Factors Influencing the Interest Levels of Male versus Female Students going into STEM Fields (Evaluation)

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Introduction

The fields of Science, Technology, Engineering, and Mathematics, also known as STEM, have experienced rapid growth in terms of their importance and the demand for qualified graduates [1]. STEM careers provide an essential driving force behind new innovations and growth in the United States. STEM fields have seen a job growth rate three times that of non-STEM careers, and are continuing to grow [2]. Despite efforts to increase the number of STEM graduates, The United States is struggling to supply enough qualified workers to fulfill these demands. The United States is facing a problem as students' interest, and therefore literacy in STEM has been declining while the demand for STEM graduates has been increasing [3].

The gender gap in STEM fields has become increasingly evident in recent years. Women have made strides regarding equality in education, degrees awarded, and in the workforce. However, one area where there is still significantly more males than females enrolling and graduating is in STEM fields [4]. Primary and Secondary school grades show that females perform just as well, if not better than males in math and science courses [4]. However, once students reach the undergraduate and graduate levels, the female interest in STEM drastically drops off. According to the National Science Foundation, while in total, women are earning 57% of all bachelor's degrees, they are only earning about 20% of engineering degrees, about 20% of physics degrees, and less than 20% of computer science degrees. The percentage of women earning bachelor's degrees in Mathematics and Statistics has increased to over 40%, but there is still a large gap for woman to fill in other STEM fields [5].

This study looked into which factors influence both male and female students to pursue STEM fields. This work reports the results from two summer outreach engineering camps in 2017 and 2018. The summer camps focused on increasing students' interest in STEM. Discovering which factors influence these students, especially the female students, can help gain an understanding of what is needed to promote interest in STEM fields, and help fill the demand of the workforce.

Program Description

Students and teachers from multiple school districts in Utah were invited to attend a week-long summer engineering camp designed to increase their interest in STEM. The camps took place in the summers of 2017 and 2018. The camps are part of a 7-year grant funded by the Department of Education as part of the GEAR UP program. The grant's overall goal is to help more than 3,000 middle and high school students' to improve their academic achievement, creating a pipeline of academically prepared students enrolling and excelling in college. During the summer camp, STEM teachers and students participated in a variety of engineering activities. They developed research hypotheses, and proposed methods to test those hypotheses, and thought like engineers. Participating teachers applied the research and engineering camp activities to develop classroom lessons for their science classroom to meet the Next Generation Science Standards (NGSS) framework which has engineering as a fundamental component. The number of participating students in the 2017 camp was 33 and the number of teachers was 10.

For the 2018 camp, the number of participating students was 44 and the number of teachers was also 10. This paper builds on the work of researchers who had presented results from a previous year of the program [6].

Participant demographics for student participants is shown in Table 1 below.

Table 1. Demographics of student participants

Category	Number (Percentage)
Age in years N (%)	
13	3 (3.9%)
14	41 (53.3%)
15	35 (45.5%)
16	1 (1.3)
Gender N (%)	
Male	40 (51.9%)
Female	37 (48.1%)
Ethnicity N (%)	
White	59 (76.6%)
Asian	3 (3.9%)
Hispanic	11 (14.3%)
American Indian or Native Alaskan	3 (2.5%)
Other	3 (2.5%)

As to be expected, most of the students are the same age at 14 and 15 years old (eighth graders going into ninth grade for the 2017 camp and ninth graders going into tenth grade for the 2018 camp). Most of the student participants are also from the White ethnicity (76.6%). Hispanic students made 14.3% of the sample. Asians and Native Americans also made up 3.9% and 2.5% of the population, respectively, and other ethnicities represented 2.5% of the sample. Those numbers are comparable to the Census data for Utah. Gender distribution was almost even with 51.9% male and 48.1% female.

The program was designed to promote hands-on learning, and minimized passive classroom learning. The main theme of both engineering camps was water and environmental engineering. The 2018 camp included advanced water engineering including drones used in agriculture and air quality engineering. Before the camp activities started, students completed a pre-camp survey to determine their perceptions of and interest in STEM, as well as the factors influencing that interest. The same survey was given to students at the end of the engineering camp to determine the impact the camp experience had on improving the student's perception and increasing their interest in STEM, as well as examine which factors influenced that interest. This research focused on the differences between males and females in terms of the factors influencing their interest in STEM fields.

Below is a description of activities the students and teachers were involved in during both the 2017 and 2018 camps.

