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Report

East Los Angeles College
Roosevelt High School 2019 Workshop Survey Results

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Executive Summary

0.1. The Roosevelt High School (RHS), Math, Science and Technology Magnet Academy Summer program was held between August 12 and 14, 2019 and presented to between 101 and 105 students about to enter Ninth grade. Only two instructors taught the workshop. The large size of the group created problems for effective delivery of the workshop. In retrospect the instructors admitted that using only two staff was a mistake that they will not repeat in future workshops.

0.2. Due to unavailability of a sufficient number of computers in an East Los Angeles College (ELAC) computer lab, the survey was presented on paper, instead of electronically as planned, on the first and last days of the workshop. That plus hand entry of the survey results introduced some errors and potential biases into survey results. A few handwritten comments were hard to read.

0.3. The number of respondents differed for the pre-workshop survey (72) and the post-workshop survey (88). Not every respondent completed all questions in their surveys. In order to protect identities of respondents, the evaluation methodology deliberately included no way to track individual respondents. Because of the non-random nature of the survey the results cannot be projected to the pre-workshop and post-workshop workshop populations. The results should be viewed cautiously as the opinions of a limited but large sample of incoming RHS students interested in STEM (Science. Technology, Engineering or Math).

0.4. The demography of the RHS workshop was appropriate for the purposes of NSF ATE Grant 180188/ A key goal of the grant is to interest and ultimately involve more Hispanics in land surveying as an academic discipline, profession, and career. About 89\% of the pre-workshop students self-identified as Hispanic, and 83% of the post-workshop respondents did so.

0.5. Another purpose of the grant is to increase the number of females interested in and ultimately entering land surveying as an academic discipline, profession, and career. The RHS group was also well-suited for meeting this goal. About 59% of the total population and 58% of the Hispanic sub-group self-identified as females.

0.6. About 64% of the students agreed or strongly agreed that they were interested in a STEM career at the beginning of the workshop. Only 46% did so at the end of the workshop. We cannot tell from the survey data if participation in the workshop contributed to the apparent drop in interest in a STEM career, but if so it would have been an unintended consequence.

0.7. Before the workshop over half (54%) of the students reported that they weren't very interested in land surveying. They also didn't know much about the field or the equipment used. After the workshop 85% of the students reported that they had learned "a great deal" or "a fair amount" about what land surveyors do in the field. However, 44% disagreed or strongly disagreed that they were interested in land surveying, and only 15% agreed or strongly agreed. Because of the way the pre-workshop and post-workshop survey data were collected and the differences in group size, we cannot tell exactly but it appears that the workshop may not have convinced many more students to be interested in land surveying. It did, however, do a good job transmitting knowledge about land surveying and may have increased the proportion of students in the neutral category about land surveying career interest.

0.8. Students as a group gave the workshop an average 3.5 star rating on a five-star scale (with "5" being best). About two-thirds (67%) would recommend the workshop to another student, a similar proportion (66%) enjoyed it, and over half (53%) agreed or strongly agreed that it was fun. For this kind of an opinion survey use of the top two categories by about two-thirds to three-quarters of respondents indicates an acceptable but not outstanding workshop. The fun factor is the area in which the workshop could most improve, especially with young women, who rated how fun the workshop was significantly lower than the young men did. All of these factors correlated significantly and moderately to strongly with intentions to undertake follow-up academic and career=-related actions related to land surveying. It was not possible to determine which factor was more important or most important in relation to interest in follow-up actions.

0.9. Interest in a career in which one gets to works outdoors remained about the same before and after the workshop. The workshop included outdoors activities related to land surveying that led to a few complaints about the heat and walking. Females were significantly less likely than males to be interested in a career where one gets to work outdoors. Stressing that aspect of land surveying may be counterproductive in seeking to attract women to the profession, but might work with men.

0.10. Students viewed the workshop curriculum element and activity implementation most often as "good" rather than "excellent" or "fair," and very few rated any of 12 items as "poor" or "very poor." The most highly rated curriculum items included Academic Pathway Information (71% "Excellent" or "Good"), Career Research Project (69%), Field presentations (66%) and Budget 101 (65%). The middle range of 61% to 62% "Excellent" plus "Good" included the three videos about GIS, CAD and BIM, the Introductions to GSET lecture, career presentations, and a costing out a project exercise[1]. "Taking out a building footprint" (which was not actually done with a different activity substituted) received only 54% "Excellent" plus "Very Good" ratings.[2] There were no statistically significant differences by gender in responses to these questions, or by Hispanics compared to others.

