model had. Statistical details regarding these results are provided in Appendix B, Table 7.

From here on, we will only refer to men and women who have found a role model and described at least one salient characteristic. Figure 4 shows the percentage of participants in each gender who identified at least one salient characteristic

Fig. 2 Percentage of questionnaire respondents' in each career stage and their role models' characteristics they described. * $p < .05$



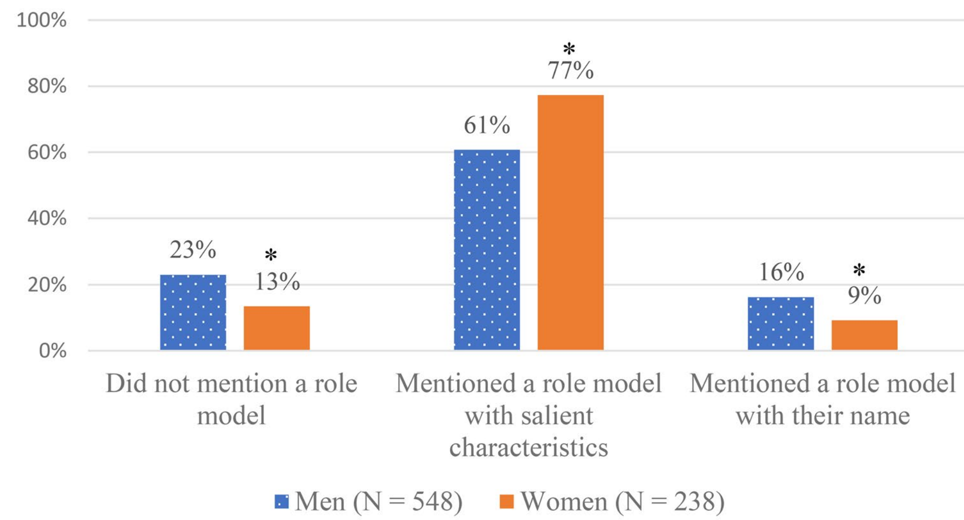


Fig. 3 Percentage of men and women divided into three categories based on the role models found and their descriptions ($N = 786$). * $p < .05$

in their role model, out of the total number of participants who described role model(s) with salient characteristics. As can be seen in Fig. 4, *empathic and encouraging* was the most common characteristic (41%) to look for in role models by both men and women. Higher percentage of women (22%) than men (17%) chose to describe their role models as *ambitious*. Also, we found that more women (23%) than men (17%) spoke about being inspired by the role models they chose. Comparison of chi-square values for role model characteristics by gender, we found no significant differences between men and women.

Discussion and Contributions

Role models are crucial for many STEM professionals, regardless of gender or career stage. This study underscores the importance of strong interpersonal skills, like empathy and encouragement, for STEM professionals. Success in science and engineering hinges on effective interactions with mentors and role models. The global hi-tech industry heavily relies on STEM professionals, but there is a shortage due to declining interest among young adults (Avargil et al., 2020; Kohen & Nitzan, 2022) and challenges faced by women and minority STEM students in higher education (Burt et al., 2023). Role models can profoundly influence these students' aspirations and careers. However, finding suitable mentors remains a persistent challenge across educational and career stages.

STEM Role Models

In this section, we discuss the findings in light of the research questions and the pertinent literature.

Discussing the Main Characteristics of STEM Role Models

Our first research question concerned the characteristics of role models that STEM students and professionals look up