Engineering Camp 2017:

The **first** day of the engineering camp included activities to pique the students' interest in using STEM activities to better manage water resources. The day began with an activity showing students the water cycle and illustrate the amount of available fresh water for human use in the hope of increasing their appreciation for the scarcity of usable water. The results of this activity showed up many times in the daily journals students wrote as they learned more about the importance of water conservation. The water cycle activity was followed by a fish tagging activity. This included how the fish tagging process was done, the importance of it, and how scientists and engineers use the process to determine the health of streams and movement of fish in the stream. With the aid of a graduate student in Fisheries Biology, students had the opportunity to engage in the practice of tagging fish.

During the **second** day of the engineering camp students visited three sites along a river in a local water shed. The first stop was upstream in the mountains where the river is fed from melting snow. The second stop was downstream of camping, fishing, kayaking and other recreational uses of the water at a point just before the river enters the city. The final stop was after the river had passed through the city, farms and ranches in the area. At each stop, students took various physical and chemical measurements of the water including temperature, flow velocity and volume, dissolved oxygen, turbidity, and nutrient concentrations including phosphates and nitrates. The students also collected and characterized macro invertebrates living in the river. The point of this activity was to show the students what happens physically, chemically, and biologically to the water as it flows downstream, passes through a city, and changes in response to the influence of human civilization. The day's activities also included a hike to a beaver dam.

The **third** day of the engineering camp focused on storm water impacts and water treatment. This included a simulated storm water activity comparing run-off volume and intensity as rainfall was simulated on an area covered in vegetation and another area covered with asphalt/concrete to show the potential impact of urban development (increases in impervious surface areas). The students then visited a parking lot storm water system at a local chain box store and observed the plants used to filter pollutants running off of the parking lot such as oil/gas. Those pollutants get washed away by the rain, but before the water enters the storm water system, it passes through this thick vegetation area and is cleaned by the specialized plants. Students also had the opportunity to see what happens as a non-reactive fluorescent tracer (simulated pollution) is dumped into the local river and observed how fast and how far pollution can spread. Finally, teams of students competed at building a water filter from sand and gravel. Faculty and student researchers judged the quality of the filters based on the clarity of the filtered water as well as the speed at which the filter worked.

The **fourth** day of the engineering camp focused on wastewater treatment plants. Students looked at bacteria under the microscope and saw some of the bacteria that are at work at biological treatment plants such as the ones they would visit later that day. After learning about

bacteria related to treatment plants, students visited a local treatment lagoon and wetland system that filters the water of the surrounding county and then visited and sampled and analyzed water quality parameter at another mechanical treatment plant. The students learned the differences between the two treatment methods; natural and mechanical as well as the advantages and disadvantages of both.

During the **final** day (Day 5) of the engineering camp, students presented what they had learned in a poster session followed by a presentation session. Finally, students completed a post survey to gauge their learning and what had changed about their perceptions of STEM.

Table 2 below shows a summary of the activities students and teachers engaged in during the week-long engineering camp in 2017.

Table 2. *Outline of the weeklong engineering camp 2017*

Day	**Activity 1**	**Activity 2**	**Activity 3**	**Activity 4**
Monday	Water Cycle	Fish tagging		
Tuesday	Measuring water properties at multiple locations along a local river, starting upstream and then going all the way downstream.			
Wednesday	Water Run off experiment	Storm water impacts/multiple location	River Dye activity	Building and testing a water filter
Thursday	Looking at bacteria under a microscope	Site visit to local lagoons treatment facility, sampling and analysis of water quality parameters	Site visit to local mechanical waste water treatment facility, sampling and analysis of water quality parameters	
Friday	Poster Session	Presentation Session		

Engineering Camp 2018

The camp in 2018 was structured differently from the 2017 camp. Instead of all the students and teachers being together all week, the students were split into four groups, and aside from the first and last day, each group was doing something different. The groups rotated through the four activities during the week, and all students experienced all activities. This allowed for more interaction between the faculty, engineers and undergraduate students that facilitated the camp.

The **first** day of the camp, students filled out a pre-survey similar to the 2017 camp and then they attended a short presentation by each of the facilitators of the activities to pique the students' interest and get them prepared for what they would be doing the rest of the week. Next, the groups of students participated in assembling simple submarines/submersible ROVs (Remotely Operated Vehicles) to use during the week to check water parameters such as temperature and turbidity (water clarity) as well as take underwater videos.

The **second** and **third** days of the camp involved students participating in all four activities described below. The activities were:

Sea Perch Submarines: Students took the ROVs they had assembled on the first day to the local river dam reservoir and used remote controllers to maneuver the submarines in the water, collected water samples, gathered a variety of data and took underwater videos using Go Pro cameras.

GIS Stream Data: Students went to the water lab affiliated with Utah State University to gather stream data on the river. The students checked water depth and water flow at multiple depths. They also measured some water properties.