0.11. About 36% of the respondents agreed or strongly agreed that after the workshop they had become more interested in taking one or more land surveying courses in high school, taking land surveying courses at a community college or university, or earning a B.A. or B.S. degree in land surveying. There was a greater increase in interest in obtaining a community college certificate (33%) than an Associate degree (30%) land surveying. As a result of the workshop about 29% of the students had become more interested in pursuing land surveying as a career, 27% in becoming a professionally certified land surveyor, but 41% in becoming a Civil Engineer. These are intentions, not actual beahviors. The NSF grant co-PIs have not yet stated whether they intend to reach their grant goal targets by offering their workshops to large groups of Hispanics or women and attracting small percentages to land surveying, or if they have larger percentage targets, or are trying to attract greater percentages of women to men to the field during their workshops and courses.

0.12. Females were always statistically significantly less interested than males in each of these outcomes, except in regards to taking one or more land surveying courses in high school. While only a quarter

[1] The survey question concerned "costing out construction of a house" but a different exercise might have been used.

[2] Several items in the curriculum were not delivered as expected. However, no specific information about what was done instead or what instructions, if any, the teachers gave to students about responding to this part of the survey was available to the evaluator as of the writing of this report.

of 41 females compared to just over half (51%) of 31 males agreed or strongly agreed that the workshop had increased their interest in taking one or more surveying courses in high school, the variation in response distributions was not statistically significant. There is an opportunity to try to convince the 40% of RHS females who are neutral on the matter to join the one-quarter of young women who agreed or strongly agreed that the workshop had encouraged them to take one or more land surveying courses in high school. The grant co-PIs have not yet clarified if they intend to meet their grant goal of increasing the number of women pursuing land surveying as an academic and career option by getting a certain percentage of women from large groups of women to become interested, or by gearing their workshops so that they attract an equal or greater percentage of females than males into the profession. If the latter, this workshop did not succeed as well as might be hoped since the females were statistically significantly less likely than the males to be interested in land surveying after the workshop or in taking future actions to engage in land surveying as an academic discipline or a profession.

0.13. Given that on many variables other than prior interest in land surveying and working outdoors, the young women responded to the workshop very similarly to the young men, it is not completely clear what contributed to the differential response of females on future actions related to land surveying. Since math anxiety and less prior math preparation are known to be factors correlated with lack of STEM interest or participation, the evaluator explored correlations of prior geometry course taking with responses to the workshop. In the post-workshop survey females were statistically significantly less likely to have passed a geometry course by the time of the workshop (16% of females had passed geometry compared to 39% of males and 16% of Latinas compared to 42% of Latinos). However, a series of crosstabulations found no reliable and valid statistically significant correlations between having previously passed geometry and responses to survey questions. It could be that the workshop was run in such a way that a geometry background was not necessary. In qualitative responses a few females did mention mathematics, including being confused, as the worst thing about the workshop (compared to one male). Going forward, there may need to be counseling attention and encouragement of the RHS young women regarding taking geometry and perhaps eventually trigonometry if they are going to catch up with their male peers in actually taking land surveying courses, especially a more advanced course, while in high school.

0.14. Open-ended comments by the females especially focused on interactions with other people, friends and new people, as the best thing about the workshop. The evaluator deduces that talking about and having workshop or course exercises stressing the teamwork aspects of land surveying may be especially effective in attracting females to the field.

Overview

1.1. This evaluation report has been prepared by REAP Change Consultants for the East Los Angeles College (ELAC) ATE grant 1801188 "Filling Skills Gap Through the Geospatial Engineering and Technology Program." The grant and its evaluation are funded by the National Science Foundation (NSF). A part of the grant concerns presenting information to high school students about land surveying and offering land surveying courses at the high school level. Grant co-Principal Investigator Dr. Humberto Gallegos successfully recruited several high schools as project participants. This report evaluates the land surveying related workshops presented to students of Roosevelt High School (RHS) Math, Science, and Technology Magnet Academy students between August 12 and 14, 2019. The workshops were presented on the campus of East Los Angeles College (ELAC).

1.2. Teresa Sutec, the RHS Counselor for the Academy reported in an e-mail dated August 27, 2019 that:

105 students attended on August 12;
102 on August 13; and
101 on August 14.

Despite the large number of students and an offer of help from RHS staff, grant Dr. Gallegos decided to handle the workshops by himself with help from just one colleague. In retrospect he told the evaluator that this was a mistake and that in future such workshops of this size he would include ELAC teaching assistants or would ask high school staff to help out during the workshops.

