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The Effect of Summer Engineering Camps on Rural and Urban Students' Interest in STEM (Work-in-Progress)

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Introduction

Jobs in STEM are vital to an ever-growing economy [1]. There has been a push for STEM education due to the concern that there won't be enough STEM graduates in the future [2]. As of 2015, STEM field occupations have grown by 10.5% whereas non-STEM field occupations have grown by 5.2% [3]. Exposing students to more science and math courses allows them to experience real-world problems which enables them to make connections to STEM fields [2].

Data show that K-12 students from rural areas are less likely to have experience with STEM fields in the classroom compared to urban areas. This is due to a multitude of factors including budgets and teachers not having the necessary resources [5]. Many urban schools receive more funding, therefore drawing in more qualified teachers and more resources [4]. A difference in STEM education between rural and urban schools seems to be due to financial reasons [4][5].

Data was collected from a 2019 outreach summer camp designed to increase student interest in STEM. The hypothesis is that summer camps affect students' interest in STEM differently based on whether they are from an urban or rural area.

Program Description

During the summer of 2019, students and teachers from the state of Utah attended a week-long engineering camp at Utah State University in hopes of sparking their interest in STEM. This summer program was a part of the GEAR UP program which is funded by the Department of Education. To pique students' interest in STEM, they engaged in various engineering-related activities to help them better understand some of the fascinating aspects of STEM. Detailed description of those camps is available in previous work by the researchers [6].

Data Collection

At the start of the engineering camp, students took a pre-survey that included some demographic information and the STEM-CIS (Career Interest Survey) based on the work of Kier, Blanchard, Osborne, and Albert [7]. The STEM-CIS consists of 44 five-point Likert scale questions. The survey is divided into four sets of 11 questions based on the four areas of STEM. An example question was, *"I am interested in careers that involve engineering."* The same survey was given immediately after the camp.

Qualitative data was collected in the pre and post surveys, as well as daily journals. The open-ended questions included, *"What made you choose to come to this camp?"; "Name in order the three biggest influences on your choice of career in the future;" "Tell me about your experience with STEM (Science, Technology, Engineering, and Mathematics) fields;" "What is your*

perception of STEM careers and their importance?"; "Are you interested in a STEM career? Why or why not?; And, what would make STEM more interesting for you?"

Student demographics of interest in this research are given below in Table 1. We note that the students self-reported as living in an urban or rural area.

Table 1: Demographics

Location	Male	Female	Total
Urban	12	13	25 (58.14%)
Rural	13	5	18 (41.86%)
Total	25 (58.14%)	18 (41.86%)	43

Data Analysis

The quantitative and qualitative data were analyzed concurrently in a mixed method research design. The quantitative data was analyzed using Microsoft Excel and R. The qualitative data analysis was split between rural and urban. The data was read by the faculty advisor and two undergraduate students. Using Emergent coding, the group found common themes in the data, and then the data were coded by the two undergraduate students using the software MAXQDA. The two undergraduate students were advised on how to conduct the qualitative coding by a faculty advisor. The coding was informed by The Coding Manual for Qualitative Researchers by Saldana [8] and The Qualitative Inquiry and Research Design book by Creswell [9].

Qualitative Data Results

The qualitative data analysis focused on students' responses to a series of open-ended questions in the pre-and post-surveys. The result of the coding is shown in Table 2, which displays the frequency of each of the themes as well as the percentages relative to their respective columns.

Table 2: Qualitative Data Analysis Results

Theme Frequency/Percentage	Rural Pre	Rural Post	Urban Pre	Urban Post	Rural Total	Urban Total
Hobbies and Interests	2/3%	5/7%	16/13%	10/9%	7/5%	26/13%
Future Career	22/32%	21/30%	42/34%	37/35%	43/31%	79/40%
Learning Opportunities	12/18%	19/27%	21/17%	27/25%	31/22%	48/24%
Relationships & Influencers	17/25%	14/20%	19/16%	14/13%	31/22%	33/17%
Impact of STEM	14/21%	12/17%	24/20%	19/18%	26/19%	13/7%
Frequency Total	**67**	**71**	**122**	**107**	**138**	**199**