Air Quality/Drones: Students learned about air quality and methods of measuring it. They assembled a simple sensor that tells them the quality of the air based on the color of the LED light that gets activated by the pollutant particles in the air. They also collected vertical air quality data as a drone carrying more advanced sensors was flown over an open area at the university to measure air quality.

Flying Aggies: Students learned about the use of drones in agriculture and how the images drones capture can provide valuable information about what steps farmers can take to improve their fields.

The **fourth** day: During the evening before the fourth day, groups of students picked which of the four activities they experienced earlier in the week they would like to spend more time on and go in it in more detail. Each group developed a research question about the topic, collected data, and analyzed it.

During the **final** day (Day 5) of the engineering camp, students presented what they had learned in a research poster session followed by a presentation session. At the end of the engineering camp students completed a post survey to gauge what had changed about their perceptions of STEM.

Table 3 below shows a summary of the activities students and teachers engaged in during the week-long engineering camp in 2018. The table follows one of the groups, the other groups would have had slightly different schedules.

Table 3. *Outline of the weeklong engineering camp 2018*

Day	Activity 1	Activity 2
Monday	Presentations summarizing the activities for the week	Building submersible ROV's
Tuesday	Sea Perch Submarines	GIS Stream Data
Wednesday	Air Quality/Drones	Flying Aggies
Thursday	Activity choice	Working on Poster and Presentation
Friday	Poster and Presentation Sessions	

Data Collection

Students' Pre and Post Surveys

The first day students arrived at the engineering camp they completed a pre-survey which contained demographic questions and the STEM-CIS Career Interest Survey, based on the work of Kier, Blanchard, Osborne, & Albert [7]. This survey measures the attitudes and interest of students towards STEM fields and has four sections, each pertaining to one part of STEM. Each section includes 11 questions for a total of 44 questions. The STEM CIS includes questions such as, "*I am interested in careers that involve engineering*". The survey is a 5-point Likert scale from 'Strongly Agree' to 'Strongly Disagree'. The pre-survey also included four questions regarding peer attitude to science. These four questions were based on the work of Talton and Simpson [8] and included statements such as, "*My best friend* likes science." Responses were on a 5-point Likert scale ranging from 'Strongly Agree' to 'Strongly Disagree.' More questions were drawn from the work of Franz-Odendaal, Blotnicky, French, & Joy [9] and targets students' engagement with STEM activities. Questions such as, "*Which of the activities listed below have you participated in in the past year?* (You can choose more than one)" were included. These questions were used to understand the level of student engagement with informal STEM activities. The students' involvement in these activities was evaluated with respect to the degree of engagement as follows: *No STEM engagement, low level of STEM engagement* (visits to science centers/museums/zoos), *moderate level of STEM engagement* (specialized group visited their class/ after school STEM club), and *high STEM engagement* (involved in a STEM program/competition/fair). This was based on the work by Franz-Odendaal et al. [9].

All of these are factors that potentially influence student interest in STEM fields, and the data were collected in an attempt to understand the effect of these factors on students' interest.
At the completion of the engineering camp, students, once again, completed the post-survey. The pre and post surveys contained the same set of questions concerning interest in STEM and factors that potentially influence their interest in STEM. The post-survey also included students' ratings of the various camp activities.

Qualitative data was collected using open ended questions in both the pre and post surveys. The students also filled daily journals about their experiences of the day. The questions included "*Name in order the three biggest influences on your choice of career in the future*", "*I would like*

you to write about your experience with STEM (Science, Technology, Engineering, and Mathematics) fields", "*Are you interested in a STEM (Science, Technology, Engineering, and Mathematics) career? Why or why not?"*

Data Analysis

Based on the data collected from the STEM CIS surveys, correlations were examined between the level of interest and various factors that possibly influence student interest. This included parent perceptions, friend attitudes and level of STEM engagement.

The nature of this research involved students who volunteered to participate, which explains their high initial interest in STEM [10]. Additionally, the GEAR UP program targets students from low-income families. Those two factors indicate that the sample is not random or representative of the total population of Utah or the United States of America. Thus, the data cannot be generalized to the population of Utah or the United States of America and thus inference statistics will only look at the differences between the factors influencing male and female interest in STEM, but will not be used to draw inferences about the population [11].

The qualitative data collected in the pre and post surveys using open ended questions was gathered and then split by male and female students. The data was then coded using the coding software MaxQDA. Coding was completed by two undergraduate students under the supervision of a faculty advisor who trained the two students in the process of qualitative analysis. Coding followed recommendations from the literature. Specifically, the Coding Manual for Qualitative Researchers by Saldana [12], as well as the Qualitative Inquiry and Research Design book by Creswell [13].