1.3. The evaluation data collection consisted of two surveys presented by project staff to the students on August 12 (pre-workshop) and on August 14 (post-workshop). The survey instruments are included in this report as Appendix A and Appendix B, respectively. The surveys were originally designed to be presented online using the REAP Change Consultants Survey Monkey account, set up with password protection and an option for multiple responses from the same IP address so that a computer lab could be used. However, ELAC only had about 25 computers available to the Geospatial Engineering and Technology (GSET) program and this was insufficient for timely completion of the surveys by around 100 students. Perhaps not realizing that Survey Monkey surveys can be completed on cell telephones or tablets, Dr. Gallegos handed out and collected on site photocopied paper surveys. Dr. Maack, the REAP Change evaluator, later entered the survey results into the Survey Monkey account by hand. This change in data collection approach somewhat reduced the validity and reliability of the evaluation findings. Plans now are to use online surveys with other workshops in the future.

1.4. Only 72 students returned pre-workshop surveys on August 12, a 69% response rate. A larger number, 88 students (87% response rate) returned surveys on August 14. All students who answered the question on each survey indicated that they will be 9th graders in Fall 2019.

1.5. Students were given an option not to respond to the survey at all, and could stop responding at any point during the survey (which some did). In order to protect confidentiality, students were not asked to put their names or any identifying numbers on the pre-workshop and post-workshop surveys, so there is no way to analyze pre-workshop and post-workshop results for the same students. Both surveys were non-random in nature, with attempts made to get 100%

participation. We do not know why 33 students did not participate on August 14 and 13 students did not participate on August 14 and we do not know if all students who participated at the end had also participated at the beginning of the workshops. As a result, the findings, analyses and interpretation in this report should be viewed cautiously as only representing the views of two different groups of respondents, some of whom may not have attended the entire workshop or completed both surveys. The specific results cannot reliably be projected statistically to represent the entire RHS Math, Science and Technology Academy student body. We do not know what the potential responses are of those who did not take on or the other or both surveys and if they would change the findings if included. However, we do know that the results represent the opinions of over two-thirds of the students at the beginning of the workshop and almost 90% of those who attended the last day. The results may be considered as typical, rather than definitive, of those which one might find among 9th grade students entering the Roosevelt High School Math, Science, and Technology Magnet Academy.[3]

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Findings

Demographics

2.1. In addition to trying to increase the number of land surveyors, the NSF grant specifically targets Hispanics and women in an effort to increase diversity in the land surveying profession. As seen in Tables 1 and 2 offering the workshops to RHS students targeted an appropriate population of students.

Table 1. Ethnic Distribution of Roosevelt High School Workshop Students

	Pre-Workshop	Post-Workshop
Caucasian	3	3
African American	0	1
Hispanic or Latino/a	64	73
Asian American	3	3
American Indian	3	0
Pacific Islander	0	0
Other	0	0

Multiple responses were allowed for ethnic/"racial" distribution and some students did not check any of the responses. However, 89% of the pre-workshop respondents and 83% of the post-workshop respondents positively identified themselves as Hispanic or Latino/Latina. There were also more students who answered the post-workshop survey than who answered the pre-workshop survey who identified as Hispanic or Latino/Latina. From a grant perspective, the 2019 summer workshop

[3] Both surveys asked a question that verified that they will be entering 9th grade in Fall 2019 but did not verify whether they would be ninth grade students at Roosevelt High School. Because this was a Roosevelt High School Academy, it is a reasonable assumption that they would be attending that high school in the fall.

reached the right target audience. To the extent that the workshop was successful, because of the very skewed distribution Latinos or Latinas will most likely be well-represented among those who become interested in land surveying.[4]

2.2 Females were well-represented in the summer workshop, as shown in Table 2.

Table 2. Gender Distribution of Roosevelt High School Workshop Students

	Pre-Workshop	Pre-Workshop	Post-Workshop	Post-Workshop
Female	41	57%	44	50%
Male	29	40%	33	38%
Other	1	1%	1	1%
Prefer Not to Answer	1	1%	1	1%
No Response	0	0%	9	10%
TOTAL	**72**	100%	**88**	100%

Women made up 57% of pre-workshop survey respondents, and half of the post-workshop survey respondents. However, the number of women as well as the number of men increased in the post-workshop survey. The percentage of all respondents who identified themselves as females and the percentage identified as males also fell only because the percentage who didn't respond to the question at all increased from zero to 10%.