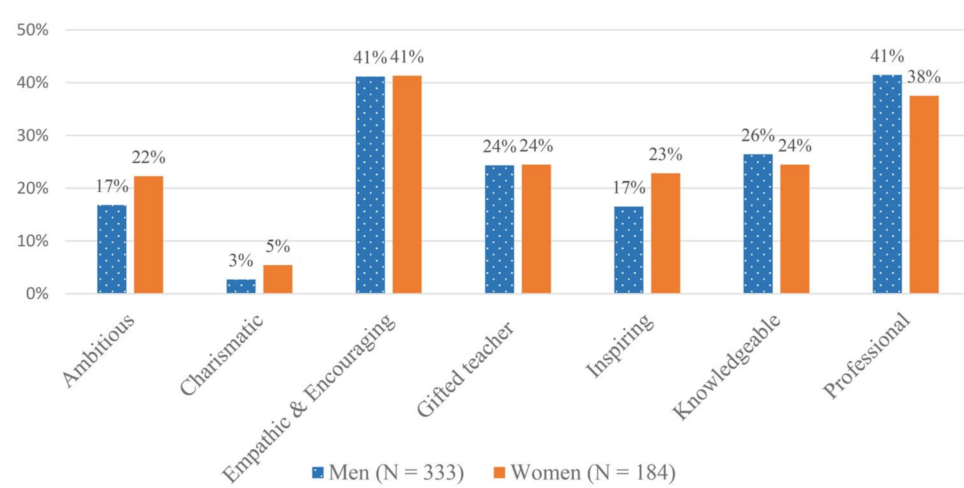


Fig. 4 The distribution of the characteristics in questionnaire respondents by gender

to. Most participants (80%) indicated they had found a role model during their early academic career. Based on the analysis of the questionnaire respondents, we identified seven key characteristics of role models: *ambitious*, *charismatic*, *empathic and encouraging*, *inspiring*, *knowledgeable*, *gifted*, and *professional* (summarized in Table 2). Our analysis of the interviews of the senior women further supported these characteristics. All seven characteristics were discussed by senior-level women during the interviews (Table 4, see Appendix A).

Previous studies have already identified several of these characteristics as key features of role models in STEM fields (Aish et al., 2018; Shin et al., 2016). The researchers (Aish et al., 2018) focused on developing the intrinsic motivation of STEM minorities' students, calling for a larger pool of realistic STEM role models. They began their study by identifying the qualities valued by STEM higher education students' existing role models and defined five qualities such as constant improvement and resilience (ours *ambitious*), relatable (ours *inspiring*), and empathetic and helpful (ours *empathic and encouraging*). However, they had a much smaller sample, and they did not investigate the characteristics of role models found by STEM professionals in various stages of their careers. Others (Shin et al., 2016) examined participants' perception of role models to determine whether role model biographies were viewed as possessing the key features of effective role models (such as *inspiring*, competent, likable, and obtainable). In contrast to the present study, they used features and characteristics mentioned in previous studies and did not refine them based on participants' responses (Shin et al., 2016).

Role models' most important characteristics, according to the questionnaire respondents, were *empathic and encouraging* as well as *professional*. Many women and men, particularly in the early career period, chose to describe mentors with these characteristics. During the interviews, senior women often emphasized the importance of encouragement and support. Some of them explicitly attributed their professional skills development to their role models. Participants emphasized their rapport with teachers, lecturers, and advisors, who supported them personally and whose engaging manner fostered their scientific curiosity.

This finding comes as no surprise, as *empathy* is an important factor in fostering learning and interest in any filed, including STEM. In a recent study, narrative design elements in science museums were examined to see if they helped fostering empathy to engage girls in engineering activities. Researchers found that eliciting empathy made girls show more engineering skills (Peppler et al., 2022). Based on SCT (Bandura, 2012) and mindset on theory (Gladstone & Cimpian, 2021), role models may empower young women and men by developing their self-efficacy and self-confidence. Young people who choose STEM as a result of finding a *professional* and *emphatic* role model are likely to adopt these characteristics in their future career.

Characteristics of STEM Role Models by Career Stage

The second research question dealt with the differences between participants according to their three career stages—students in their final year, twenty-first century alumni usually just starting their careers after graduating from university, and twentieth century alumni who are at their peak many years after graduation. Overall, students appreciated more empathetic and encouraging role models, while alumni, especially the older ones, appreciated more professionalism and deep knowledge.

In retrospect, twentieth century alumni likely remember the mentors who encouraged them to persist and feel that these mentors had a significant impact on their careers. The characteristic of ambition was more valued among students than alumni. We believe that during their rigorous academic studies, they faced significant challenges for the first time, mainly due to the intense and high level of study they experience in the Institute (Avargil et al., 2020). Therefore, this is the career stage when persistence, high demands, and ambition begin to develop and are most appreciated. Studies indicate that ambition and hard work are qualities valued by school and higher education students (Shin et al., 2016). Unlike the present study, (Shin et al., 2016) examined only undergraduate students and referred them to particular features that interested the writers.