Both the undergraduate student and faculty advisor read through the data multiple times before coming to an agreement on the major themes contained in the data and creating a coding table. The data was coded based on the four themes: *Educational Activates, Hobbies and Interests, Future Plans and Relationships*. During this cycle of coding, the coders and faculty advisor found and discussed the sub-themes which was used in the second cycle of coding. During both the first and second cycles of coding, the coders met to arbitrate the results until agreement was made on the codes. The target was an interrater reliability Cronbach's Alpha of 0.8 [14].

The results from coding the qualitative data was then interpreted in conjunction with those from the quantitative portion. This was completed according to recommendations from the literature about mixed methods research, such as Creswell's book, Designing and Conducting Mixed Methods Research [15].

Results

Qualitative Data

This section discusses the most influential factors found in the students' written responses to the survey questions and the frequency those responses appeared. The specific questions where the data was obtained from are, "*Name in order the three biggest influences on your choice of career in the future*", "*I would like you to write about your experience with STEM (Science, Technology,*

Engineering, and Mathematics) fields", "*Are you interested in a STEM (Science, Technology, Engineering, and Mathematics) career? Why or why not?*", "*Any feedback or comments to improve the camp next year?*", and *"What made you choose to come to this camp?"*. Four major themes were established during coding, and various sub-themes later emerged from these categories.

Factors were coded into these sub-themes, and the frequency of each factor mentioned was recorded. If a student mentioned that a factor influenced them multiple times, the factor was only counted once. The responses of the male and the female students were recorded separately as were the responses from the pre and post-surveys. In Table 4, the themes as well as the frequency those themes and subthemes appeared in both male and female responses are listed. The table is arranged in descending order of total frequency with the factor having the highest frequency on top.

Table 4 shows a variety of factors that play a role in influencing the students' interest and potential career path. The four factors, or subthemes, that appeared most frequently in the students' responses include; *career plans, immediate family, interest, and camps/clubs*. All of which fall under a different main theme.

In general, there were more factors found in the responses of the females than the males. This could be due in part to the fact that the female responses tended to be more detailed and elaborate than the male responses.

Consistently in the male and female responses, and the factor with the highest total frequency, was *career plans*, appearing a total of 104 times. This factor appeared 58 total times for females and 46 times total for males. Though it appeared 12 more times in the female surveys than the male surveys, career plans was still the most frequent factor for both genders. Factors that had a relatively low frequency included *role models, dreams, grades and college* with a total of 15, 11, 4, and 3 respectively.

Class/subject and hobbies were the two factors besides career plans to have the largest difference in frequency between the two genders. For both factors, they were found 8 more times in the female responses than the male responses. A female student wrote about this factor saying, "*Science is one of my favorite subjects. We always learn more every minute.*" A male student wrote, *"I'm also very good at both mathematics and science."*

Table 4. Qualitative Data

Factor	Frequency in Females			Frequency in Males			Both
	Pre	Post	Both	Pre	Post	Both	Total
Main themes							
Educational Activates	43	35	78	33	40	73	**151**
Hobbies and Interests	58	54	112	57	37	94	**206**
Future Plans	49	40	89	38	41	79	**168**
Relationships	41	45	86	45	41	86	**172**
Sub-themes							
Career Plans	30	28	58	21	25	46	**104**
Immediate Family	16	21	37	17	16	33	**70**
Interests	16	15	31	17	14	31	**62**
Camps/Clubs	16	11	27	13	20	33	**60**
STEM Related Interests	14	14	28	19	11	30	**58**
Class/Subject	16	15	31	11	12	23	**54**
Enjoyment	13	10	23	11	8	19	**42**
Hobby	15	9	24	12	4	16	**40**
Money	7	7	14	9	10	19	**33**
Friends	7	11	18	7	8	15	**33**
Teachers	10	8	18	8	6	14	**32**
Extended Family	5	3	8	8	6	14	**22**
Altruism	4	3	7	6	4	10	**17**
Role Models	3	2	5	5	5	10	**15**
Dreams	7	2	9	0	2	2	**11**
Grades	1	1	2	1	2	3	**4**
College	1	0	1	2	0	2	**3**

Hobbies were commonly listed when asked for the three biggest influences in their career choice. The word "Hobby" itself was listed many times in this category, but a few more specific hobbies listed by females include, "*Building things*", "*I love to fix things*", and "*sports*". One female student also wrote, "*I sometimes practice engineering at home by creating robots (following an instruction manual).*" Hobbies that males listed included, "*Camping*", "*Fishing*", "*Comic books*", and "*I like to build things*". When talking about his interest in STEM, a male student wrote about one of his hobbies when saying, "*I really enjoy technology since its affected my life so much. I've always enjoyed playing video games and always wonder how the games are made up.*"