2.3. Table 3 shows the gender distribution of Hispanic/Latino/a students only.

Table 3. Gender Distribution of Roosevelt High School Workshop Hispanic Students

`	Pre-Workshop	Pre-Workshop	Post-Workshop	Post-Workshop
Female	38	59%	42	58%
Male	25	39%	30	41%
Other	1	2%	1	1%
TOTAL	**64**	100%	**73**	100%

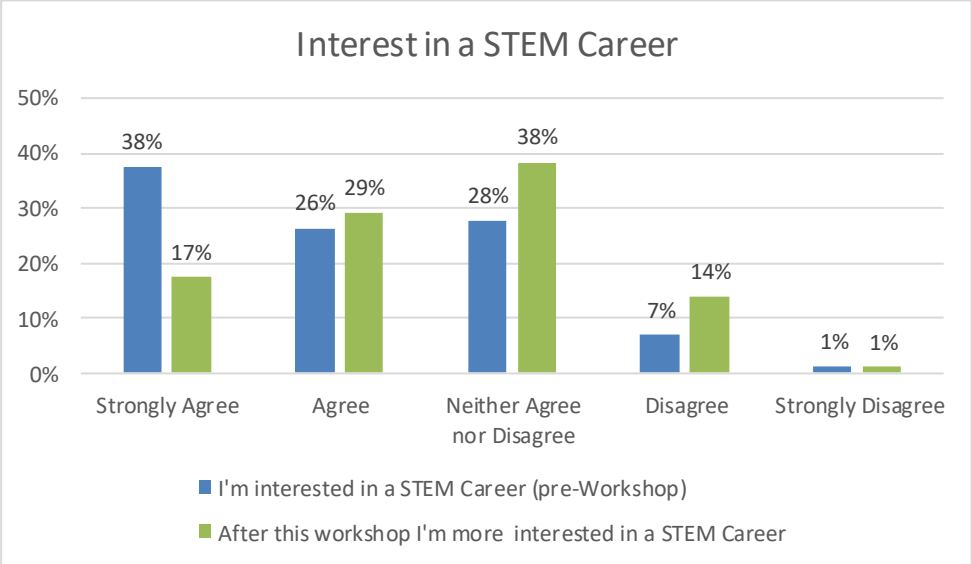
[4] Because of the small numbers of people who identified as other than Hispanic, and allowing identification with more than one ethnic/"racial" group, it is a logical assumption that many or most of those who become interested in land surveying are liable to be Hispanics. This is specifically quantified for Hispanics elsewhere in this report for a few variables especially relevant to the grant. The same is not done for other ethnic groups in order to protect individual identifies. Also, because of the strong skew in the data toward Hispanics and the small numbers of any other ethnic group who are not also Hispanics, it is not possible to provide reliable and valid statistics concerning the question of whether the workshop resulted in greater

Both before and after the workshop the percentage of females among Hispanics is greater than the percentage of females among all respondents to the surveys. There were a net four more Hispanic women and five more Hispanic men who answered the post-workshop survey, resulting in a small percentage change for women among this sub-group. The percentage of females who are Latinas increased from 93% of pre-workshop survey respondents to 95% in the post-workshop survey. Therefore, if there are significant or important differences among female respondents compared to male responses it is because Latinas are responding differently than Latinos and other men.

Interest in STEM, Land Surveying, and Working Outdoors

3.1. Given the focus of the RHS Summer Academy on Science, Technology, Engineering and Mathematics (STEM), it isn't surprising that both before and after the land surveying workshop students were more likely to strongly or agree that they were interested in a STEM career (Chart 1)