Further, we found that the *inspiring* characteristic was significantly more important for students and twenty-first century alumni than twentieth century alumni. During the early stages of a career, finding an *inspiring* mentor is important for developing a successful career and raising personal and professional self-confidence.

A number of studies have examined the positive impacts of an inspirational and relatable STEM role model on a career in STEM (Aish et al., 2018; Shin et al., 2016; Sjaastad, 2012). Almost all were carried out with high school or undergraduate students, and none involved advanced career stages. Sjaastad (2012) studied Norwegian STEM students; he indicated that high school students' interpersonal relationships with science professionals are key factors in order to inspire and motivate a choice of STEM fields in higher education.

Among the questionnaire respondents, significantly more alumni (both twenty-first and twentieth centuries) than students described role models with deep knowledge of their fields. According to another study (Shin et al., 2016), these two characteristics were merged and called competent and listed as one of five key features of STEM role models. In contrast to our results, the undergraduate students participated in this study gave a very high rating to this feature. As mentioned before, their study included only undergraduate students, so it is impossible to know how this characteristic was ranked among participants who were at a more advanced career stage. In our opinion, alumni who have already entered the labor market tend (in retrospect) to credit their academic studies with giving them valuable professional knowledge and often describe *knowledgeable* people they met during this period as their role models.

Characteristics of STEM Role Models by Gender

Finally, answering the third research question, we discussed the differences in the role model characteristics as described by men and by women. Significantly more women than men reported having found a role model during their higher education studies. There were significantly more women than men who defined salient characteristics in their role models among those who found a role model.

The results of this study, along with previous ones, have illustrated that women benefit from supportive environments more so than men (Avargil et al., 2020; Lent et al., 2000, 2008). Mentors and role models have been shown to facilitate self-efficacy for STEM achievement (Kang & Kaplan, 2019). They are of particular importance for women, since studies have shown that women studying science and engineering tend to lack self-efficacy and assertiveness (Seron et al., 2016; Wilson et al., 2015) and that some women who are STEM professionals tend to attribute their success to luck rather than to strong abilities or hard work (Simpson & Maltese, 2017).

A key gender difference is that women tend to lack self-efficacy and assertiveness (Stewart et al., 2020; Avargil et al., 2023). Women exhibited significantly lower self-efficacy for math and science classes than men. The authors advised enacting policies including intervention strategies that have been demonstrated to promote STEM self-efficacy, such as exposing students to successful peer role models.

The characteristics of ambition and inspiration was described by more women than men. Perhaps, women (more than men) experience that advancing and achieving in the male-dominated STEM world requires them to fight. Many women STEM professionals, especially the older generation, have struggled to prove themselves to others; they have faced significant obstacles on their path to a successful career.

Women emphasized both *professional* and personal inspiration from their role models. The respondents felt more confident when they followed the character who inspired them. Men were more likely to describe *professional* inspiration (enthusiasm in a particular field), while women also described drawing personal inspiration, including how to balance work and family life. Many of the role models described as personally *inspiring* were senior women who also served as lecturers or advisors. These findings are in line with those of Bandura (2012) and Gladstone and Cimpian (2021), who discussed the constructs of *professional* inspiration, perceived attainability, and perceived similarity. In the Israeli context (which we described in the research setting), many women in Israel balance career and family but pay the price of lacking self-confidence in their ability to manage both areas simultaneously (Yair, 2020). In this study, we observed that choosing role models who are women with families enhances the self-efficacy of young women in the STEM fields that they too can achieve this integration and develop a successful career (Avargil et al., 2023).

Students mentioned *ambitious* significantly more than alumni and *empathic and encouraging* significantly more than twenty-first century alumni. Conversely, alumni mentioned *knowledgeable* significantly more than the students.

The STEM senior women and men in our study described their role models as professionals and *knowledgeable*. Other researchers (Kenneth Jones & Hite, 2020; Zhang et al., 2023) investigated the effect of role models on young people after they interacted with professional scientists or workers in advanced industry such as biotechnology. This experience increased students' confidence of learning sciences and enriched their understanding of STEM careers. Our results are similar to those of Skov and Lykke (2023), who describe how STEM role models can illustrate authentic work tasks and environments through virtual field visits that allowed students to study work processes in production companies, laboratories, or remote locations.

