Board 179: The Effect of Role Models on Interest in STEM (Work-in-progress)

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The Influence of Role Models on Students' Interest in STEM (Work-in-Progress)

Introduction

STEM fields drive our nation's economic growth and competitiveness with new innovative technologies [1]. In a projection, it was estimated that from 2019 to 2029 STEM jobs will grow by 8%, compared to 3.7% for all other occupations. However, it is a concern that some STEM fields will not have enough graduates to satisfy the demands of the industry [2]. In addition, there have been concerns that STEM education is not well understood and could be contributing to the decline of future professionals in STEM [3]. The presence of role models in STEM could have a large impact on students' interest in pursuing a STEM field, especially if they identify with it[4].

Role models have a positive influence on students' motivation and desire to accomplish their goals [5]. Some qualities that role models have, such as confidence and relatability, can have a large influence on student outcomes, particularly for women in STEM [4]. Studies show that while parents have significant influence on students' interest in STEM, both parents and friends have significant influence on students' career choice intention [6]. Role models can be a powerful influence on the way students view themselves and how they conduct their lives [5].

In this study, male and female students' interest in STEM was examined and its connection to the presence of role models. Data was collected from summer outreach camps from 2017 to 2022, although, because of COVID-19, years 2020 and 2021 are not included. These camps were designed to increase interest in STEM. Data was analyzed to evaluate the influence role models can have on students' interest in STEM.

Program Description

During the summers of 2017 to 2022, students and teachers from Utah were given the opportunity to attend a week-long engineering camp at Utah State University. The camp was designed and led by engineering faculty members with the help of college student mentors. The goal of the camp was to spark students' interest in STEM. The summer program was a part of the GEAR UP program which is funded by the Department of Education. While at the camp, students engaged in various project-based activities to help them better understand STEM [7].

Data Collection

Students took a pre-survey on the first day of the camp, which included demographic information and the STEM-CIS (Career Interest Survey) based on the work of Kier, Blanchard, Osborne, and Albert [8]. The STEM-CIS consists of 44 five-point Likert scale questions/statements. The survey was divided into four sets of 11 questions/statements based on the four areas of STEM. An example statement was, "I am interested in careers that involve engineering." The same survey was conducted immediately after the camp.

Those same surveys included open-ended questions in order to collect qualitative data. A few examples of the open-ended questions are, *"What made you choose to come to this camp?"*,

"Name, in order, the three biggest influences on your choice of career in the future." , and *"What is your perception of STEM careers and their importance?"*

Demographics

There were 137 participants, 44% of them were female and 56% were male. The students were in grades 8 through 11.

Data Analysis

A mixed research design method was utilized for this research that allowed for the analysis of quantitative and quantitative data. The quantitative data was analyzed using R and Microsoft Excel. The qualitative data was split by years of the camp and gender. The data was read by two undergraduate students and their faculty advisor. Each member read through the data and agreed on common themes in the data. Next, the data was coded by two undergraduate students using the MAXQDA 2022 software. The faculty advisor provided guidance for the students on how to perform qualitative coding. The coding was informed by the literature [9] and [10]. Intercoder reliability was over 80%.

Qualitative Data Results

Table 1. Qualitative Data Results

Themes	Male Pre	Male Post	Male Total	Female Pre	Female Post	Female Total	Total
Immediate Family	29	28	**57**	26	34	**60**	**117**
Extended Family	8	8	**16**	6	3	**9**	**25**
Celebrities	21	15	**36**	5	5	**10**	**46**
Friends/Peers	18	14	**32**	10	16	**26**	**58**
Teachers/Mentors	10	10	**20**	13	10	**23**	**43**

As shown in Table 1, the most frequent theme that the students observed was "*Immediate Family"*. Female students had a total of 60 mentions of their immediate family being a positive influence on their choice of future career. One female student mentioned that, "*Seeing the things engineers in my family have done*" was a positive influence on their choice of career. Another female student wrote, *"My oldest brother was an engineer."* A male student mentioned, "*Last is because of my parents I really want to make them proud so that none of their hard work goes to waste. So I can accomplish the dream they never had the chance to take."*

The second most common theme was "*Friends/Peers"*, with a total of 32 mentions by males and 26 by females. Many students' responses mention different friends or peers in their lives. In a post-camp survey, a male student said that their *"friend's dad"* was an influence. *"Friends",* was a common response among both male and female students.

"*Celebrities"* was the third most frequently encountered theme. There were more male students than females that listed celebrities, with 36 males and 10 females. Some students listed

celebrities in STEM whereas others listed celebrities that they see as role models. One male student mentioned that "*Neil Armstrong, Elon Musk, and Albert Einstein*" were the top influences on his choice of career. In a post-camp survey, a female student wrote *"Neil Degrass Tison"* as one of their biggest influences.

The fourth theme was "*Teachers/Mentors*", which was not far behind "*Celebrities*", with a total of 43 mentions. The totals among males and females were roughly equal. Many students listed teachers they have had and some specifically mentioned teachers in the STEM area. One female student mentioned in a response to who influenced their choice of career, "*My teachers and how well they do the subjects but also my other teachers that teach me other things that I might want to go into.*" A male student in a post-camp survey listed *"math and science teacher"* as an influence. *"My AP Teacher"* was a response from a female on what influenced her to attend.

The final theme was "*Extended Family*". The number of mentions to extended family was small. Some students listed aunts or uncles, as well as grandparents. A female student said, "*My great grandfather was the Dean of Students for the engineering building for USU.*" Another male student mentioned, "*My grandfather repairs old pc's*." Many students also mentioned their grandparents and cousins as people who have had a positive influence on their choice of career.