Chart 1. Interest and Greater Interest in a STEM Career

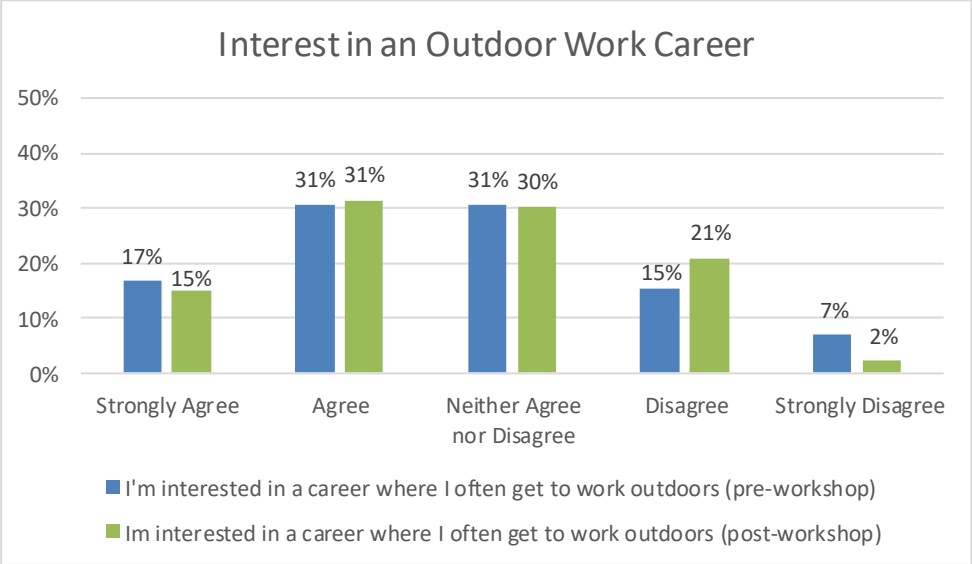


The questions about STEM career interest in the pre-workshop and post-workshop surveys were different so the results are not strictly comparable. Also, the phrasing of the post-workshop survey was to ask if they were more interested in a STEM career after the workshop.[5] A neutral response or even disagreement with being "more interested" could mean that the students already agreed or strongly agreed that they were interested in a STEM Career, and the workshop simply didn't increase their interest. However, the fact that the percentage in the "Strongly Agree" percentage was less than half what it was before the workshops might indicate that the students weren't especially excited about land surveying as a STEM Career. There was no statistically significant difference by gender in the responses for the entire population or among Hispanics.

[5] This is a mistake by the evaluator that should be changed in future surveys. This is also an example of where a look at the same group of students in the pre-workshop and post-workshop surveys would have been desirable.

3.2 In preparing the curriculum for the workshop Dr. Gallegos included outdoor hands-on exercises. He is interested in determining the extent to which the fact that land surveyors often must work outdoors will attract students into an interest or increased interest in land surveying. Chart 2 shows the results of a pre-workshop and post-workshop question about student interest in a career where they get to work outdoors.

Chart 2. Interest in a Career Where One Gets to Work Outdoors



The question was asked the same way in both the pre-workshop and post-workshop surveys so that changes in results are more logically attributable either to what happened during the workshop, or to the change in the makeup of the pre-workshop and post-workshop survey respondents. The results were very similar with 48% strongly agreeing or agreeing that they were interested in a career where they often get to work outside before the workshop and 46% afterwards. There is also an increase from 15% to 21% of respondents who disagree, and a counter-balancing decrease from 7% to 2% of those who strongly disagree. The workshop might have made a few people less negative about outdoor work after hearing and experiencing firsthand what land survey work outdoors was like, but that cannot be said with certainty since the same people might not be involved. The net effect of the workshop and its efforts appears to be neutral on the question of outdoor careers, since 31% neither agreed nor disagreed with the outdoor work statement before the workshop and 30% afterward and the positive and negative responses also remained similar. Without being able to match individual pre-workshop and post-workshop responses we cannot say with certainty that these are the same individuals giving the same responses at two points in time. That is, we can't rule out the possibility that some people are simply pre-disposed to outdoor work and some not, with the workshop and its outdoor activities making little difference in individual attitudes.[6]

[6] This is another instance in which being able to match individual pre-workshop and post-workshop responses might have allowed for a better analysis and more certainty in conclusions.

3.3 Prior knowledge about land surveying was explored using three questions in the pre-workshop survey. These questions were all presented with negative phrasing so that strong agreement or agreement indicates that the person had little prior knowledge, exposure, or experience with land surveying. The results are shown in Table 4.

Table 4. Prior Experience, Knowledge and Interest in Land Surveying
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Before participating in this workshop	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I had never used land surveying equipment	39%	33%	17%	7%	4%
I didn't know very much about land surveying	28%	44%	18%	7%	3%
I wasn't very interested in Land Surveying	16%	39%	34%	7%	4%

Almost three-quarters (72%) of the students strongly agreed or agreed that they had never used land surveying equipment previously. Similarly, about three-quarters indicated that they didn't know very much about land surveying, although a larger percentage agreed than strongly agreed. Finally, over half (55%) agreed or strongly agreed that they weren't very interested in land surveying, with another one-third (34%) neutral – neither agreeing nor disagreeing. There were no statistically significant differences in these findings by gender in the responses for the entire population or among Hispanics. Dr. Gallegos clearly had an opportunity to present information about and experiences with land surveying to a group of students with little prior knowledge or exposure to it. However, the effort might have been a hard sell since almost all of the students (89%) started from a stance of being neutral to strongly agreeing that they were not very interested in this STEM field.