Senior women in particular described personal inspiration during their STEM doctoral or post-doctoral studies and felt that they believed in their ability to lead a career and build a family of their own when they were advised by women who also had children. According to the expectancy-value theory (Morgenroth et al., 2015), similarity and attainability are important role model features of an advisor or mentor. Starr and colleagues (2019) explored virtual reality as a space for a possible self-intervention to decrease stereotype threat and increase (physical) STEM motivation. They found that virtual reality can increase academic motivation when participants identify with the experience. Similar to our study, they found that women who perceived their virtual mentor as similar to themselves demonstrated higher STEM motivation, while women with a low perceived similarity lost motivation to pursue a STEM profession.

We present seven role model characteristics and presume that the positive effect on the success of the STEM senior women in our study was enhanced since the level of similarity and attainability of the role models were high. The innovation of this study is the investigation of the role model effect on more mature students or professionals in science and engineering. We narrow the gap between career choice and career retention using a retrospective view of professionals help expand the STEM workforce. The media often portrays women in STEM careers as struggling in their personal lives (Colatrella & Gomard, 2011). Therefore, women lack positive female role models who are both successful scientists and have a long-term partner.

In relation to SCCT, the existence of role models can fall under the immediate and close environment (Lent et al., 2000), which affects the student's or professional's personality and behavior and ultimately their career choices. The findings of this study clearly show that STEM role models play a larger role in the career choice of women than that of men, whether students or professionals, and that role models which are perceived as empathetic and encouraging as well as those who are perceived as professional play the largest role within this category. Based on this implication, a couple of potential suggestions might be (a) to train faculty, managers, and people in similar roles to improve these particular characteristics within themselves so they can serve as better role models for a larger number of women in STEM and (b) to expose female engineering and science students to female engineers and scientists who can serve as relatable role models and mentors, helping to counter stereotypes and increase representation in the field.

The main findings of this study and their relationship to the SCT and SCCT are illustrated in Fig. 5.

The findings of our study are consistent with previous studies showing that role models could promote female STEM attainment, both at entry and senior levels (Curtin et al., 2016). Unfortunately, it can be especially problematic in fields of STEM where female representation is notably low. Firstly, women who hope to make a career in these fields may find it difficult to find a female role model. Secondly, the low representation of women in these fields could deter them from pursuing careers in these fields.

A Limitation, Contributions, and Call for Mentoring Programs

The limitation of this research is that our sample of students and alumni was from one STEM research university. The main contributions of the study are as follows:

- The list of role model characteristics was derived through content analysis, rather than being predetermined, thereby increasing the likelihood that this list of characteristics is fully comprehensive.