Other factors found to have a large difference between male and female were dreams, *extended family,* and *camps/clubs*. While females outnumbered males by 7 in the subtheme *dreams*, both

extended family and camps/clubs were more frequent in the male responses. A female student wrote about her dream saying, "*I'm hoping to become the first woman on Mars."* In comparison, a male student wrote about his dream by stating, *"I really want to build cars for either Tesla or GM."*

Altruism was found more frequently in the answers of the male students than the females, outnumbering them 10-7. One male wrote, "*I want to learn how to create things that will help others,*" while a female wrote in response to if they want to enter a STEM career, "*Yes I'm interested in STEM career. Because of the option of able of helping others with technology.*" "*I want to help make things that will benefit others and make people's lives easier if possible,*" was the response of another male student.

Of the four different main theme, *hobbies/interests* had the most frequency with 206 total - 112 for female and 94 for male. The main theme of hobbies/interest was divided into the sub-themes *STEM related interest, interests, hobby,* and *enjoyment*. The total amount they appeared respectively were 58, 62, 40, and 42.

Under the subtheme *STEM-related Interests,* one male wrote, *"It is always a learning experience, I never get bored, and I usually try to replicate and use what I learned in my everyday life."* Another male student wrote, *"I am interested in them because, they make me work hard and I get to find out what I can do and what I need to work on. This allows me to fix my mistakes and keep getting better and 'well rounded:"* One female expressed her interest by writing, "*I enjoy working with things that involve STEM with real life application and I've gotten many opportunities to work with STEM related things which I've enjoyed.*" Another female student wrote when referring to STEM, "*I enjoy the challenge they present*".

A male student showed his enjoyment in STEM when he wrote, "*I love how I can make things to feel accomplished and hands on activities which get me to think through things and work with others.*" A female student mentioned how her enjoyment in STEM influenced her career decision when she wrote, "*I think that a STEM career would be super fun if I were to do it so I am definitely interested.*"

When asked if they are interested in a STEM-related career, one male responded, "*YES I AM. I love everything with hands-on crafting, experiments, creations, and everything to do with STEM. But now I am also incorporating S.T.E.A.M. Science, Technology, Engineering, Art, and Mathematics."* This implies a variety of factors influenced their decision, such as STEM related interests, enjoyment, and class/subject.

Relationships were also a major influence on both male and female students with the theme having the second highest total of 172 occurrences split equally among male and female students with 86 occurrences each. The five subthemes in the category included *immediate family, extended family, teachers, friends,* and *role models*. When mentioning immediate family, male and female students would often list their parents or siblings as some of the biggest influences on their career choice. Immediate family also was the second most frequent factor found in both the male and female surveys with 70 occurrences. Females mentioned immediate family 37 times while males mentioned it 31 times. One female student wrote in response to a question asking if

they were interested in entering a STEM career field, "*Extremely I would want to become an Astrophysicist. Science is one of my favorite subjects. We always learn more every minute. Both of my parents have a STEM career choices. So I have a constant influence throughout my life."*

Similar to immediate family, factors such as *friends, teachers*, or *extended family* were listed when students were asked for their biggest influences. One male student included multiple role models when asked this question, responding with, *"Frank Sinatra, Stevie Wonder, Bruno Mars"*. A female student cited both a role model and extended family as factors influencing her choice of career saying, "*My cousin wants to be in the marines*". Another male student wrote, *"My math teacher last year (Mr. Davis the best teacher ever) got me interested in math which I usually hate."* When speaking about her teacher, a female student wrote when listing the biggest influences on her 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.*"

The main theme of *future plans* had the most frequent sub theme, *career plans*, and also included the subthemes of *money, dreams, college* and *altruism*. In the female responses, this subtheme had a frequency of 89, compared to 79 in the male responses. A career plan written by one female student said, "*Yes I'm interested in STEM career. Because of the option of able of helping others with technology*." Another female student was confident about her career plans when she said, "*I'm interested in being a photographer which requires you to know about technology because you use a camera.*" Responding to whether they were interested in a STEM career, a male student wrote, "*Of course. There are so many career choices with STEM.*" Money was cited by a male student as being a major influence in their career decision when they wrote, "*I think that most careers in STEM are big money earners.*" When responding to if they are interested in a STEM career, a female student wrote, "*yes, it pays good and you can do what you want.*" Money was mentioned 19 times by males and 14 times by females.