Prior Mathematical Education

4.1 Advanced land surveying requires knowledge of trigonometry for area calculations. However, as was discovered during an earlier evaluation of a summer land surveying course for students moving from eighth grade to STEAM high school, some aspects of land surveying require only simple knowledge of addition, subtraction, multiplication or division for measurements and geometry for calculation of areas of simple shapes such as rectangles and right angle triangles In evaluation of the land surveying summer course given to soon to be ninth graders at STEAM high school prior pre-algebra and algebra courses were much more frequent than geometry courses. During informal observation of a demonstration by land surveyor professionals to the STEAM students the evaluator noticed body language indicating more interest from students when the guests stopped talking about trigonometry and focused on demonstrating measurement and mathematics involving only addition and subtraction. In a different evaluation of the land surveying workshops given to ELAC MESA STEM Summer Academy students who had mostly been in their senior year in high school in the spring and were about to enter college, many

students had taken geometry but fewer had taken trigonometry. The working evaluation hypothesis is that student reaction to presentation of a land surveying workshop to students may depend on the prior mathematical background of the students, what mathematical education was attempted during the workshop, whether students understood that mathematical education, and what aspects of land surveying activities were presented.

4.2 Evaluation of the RHS workshop did not include any observation by the evaluator and the evaluator has not interviewed Dr. Gallegos about how he discussed the mathematics involved with land surveying or what level of mathematics any workshop activities or projects might demand. However, both the pre-workshop and the post-workshop survey asked students to self-identify which mathematical courses they had passed. The results are shown in Table 5.[7]

Table 5. Mathematical Backgrounds of Students

	Pre-Workshop			Post-Workshop		
	Yes	No	No Ans.	Yes	No	No Ans.
Basic Mathematics	92%	3%	6%	83%	5%	13%
Pre-Algebra	74%	17%	10%	66%	19%	15%
Algebra	57%	33%	10%	59%	28%	13%
Geometry	22%	56%	22%	19%	60%	20%

As can be seen in Table 5, most students self-reported that they had passed basic mathematics, two-thirds to three-quarters (depending on the survey) pre-algebra, and almost 60% had passed algebra, but only around one in five had passed geometry.

4.3 There were no statistically significant differences by gender among the entire group or among Hispanics in having passed Basic Mathematics or Algebra in either the pre-workshop or the post-workshop surveys. However, among both the entire group and among Hispanics analysis of the pre-workshop survey results found that females were statistically significantly more likely to have passed Pre-Algebra than males were[8]. Among those who gave a yes or no response about Pre-Algebra in the pre-workshop survey the difference was 93% of women compared to 61% of men in the entire group, and 95% of Latinas to 70% of Latinos responding "yes." However, there was no statistically significant difference by gender among pre-workshop survey respondents in having passed geometry. The students who took the post-workshop survey were not the same group as those who took the pre-workshop survey and there was no statistically significant difference by gender in having taken pre-Algebra in that survey. However, there was a statistically significant by gender in having passed Geometry in both the entire group and between Latinos and Latinas[9]. Among the entire group of post-workshop respondents 39% of the males compared to 16% of the females had passed geometry. Among Hispanics who answered

[7] "Basic mathematics" was defined in the question as addition, subtraction, multiplication and division.

[8] For the entire group, Fisher's Exact Test p = .003 one-sided and Cramer's V = .388, p = .002. For Hispanics only, Fisher's Exact Test p = .017 one-sided and Cramer's V = .338, p = .011.

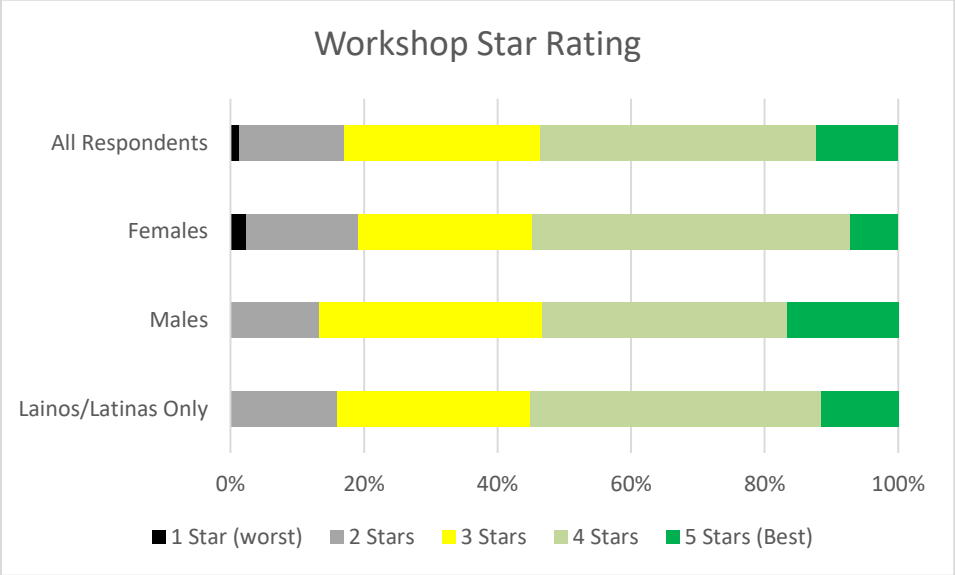
[9] For the entire group Fisher's exact test p = .031 one-sided and Cramer's V - .266, p = .031. For Hispanics only, Fisher's Exact Test p = .023 one-sided and Cramer's V = .289, p = .022.