As seen in Table 2, the most frequent theme was "**Future Career**"; 31% of the codes for rural students mentioned future careers and 40% from urban students. One rural student, when asked

about their future, responded *"I'm not sure, I feel like a STEM career would be interesting because there are lots of STEM jobs to choose from."* Another rural student wrote, *"I am not currently interested in a STEM career, but I would like to know some background on STEM just in case I change my mind."* That response was in a pre-camp survey. In response to the same prompt, an urban student wrote *"STEM careers include a lot of different things and provide a lot of options."* In a post-camp survey one urban student wrote, *"I definitely will take it into consideration now because I do find STEM interesting."*

"**Learning Opportunities**" was the second most common theme with a total frequency of 22% of the codes from rural students and 17% from urban students. Many students' responses mentioned different camps or school experiences they have had regarding STEM. A response from a rural student under this category was, *"I've gone to many GEAR UP camps and they taught me many things that engineers should know."* In a post-camp survey one rural student wrote, *"STEM camp really helped me understand a lot of things in the field."* One urban student described some intern experience they have had, *"I have interned with the local fire department to learn skills in Engineering and Technology areas."* Another urban student described an in-school experience, *"During middle school we made science projects for the STEM fairs. This camp is also a major source of my knowledge of STEM."*

The third most common theme was "**Relationships and Influencers**". The percentages from rural pre and post were larger than urban pre and post. This signifies that rural students may place a greater emphasis on relationships when determining their future. Many students listed family members, teachers, or icons as influencers. A rural student listed, *"My teacher, family, and peers."* Another rural student wrote, *"My two uncles."* An urban student mentioned, *"My family, my friends, and my teachers,"* another urban student said, *"My brothers, my dad, and my cousins."* Students from both rural and urban areas had similar responses under this theme.

"**Impact of STEM**" was the fourth theme. Rural students had roughly double the frequency when compared to urban students (19% vs 7%). Students talked about how STEM careers have and continue to change the world. In the pre survey, one rural student responded, "*Without people in those careers we wouldn't have a lot of things we do today."* A post camp response from a rural student explains, *"The reason we view the world as we do now is because of STEM."* In addition, an urban students wrote, *"Without it we probably wouldn't have many inventions being made and new discoveries being made either."* Another urban student said, *"I believe STEM careers are very important for the development and advancement of our future in order to improve on technology and solve problems as efficiently as possible."*

The final theme was "**Hobbies and Interests**". The total percentage of urban responses was more than double that of rural students. Some rural students mentioned school activities as their interests or hobbies. A rural student wrote, *"I have a love of engineering and programming."* Another rural student wrote, *"I enjoy programming, I am part of the robotics club, and I design games and different devices."* Both students mentioned interest in programming. Furthermore, an urban student said, *"Engineering is something I am very interested in."* Another urban student in

a post-camp survey wrote, *"I liked the activity because I love the outdoors and enjoy learning new things."* Numerous urban students listed their interests as an influence in their future.

Quantitative Data Results

The quantitative data was analyzed using Microsoft Excel and R. A brief analysis of the mean interest in various STEM fields between rural vs. urban students is shown in Figure 1. It appears that the camp was more influential on rural students than on urban students.

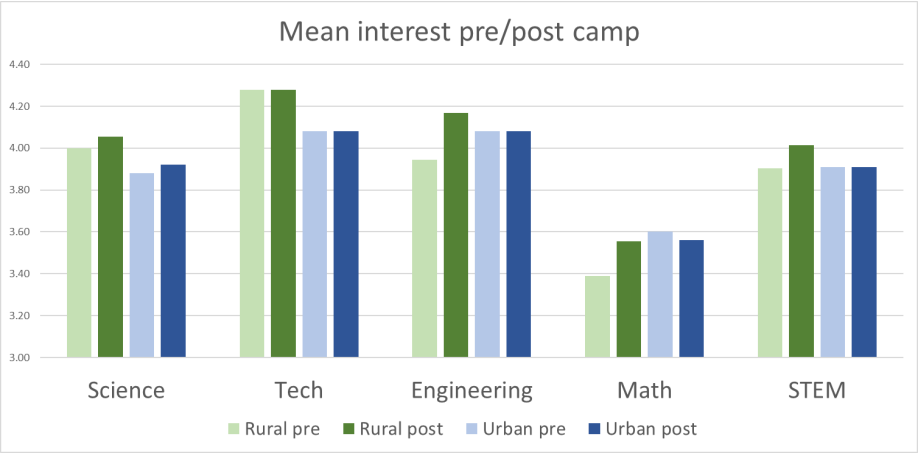

Figure 1: Mean interest pre/post camp of rural vs. urban students.