The final theme, *educational activities*, had the least total frequency, with 78 occurrences found in the female responses compared to 73 for males. This theme included the subthemes of *camps/clubs, class/subject, teachers* and *grades*. They appeared 60, 54, 32, and 4 times respectively. One female student, when referring to STEM, wrote about camps/clubs saying, "*Engineering camp gave me a whole new view on all of it.*" When talking about the camp, one male student said, "*I had a great time learning more and more about what I love doing, STEM or STEAM is my life and I plan do any of those as a career.*" While a few females listed grades as an influence for STEM, one female student wrote, "*I have had my struggles with these fields but I always persevere through it and end up getting a good grade as long as I have help throughout.*" Males listed "*good grades,*" and "*my different grades,*" as one of their top three factors influencing their choice of career.

Table 5 below shows the students' responses to the question "*What made you choose to come to this camp?*" This was asked to understand and shed some light onto the reasons why student choose to spend a week of their summer at an engineering camp learning instead of spending their summer break doing other things. This information could help recruit more students to attend those camps, and by extension potentially increase their interest in STEM.

This data was collected from a total of 44 students 19 females and 25 males (This question was only asked during the 2018 camp). The leading reason for both males and females was *Camps and Clubs*, appearing 8 times for females and 10 times for males. A female student said "*The fact I had gone before and had learned much.*" A male mentioned his previous experiences with the camp saying, "*I loved participating in the camp 2 years ago and look forward to learning more this year.*" Another male student said, *"I had come before and it was fun so I decided to come again."* This could mean that the reason for them to come to this camp was having been to a similar camp, and that encouraged them to attend another one. Factors mentioned only by females as a reason to come to camp were *teachers, college* and *hobbies*. Factors mentioned only by males included *class/subject* and *intermediate family*.

Table 5. Students' responses to the question "*What made you choose to come to this camp?*"

Factor	Female	Male
Camps and Clubs	8	10
STEM Related Interest	6	6
Enjoyment	4	6
Friends	3	1
Career Plans	1	3
Intermediate Family	0	2
Classes/Subjects	0	1
Teachers	1	0
College	1	0

Other responses included "*Learn new things, even though I'm not in school*", "*Really interested in Technology and Science."*, "*The fun activities"* and *"I enjoy doing things with STEM".*

The next factor that influenced students into coming to the camp was *friends*. The females mentioned this more than the males with frequencies of 3 and 1 respectively. The male student said "*I had friend that was here".* Where a female student said "*I wanted to meet new people".*

Career plans was another reason students came to the camp; 3 male students and 1 female student said that it was an influencing factor for them. One of the male students said the reason he came was "*I want to be an engineer when I grow up."* The female student said, "*I thought that it would help me choose a specialty to branch out in."*

The two factors that only had females mention them were *teachers* and *college* and each was mentioned by one student. The student who cited teachers as an influencing factor said, "*My AP teacher recommended it."* The female student who talked about college was mainly intrigued by the university itself saying, "*The amazing atmosphere at Utah State University that I've seen every time I come up here for school".*

Similarly, *class/subject* and *intermediate family* were factors only found in the male surveys. When answering the question, 2 students said "*My Parent*" and "*Dad*" as parts of their immediate family that encouraged them to come to camp. Only 1 male student said that Class/Subject was an influence. This student said the reason he came was, "*To Learn about Engineering".*

Quantitative Data

This section explores the factors influencing student interest in a career in the various fields in STEM. The correlation coefficients were calculated using Excel software using Pearson's correlation and the interpretation was based on Cohen's [14] social sciences rule of thumb to identify strong and weak correlations. A correlation that is above 0.5 is considered strong, 0.3-0.5 is considered moderate and 0.1-0.3 is considered a weak correlation.

Table 6. Correlation coefficients between various factors and the career interest in STEM

Factor	I am interested in careers that involve STEM		
	Male	Female	Combined
Working hard at STEM activities/classes	0.47	0.66	0.55
If I do well in STEM classes and activities, it will help me in my future career.	0.81	0.83	0.82
My parents would like it if I choose a STEM career.	0.097	0.54	0.37
I like activities that involve STEM	0.59	0.78	0.7
I have a role model in a STEM career.	0.48	0.33	0.41
I am able to get a good grade in my science class	0.355	-0.0027	0.19
I am able to get a good grade in my mathematics class	0.26	0.172	0.24
I am able to do well in activities that involve engineering.	0.59	0.55	0.57
STEM grades and activities	0.60	0.39	0.50
Overall interest in STEM	0.87	0.79	0.83
STEM camps attended	0.017	0.157	0.10
Level of STEM engagement	-0.062	-0.034	-0.02
First time participating in STEM-related activities	-0.0022	-0.07	-0.03
Friends' perception of science	0.145	0.44	0.28
Parents' perception of math	0.0195	0.13	0.034
Parents' perception of science	0.123	0.39	0.20
Parent's perception of math and science	0.083	0.28	0.133
Parents' perception of engineering	-0.31	0.25	-0.063
Parents' Education	0.20	-0.24	-0.031
Parents' Income	0.15	-0.053	0.051