the post-workshop survey question, 42% of Latinos compared to 16% of Latinas had passed geometry. While these findings are confused by the differences in groups who took the pre-workshop and post-workshop surveys it is possible that there is something going on with the mathematical preparation of females that is different than that of males. Later in this report we explore the relationship of having previously taken geometry to reactions to the workshop.

General Reactions to the RHS Land Surveying Workshop

4.1 The first two questions in the post-workshop survey used "closed" questions to gauge student reactions in general. The very first question asked students to rate the overall workshop using a star rating system where 1 star was "worst" and 5 stars was "best," with no criteria for the rating. Overall the students rated the workshop at 3.5 with only very slight variations in average ratings by males (3.6) and females (3.4) and Hispanics (3.5) the same as the entire population.

Chart 3. Star Ratings of the Overall Workshop



4.2 The next three questions provided an additional overall measure (would the respondent recommend the workshop to another student?), and questions about whether the students enjoyed the workshop or thought it was fun. The results are shown in Table 6 with important differences highlighted. None of these are statistically significant differences because of the small numbers involved when spread over four of five response categories. However, a series of gamma tests that were statistically significant showed that these questions, along with the first question, were moderately to strongly correlated with one another. That is, students who gave the workshop more stars also tended to be on the neutral to strongly agree side of the questions about whether they would recommend the workshop, whether they enjoyed the workshop, and whether the workshop was fun (or vice versa). Overall the ratings are positive since about two-thirds (67%) of the students agreed that they would recommend the workshop to another student, and two-thirds (66%) reported that they had enjoyed it. As a rule of thumb, ratings of about two-thirds to three-quarters of responses in the top two categories tend to indicate that there are not major problems with a service or event. However, only just over half (53%) of the students strongly

agreed or agreed that the workshop was fun, with very little variation among sub-groups. Greater proportions of students who identified themselves as Hispanic thought the workshop was fun. This is a positive sign for the grant in regards to attracting Hispanics to and surveying. However, larger proportions of males than females strongly agreed or agreed that the workshop was fun, and slightly higher proportions of females disagreed or strongly disagreed. The numbers are small and the correlations are not statistically significant, but there is room for improvement in making the workshop more fun for females.

Table 6. General Ratings of the Workshop

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I would recommend this workshop to another student	16%	51%	29%	3%	1%
Females	5%	56%	37%	2%	
Males	30%	48%	15%	6%	
Hispanics only (either gender)	8%	61%	26%	4%	
I enjoyed this workshop	9%	57%	25%	8%	
Females	2%	56%	40%	2%	
Males	15%	70%	6%	9%	
Hispanics only (either gender)	8%	61%	26%	4%	
The workshop was fun	10%	43%	39%	5%	4%
Females	8%	45%	40%	5%	3%
Males	13%	45%	39%	0%	3%
Hispanics only (either gender)	8%	61%	26%	4%	

4.3 Important but not reliably statistically significant gender differences showed up in whether students had enjoyed the workshop and whether they would recommend the workshop to another student. The grant is focusing on trying to bring more females into land surveying and these findings go against the interests of the grant in doing that if peer opinions and word of mouth are important among teenagers. While 78% of males strongly agree or agree that they would recommend this land surveying workshop to another students, just 63% of females would do so. If asked whether they had enjoyed the workshop, a very respectable 85% of the males but only 58% of the females would agree that they had, with only one strongly agreeing.

4.4. Three other questions focused on the effect of the land surveying workshops on student interest in STEM, in land surveying and on working in a career where they would often get to work outdoors. The results are shown in Table 7. Interest in a STEM career was discussed earlier in this report (paragraph 3.1) and Chart 1 showed that the workshop did not increase that interest in a population that was already interested in STEM careers. Table 7 indicates that this finding holds across genders. To avoid a small N issue, "strongly agree" and "agree" responses were

combined, as were "disagree" and "strongly disagree," to create a three-category variable about interest in a STEM career after the workshop. When that was done, females were statistically significantly less likely than males to be interested in a STEM career.[10]