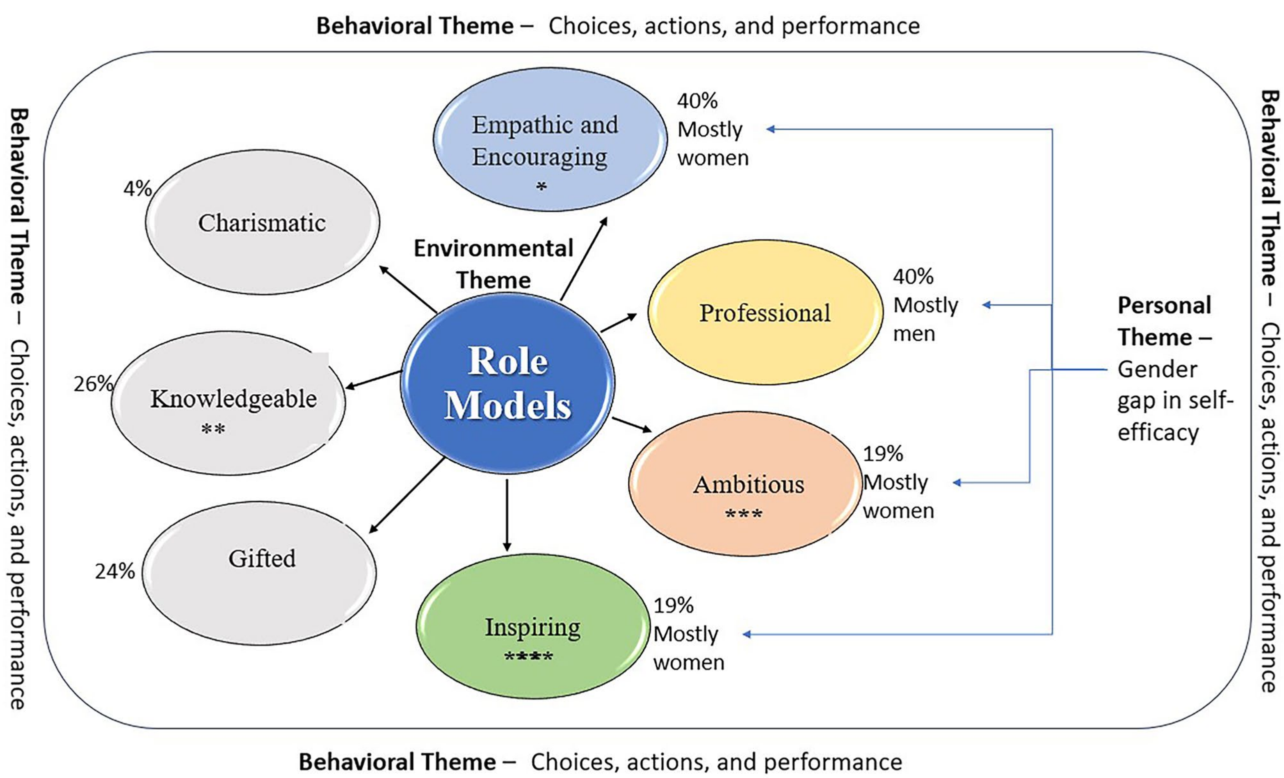


Fig. 5 Key characteristics of role models and the relationship to SCT and SCCT. *Students mentioned *empathic and encouraging* significantly more than twenty-first century alumni did. **Alumni mentioned *knowledgeable* significantly more than students did. **Students mentioned *ambitious* significantly more than alumni did. ****Students and twenty-first century alumni mentioned *inspiring* significantly more than twentieth century alumni did

- This study examined an especially large group of participants at a range of STEM career stages—students, recent alumni, and senior alumni. Cross-gender comparisons for STEM role model characteristics are also novel.
- Role models' functions, which are part of the environmental theme, help STEM individuals find reinforcement for their personal characteristics. Interaction with role models contributes to the enhancement of self-efficacy of STEM individuals in the characteristics that are important to them, leading to improvements in their STEM career path.
- The research findings support and align with the SCCT theory, demonstrating how role modeling in the environmental theme boosts intrinsic motivation in the personal theme for individuals in STEM, especially women. These processes impact women's determination and professional performance in the behavioral theme.

This study demonstrates the positive impact of role models on professionals' choice, retention, and career advancement in STEM-related fields. We believe that mentoring programs led by higher education institutions hold great potential, and therefore, we call for more structured mentoring programs or forums, especially for women, in STEM universities. Such initiatives would expand the STEM workforce, a necessity for many countries. Ideally, mentoring programs should be offered at three different levels to young people at different stages of their STEM careers.

This study, along with previous ones, has demonstrated that women benefit from supportive environments even more than men do. Collaborative and collegial atmosphere are important supports that not all STEM professionals find during their academic studies or at work, but would promote occupational retention and development. We showed that mentoring has a very important contribution. The lack of research on mentoring initiatives is consistent with higher education's lack of formal mentoring programs in undergraduate studies. One reason for the scarcity of mentors is that few senior-level professionals possess relevant expertise, time, and interest. There is a marked lack of institutional mentoring programs and a limitation to communicate how important mentors can be. Particularly for women, role models are crucial to improve their self-confidence in STEM fields mostly dominated by men, and in particular, female role models to inspire them to balance family and career successfully and show them that it is possible.

Appendix A

Table 4 provides example statements from interviewed participants' descriptions of their role models' characteristics.