As shown in Table 6, the strongest correlations, with regards to interest in STEM careers, included the students' general interest in STEM subjects, how it will impact their future careers, how much they enjoy it, how well they would perform in engineering activities and how hard they're willing to work on it. The strongest correlation, with a factor of 0.83, was found to be "*Overall interest in STEM*". This was also found to be the most influential factor for males with a factor of 0.87. For females, the factor, "*If I do well in STEM classes and activities, it will help me in my future career.*" had the strongest correlation factor of 0.83. Interestingly, females were significantly more influenced by their friend's and parent's perceptions of STEM. For "*Friends'*

perception of science", "Parents' perception of science", and "*Parent's perception of math and science*", the females were found to have correlation factors of 0.44, 0.39 and 0.28 respectively. Comparatively, the males' correlation factors for those factors were found to be 0.145, 0.123, and 0.083. Parents' influence on interest in STEM for females was found to have a strong correlation of 0.54 for the factor of "*My parents would like it if I choose a STEM career",* while for males, it only had a 0.097 correlation coefficient. For females, the perceptions of their friends and parents had stronger correlations with their interest in STEM than for males.

Males tended to be more influenced by their general interest in STEM and what grades they earned in STEM classes. "*STEM grades and activities*" had a strong correlation coefficient of *0*.60, and, as mentioned earlier, the highest correlation coefficient for males was their overall interest in STEM. Males also had correlation coefficients of 0.355 and 0.26 for the factors "*I am able to get a good grade in my science class"*, and *"I am able to get a good grade in my mathematics class"*, while females only had factors of -0.0027 and 0.172.

"*Parents Education"*, and *"Parents Income",* didn't have a strong correlation for either female or male students. Though, male had stronger correlation factors with 0.20 and 0.15 respectively, these are still considered weak correlations. Working hard and doing well in engineering activities both had relatively high correlations for male and females. In the categories, *"Working hard at STEM activities/classes",* and *"I am able to do well in activities that involve engineering"* females had 0.66 and 0.55 correlation factors respectively. Males were found to have correlation factors for those categories of 0.47 and 0.59.

Table 7 below shows the top 10 factors influencing interest in STEM for both males and females as found in the quantitative and qualitative data.

The results of the quantitative data show that the primary influences include interest, enjoyment and the ability to do well in those topics as some of the top factors for both genders. The qualitative data suggested that a variety of factors came into play when students decided whether or not they were interested in STEM careers. The quantitative data shows that grades for male students have a stronger influence than the qualitative data suggests, while the qualitative data implies that immediate family has a strong influence for males. The data from both sources suggests a strong connection with interests, career plans and family influences for females.

For females, in both quantitative and qualitative data the perceptions of other people including parents, friends and teachers were strong factors influencing their interest. For males, teachers and parent perceptions don't make the top 10. Instead, money and the ability to get good grades in STEM topics seem to be the stronger influences.

Table 7. The top ten factors influencing interest in STEM

	Top 10 factors as shown by the quantitative data		**The 10 factors as shown by the qualitative data**	
	Male	**Female**	**Male**	**Female**
1	Overall interest in STEM	If I do well in STEM classes and activities, it will help me in my future career.	Career Plans	Career Plans
2	If I do well in STEM classes and activities, it will help me in my future career.	Overall interest in STEM	Immediate Family	Immediate Family
3	STEM grades and activities	I like activities that involve STEM	Camps and Clubs	Interests
4	I like activities that involve STEM	Working hard at STEM activities/classes	Interests	Class/Subject
5	I am able to do well in activities that involve engineering.	I am able to do well in activities that involve engineering.	STEM Related Interests	STEM Related Interests
6	I have a role model in a STEM career.	My parents would like it if I choose a STEM career.	Class/Subject	Camps/Clubs
7	Working hard at STEM activities/classes	Friend's perception of science	Enjoyment	Hobby
8	I am able to get a good grade in my science class	STEM grades and activities	Money	Enjoyment
9	I am able to get a good grade in my mathematics class	Parent's perception of science	Hobby	Friends
10	Parents' Education	I have a role model in a STEM career.	Friends	Teachers

However, the qualitative data differs from the quantitative data when it comes to *parents and family* being strong influencers. The quantitative data showed that parents were not a very strong influence on interest, however in the open-ended questions, students said that parents, siblings and family members in general were strong influencers. While other researchers, Miller and Pearson Jr [16], found that the parents' educational level was a strong influence on their children taking advanced math/calculus in high school and proceed on a pathway into STEM fields, this research showed a weak correlation between the parents' education and income levels and students' interest [16].