Analysis of the data using paired two-sample t-tests and the Mann-Whitney-Wilcoxon (MWW) test revealed that none of the increases in interest were significant (See Table 3). P-values that were around or below the 0.10 level of significance were bolded. The reason to include the MWW test is because Likert data tends to not be normal, so this test accounts for that. Power analysis showed that the statistical power of the t-tests was low. This hints that a bigger sample size may be needed.

Table 3: P-values for "Increased interest in STEM fields after attending the camp" (Two sample t-test/Mann-Whitney-Wilcoxon)

	Science	Technology	Engineering	Math	STEM
Rural	0.408/0.304	0.500/0.558	**0.130/0.165**	0.227/0.260	**0.173/0.122**
Urban	0.385/0.411	0.500/0.529	0.500/0.529	0.627/0.655	0.500/0.510

The analysis of the means appeared to indicate that rural students gained more interest in STEM from the camp than their rural counterparts, but this increase, although witnessed through the lower rural P-values, was not significant. The results show that neither rural nor urban students had a significant increase in interest in any STEM field due to the camp.

In addition to comparing the interest levels of urban and rural students, the intersection between location and gender was also examined, i.e., the differences between "rural females", "rural males," "urban females", and "urban males" was examined. The results are shown in table 4.

Table 4: P-values for "Increased interest in STEM fields after attending the camp" (Two sample t-test/Mann-Whitney-Wilcoxon)

	Science	Technology	Engineering	Math	STEM
Rural female	**0.035/0.074**	0.311/0.386	0.187/0.500	0.187/0.500	**0.089/0.173**
Rural male	0.694/0.672	0.612/0.710	0.187/0.245	0.307/0.339	0.395/0.295
Urban female	0.500/0.681	0.251/0.286	**0.137/0.172**	0.708/0.807	0.269/0.336
Urban male	0.377/0.412	0.781/0.862	0.863/0.907	0.500/0.546	0.681/0.715

P-values that were around or below the 0.10 level of significance were bolded. It is worth noting that the P-values in the "Rural female" demographic are in most cases lower than the P-values of any other demographic. This is a potential avenue to investigate in future research. Also, there was a significant result in the "Rural female" category in "Science". This indicates that rural females had a significant increase in interest in science from the camp.

Conclusion

As stated in the quantitative section, neither rural nor urban had a significant increase in STEM interest from the camp. Despite this, there was increase in the interest in "Math," "Engineering," and "STEM", but still not significant. Further investigation using a larger sample size may be needed.

The thematic responses to the open ended questions for rural and urban students did not vary much, but the frequency and percentages of their responses differed. As seen in the qualitative data section, urban students tended to consider their "*Future Career*" more than rural students. Additionally, the theme, "*Relationships and Influencers*" had a higher percentage of the total responses for rural students. This shows the possibility that rural students place more importance on their relationships. Rural students sometimes have to make a hard decision between staying within their communities or pursuing STEM (leaving their communities). Based on the data presented, rural students tend to place a lot of importance on relationships within their communities. In order for STEM careers to be more attractive to those students, those careers need to be presented as careers that can be local.

Analysis of the qualitative data concluded that there is some difference between rural and urban students. The analysis of the quantitative data did not produce any significant findings. While more research is needed to be able to solidify any conclusions, the information found has shown some differences in rural versus urban students.

This is a work in progress and collecting additional data in future camps could provide more insight into the possible differences between rural and urban students. Additionally, collecting more data would allow for a more robust statistical analysis which could show differences in the interest of STEM in rural versus urban students. Gaining more insight from additional data could hopefully shed light on how to recruit more students into STEM. This could guide the design of future outreach programs to better serve each demographic.

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