Table 4 Statements from interviews about characteristics of role models

Category	Statement
Ambitious	"a good mentor should have] … curiosity. Being cognizant that you don't know, and it is ok that you don't know and want to know. Habits of mind (disposition toward knowledge) is more important than abilities. There are smart people who do not succeed. What distinguishes them from successful individuals was enthusiasm and hard work" [RNB_50-20th A]
Charismatic	I had a charismatic professor who taught me a lot about medicine and advanced organic chemistry. Later, he showed us his research laboratory and explained how the research is actually done. There was no doubt that he was full of charisma, which influenced many of us to specialize in the field of medicinal chemistry [NT_28-21stA]
Empathic and encouraging	My [research] advisor, a man, used to tell me repeatedly that I must stop apologizing. He would return emails that I sent him in which I had apologized. I learned a lot from him. He instigated a change in me [AR_9-20thA]
	"I really liked Professor D's approach. She always answered to the students…. As my mentor and boss, she always told me that I could do it! She saw me in the corridor one day with a coat on, and said, [metaphorically] that the work [my new position that she helped me find] is like a suit jacket, I have to make it fit well. There is nothing like support. She always says to me 'You will succeed" [AA_33, 74-21stA]
Inspiring	I was very enthusiastic about him. He [the PhD advisor] opened me up to the world of engineering. He was awarded a Nobel prize recently. [AF_16-20thA]
	"She's amazing, a very enthusiastic person who breathes science, lives science, her whole life revolves around it, she's great at motivating [others]. I could be stuck with a problem… meet with her, and even if the problem wasn't solved, I would leave the meeting motivated to continue [solving it] from other angles. She's full of a spirit of enthusiasm and curiosity, everything interests her…" [NLY_50-21stA]
Knowledgeable	I really wanted to learn from him [a post-doc advisor at a university located abroad]. The field was at its incipience, and I wanted to study it [AF_15-20thA]
Gifted	Why [did I choose] chemistry? I had an amazing, gifted chemistry teacher in high school. Out of 13 students who major in chemistry, 7 continued in this domain and studied chemistry also at the university [DA_82-20thA]
Professional	I felt he was more experienced and senior at the academic aspect, and I really wanted to learn from him, and he actually opened up to me the world of engineering [AF_15-20thA]
	I [was] welcomed in a very nice way [to the lab]. My post-doctoral advisor was a role model, in terms of how he led a group [of students], how he accomplished 1001 different things simultaneously" [SLB_50-21stA]

Appendix B

Tables 5, 6, and 7 provide statistical data regarding the results in the results section. The data were obtained by using SPSS version 24.

Table 5 Chi-square results for characteristics identified in role models, by career stage

Characteristic	*df*	χ^2	*p*
Ambitious	**2**	**17.227**	**< .05**
Charismatic	**2**	**7.037**	**< .05**
Empathic	**2**	**6.324**	**< .05**
Inspiring	**2**	**8.922**	**< .05**
Knowledgeable	**2**	**7.143**	**< .05**
Gifted	2	.444	.801
Professional	2	1.732	.421

Significant results are emboldened

Table 6 Percentages and chi-square, a *post-hoc* test results for characteristics identified by questionnaire respondents' in role models, by career stage

Characteristic/career stage	Students	twenty-first century alumni	twentieth century alumni	*p*
Ambitious	**28%**	**15%**	**13%**	**< .05**
Charismatic	**7%**	3%	**2%**	**< .05**
Empathic	**49%**	**34%**	40%	**< .05**
Inspiring	**23%**	**23%**	**13%**	**< .05**
Knowledgeable	**18%**	27%	**30%**	**< .05**
Gifted	23%	24%	26%	.801
Professional	36%	42%	43%	.421

Only significant results are emboldened

Table 7 Comparison of chi-square values for categories of role model identification, by gender

Response category	*df*	χ^2	*p*
Did not have any role model	**1**	**9.417**	**< .05**
Mentioned name(s) of role model	**1**	**6.699**	**< .05**
Defined salient characteristics	**1**	**20.176**	**< .05**

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Declarations

Ethics Approval The study received the approval of the Institute's Behavioral Sciences Ethics Committee # 2018–48.

Consent to Participate Informed consent was obtained from the participants in the study.

Conflict of Interest The authors declare no competing interests.

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