Quantitative Data Results

The first question on the questionnaire was whether the camp itself changed the response average concerning, "I have a role model in subject X". If it did change (increase) then it would seem reasonable to assume that the student may have seen an adult engineer or scientist at the camp that they admired. The researchers analyzed the responses to the question, "I have a role model in subject X", and as shown in Table 2, paired t-tests were used to obtain P-values.

Table 2. Paired T-test Results

Subjects	Male	Female	Total
Science	0.105	**0.042**	**0.021**
Technology	0.191	0.208	0.421
Engineering	**0.021**	0.172	0.267
Math	0.190	0.266	0.139

There were only a few significant entries (typeset in bold). It makes some sense that the Males had a significant change in response since most of the involved professors at the camp were male. There were ample opportunities to see an adult male engineer who is successful and giving back to the community. For females, they may have felt (significantly) that they had gained a role model (or identified a role model retroactively), but not particularly limited to the engineering domain, but rather *science*. The professors involved in the camp were all male, except for one science professor, who was female. She was present at two of the four camps. The female students may have noticed how male-dominated the engineering fields are, but this did not decrease their interest in STEM, rather, it diverted it from engineering to *science*.

Second, the researchers analyzed the correlation between the answers to, "I have a role model in subject X" and "I am interested in subject X". The researchers wanted to explore whether having

a role model in STEM was in some way affecting overall interest in STEM. These correlations were taken from both the pre-and post- surveys separately, and shown in Table 3.

Table 3. Correlation coefficients between interest in STEM and having a role model in STEM

Subjects	Pre- camp	Post- camp
Science	0.323	0.322
Technology	0.421	0.332
Engineering	0.420	0.441
Math	0.412	0.557

These correlations (Pearson correlation coefficient) are all significant (sample size n=136). This should not be particularly surprising as it is already known that if a young student has a role model in subject X, they tend to be interested in subject X. The researchers were interested in exploring whether there were gender differences regarding role models.

The researchers of this paper have had conversations about the role models that are present in popular culture in the U.S. and the notable lack of female role models in STEM. Big names include Elon Musk, Neil deGrasse Tyson, Bill Nye, Carl Sagan, Anthony Fauci, Stephen Hawking, Jane Goodall, etc. It was difficult naming a *current* female scientist or science promoter that is pervasive in popular culture. Thus, the researchers formed the hypothesis that female camp attendees would answer the Role model question at a lower rate. The researchers also investigated the correlation between Role Models and STEM interests (by gender).

The average response to the statement, "I have a role model in STEM", is given in the Table 4. *Note: The average was calculated by averaging the responses to the specific question for each of the individual STEM subjects*.

Table 4: Average response to, "I have a role model in STEM".

Male		**Female**	
Pre-camp	**Post-camp**	**Pre-camp**	**Post-camp**
3.59	3.72	3.48	3.48

As shown in Table 5, females had a lower average response in both the pre and post-surveys. If you compare the pre-camp male and female responses, they are not significantly different (p=0.231). However, comparing the responses in the post, the p-value was 0.064. It was observed that males responded higher on, "I have a role model [in STEM]", after the camp, whereas females responded at the same rate as the pre-camp. This serves as a loose indication that females are not finding role models in summer engineering camps. This data also indicates (albeit mildly) that females have fewer role models, in general.

The correlation between, "I have a role model in subject X", and, "I have interest in subject X", is broken up across gender and is shown in Table 5.

From the data, it is apparent that females' interest in STEM is not as correlated to having a role model as it is for males. We offer the conclusion that females who have an interest in STEM fields are doing so in the absence of role models.

Table 5. Correlation coefficients between interest in STEM and having a role model in STEM

	Male		Female	
Subjects	**Pre-camp**	**Post-camp**	**Pre-camp**	**Post-camp**
Science	0.395	0.454	0.214	0.164
Technology	0.496	0.423	0.332	0.230
Engineering	0.528	0.603	0.310	0.275
Math	0.477	0.621	0.340	0.494

It should be noted that there was an anomaly detected in Math where both genders displayed an apparent increase in correlation after the camps. Since there were no mathematicians present, the researchers put forward the hypothesis that the students were influenced by the vast presence of math within the engineering activities and gained more respect for the subject's standing within STEM applications. How this exactly came to be in the correlation above is not clear and therefore should be taken with a grain of salt and investigated in future iterations.

Conclusion

Findings in the literature imply that female students place a higher emphasis on role models [4]. However, the results show that males placed slightly higher importance on having role models than females. The analysis indicates that role models and influencers have a significant influence on students' interest in STEM. This is similar to findings in the literature [5]. Of particular note is that female students have fewer role models in STEM. According to the National Science Board, 34% of the STEM workforce and 14% of the engineering workforce is female [11]. If we are to increase female presence in STEM fields, one possibility is to increase female presence in popular culture that pertains to the STEM fields.

In the qualitative analysis, males mentioned celebrities and influencers at a far greater rate than their female peers. In the quantitative analysis, the data indicate that males had a higher (when compared with their female peers) presence of a role model, and a role model was more correlated to their interest in STEM.

Female students mentioned "Friends/Peers" at a higher rate after the camps than males, indicating the possibility that they did not find any new role models at the camps, and that their interest occurred by the encouragement of their friends and peers. The researchers worry that without female role models present in popular culture, female students have a high turnover rate in the STEM fields as eventually their friends and peers may elect to go to different states and schools and their underlying support network diminishes.

This is a work in progress and future GEARUP summer camps would allow for more data collection. With this, more conclusions can be drawn on the impact of role models on male and female students in future research.

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