This may be due to the fact that the number of parents who completed the pre and post-survey was not sufficient data to show the correlation properly. Additionally, the influence of parents is likely too complex to be measured in quantitative form as the questions about parents' perception of STEM, their income, and their education, aren't the only factors that influence the complex relationship between parents and their children, and thus the quantitative data may not have been able to identify parents as a strong influencer. The qualitative data explicitly asked about which factors strongly influence their career choice. Immediate family and friends came in the top 10 strongest factors, with immediate family coming in at number 2.

This aligns with the findings of Yun et al. who concluded that parents are the front line with regards to the education of their children, and are important agents in the development and educational achievement of their child in a formal setting [17].

Conclusions

There were a variety of very influential factors found in the study that impact male and female students' desire to pursue a career in STEM. The most influential factor found in the qualitative data for both male and female students was *Career Plans*. This was also reflected in the quantitative data with the factor, "*If I do well in STEM classes and activities, it will help me in my future career."*, found to have the highest correlation coefficient in females and the second highest in males.

While Career Plans was found to be the most frequent sub-theme, overall the results showed that the most influential factor in the students' interest in STEM overall stemmed from their interests/hobbies. It had some of the highest correlation coefficients, and that in general, they were found most frequently in the qualitative data. Similar results were found in a study by Kim A. Lu Lawe. A common theme among the female students was found to be that their choice to pursue a STEM career path was self-motivated and stemmed from internal influences [18].

In general, the data shows that there isn't a large discrepancy found in what influenced male vs. female students. However, found both in the qualitative and quantitative data, female students were found to be more influenced by their friends and immediate family. Specifically, in the quantitative data, female interest tended to have a stronger correlation with the perception of their parents and friends. This is contrary to the evidence found in a study done by Carol Ann Heaverlo, who found that family influence was not a significant predictor of interest in a STEM career [19]. Data found in a different study by Lisa Anderson and Kimberly Gilbride concluded that students, particularly female, were greatly influenced to enter an engineering career if someone in their family also was an engineer [20]. The literature seems to have conflicting results on this and it might be because the relationship between children and their parents is very complicated and measuring that influence accurately with a survey is not easy.

The ability to get good grades, and their concern for grades, was something males tended to be influenced by more by than females. The correlation factors for males, pertaining grades, were consistently higher than females, and it was also listed more in the open ended questions for males than females. Data found in a study done by Xueli Wan found evidence to suggest that self-efficacy plays a large role in a student's decision to go into STEM related fields. Getting good grades or believing that you can succeed in that field had a positive effect on their interest

in STEM [1]. Surprisingly, altruism was a factor found more frequently in the male surveys than the female surveys. A factor like money, which would be expected to be more frequent in the male surveys, however did reflect the expected results.

While participating in Camps/clubs was mentioned a lot in the qualitative data in both the male and female responses. In the quantitative data, it was not found to have a significant correlation with either of the male or female students. Though the educationally related activities did have an influence on students, they weren't found to be significant. However, students who participated in STEM related activities were found to have an increased interest in STEM fields [19]. Females were found to be 1.0 times more likely to pursue STEM careers if they were involved in STEM programs in high school, while males were 0.35 times more likely than their male peers who didn't [21]. These results were not necessarily found in our qualitative data, where the influence of educational activities on females was not substantially larger than on males.

According to Pittinsky & Diamante [22] the problem begins when the fun stops. They suggested that not telling students that STEM is fun, but to tell them it is challenging, would be more effective in increasing and sustaining their interest in STEM. This may make them feel a sense of pride and accomplishment when they succeed. This was seen in the Qualitative data as several female and male students said they were interested in a STEM Career because of the challenge. Sample quotes that show that include: "I enjoy the challenge" or "It's fun as well as challenging". This is an important idea to note, because as these students go through high school and college their interest in STEM won't drop off because the material becomes harder and less "fun". Seeing it in the student responses suggests that showing students both the fun and challenging aspects of STEM is potentially the right way to approach this.

As stated earlier, the importance of STEM recruitment is essential in filling the needed positions employers in the United States are demanding. Because women make up approximately 50% of the population, but only make up low portions of STEM fields, increasing women's interest in STEM fields could help solve this problem [5]. Data collected from the camp surveys provided helpful insight on the students' perceptions of STEM, and what type of factors influenced males and females. While many factors were found to be very influential for both genders, there were also some clear differences. This information can be used to help target both male and female students more specifically in order to help increase their interest in STEM career paths.

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