Table 7. Three Impacts of the Land Surveying Workshop on Student Interests

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
After this workshop I'm more interested in a STEM career	17%	29%	38%	14%	1%
Females	12%	31%	38%	17%	2%
Males	24%	30%	36%	9%	
Hispanics only (either gender)	20%	31%	35%	14%	
Interested in a career where I often get to work outdoors	15%	31%	30%	21%	2%
Females	14%	21%	33%	29%	2%
Males	18%	45%	27%	9%	
Hispanics only (either gender)	17%	32%	30%	20%	1%
I'm interested in land surveying	8%	7%	40%	28%	16%
Females	5%	5%	33%	36%	21%
Males	15%	12%	48%	12%	12%
Hispanics only (either gender)	10%	8%	42%	21%	18%

As also discussed earlier in this report (paragraph 3.2, Chart 2), the workshop and the activities outdoors did not increase interest in a career where one often got to work outdoors. However, when "Agree" and "Strongly Agree" males are combined and "Disagree" and "Strongly Disagree" responses are combined there is a moderately strong, statistically significantly by gender[11]. Simply put, males are more likely to be interested in a career involving outdoor work and females less likely. In terms of attracting females to land surveying, touting land surveying as a career option in which one frequently gets to work outdoors may, in fact be counterproductive. Making such an argument works as well with Hispanics as with the overall population, most likely because of being a good argument to use with Latinos.

4.5. In relation to grant goals, it is apparent in Table 7 that after the workshop only 15% of the overall population and 18% of Hispanics agreed or strongly agreed that they were interested in land surveying. While 40% overall (42% of Hispanics) neither agreed nor disagreed, 44% overall

[10] When "strongly agree" and "agree" were combined and "disagree" and "strongly disagreed" were combined to overcome a small N issue, Pearson Chi-Square = 9.108, df = 2, p = .011, no cells have expected counts less than 5. Cramer's V = .348. p = .011.

[11] Pearson Chi-Square = 7.363, df = 2, p = .025, no cells with expected count less than 5. Cramer's V = .313. p = .025.

(39% of Hispanics) disagreed or strongly disagreed that they were interested in land surveying. Of interest, and favorable to grant concerns, a weak but important correlation indicates that the disinterest in land surveying is much greater among those who did not check "Hispanic" as an ethnicity than among those who did.[12] The only students who agreed or strongly agreed that they were interested in land surveying were Hispanics, while 71% of others, compared to 39% of Hispanics disagreed or strongly disagreed that they were interested.

4.6 As discussed earlier (paragraph 3.3), relatively few students had known much about land surveying or had worked with land surveying instruments before the workshop and over half (55%) agreed or strongly agreed that they weren't very interested in land surveying, with another one-third (34%) neutral – neither agreeing nor disagreeing and 11% disagreeing or strongly disagreeing. Since the pre-workshop and post-workshop survey takers differ in population size and aren't matched individually, we don't know precisely what shifts occurred with individuals. However, it is possible (although not proven) that the net impact of the workshop was to shift more students into a neutral stance regarding land surveying interest, leaving fewer completely disinterested. Yet it may also be true that those interested in land surveying now were interested before the workshop even started.

4.7. While there was no reliable statistically significant difference between females and males before the workshop, after the workshop females were moderately strongly and statistically significantly less likely than males to agree or strongly agree that they were interested in land surveying and more likely to disagree or strongly disagree.[13] In particular, after the workshop over half of the females (57%) compared to 24% of the males disagreed or strongly disagreed that they were interested in land surveying. Clearly the workshop might have done better to encourage female interest.

4.8. Two survey questions addressed general goals of the workshop: acquainting students with what land surveyors do in the field and encouraging them to learn more about land surveying. Table 8 shows the distribution of survey responses on these questions. The summer 2019 land surveying workshop did an exceptionally good job in giving Roosevelt High School students a working knowledge of what land surveyors do in the field. About 85% indicated that they had learned a great deal or a fair amount about that, with no significant variation by gender or for Hispanics. It did less well in encouraging students to learn more about land surveying. About 62% of the respondents reported that the workshop had done a great deal responded significantly better to the workshop than non-Hispanics and those who didn't answer the ethnicity question at all[14]. While two-thirds of Hispanics reported that the workshop encouraged them a great deal or a fair amount to learn more about land surveying, only a bit over a quarter (27%) of any other respondents reported the same.

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[12] To overcome the small N issues, "strongly agree" and "agree" responses were combined and "disagree" and "strongly disagree" responses were combined. Pearson Chi-Square = 5.768, df = 2, p - ,055 (so not significant at the 5% level of significance), 1 cell (16.7% has an expected count (2.14) less than 5. Cramer's V = .261, p = .055.

[13] To overcome the small N issues, "strongly agree" and "agree" responses were combined and "disagree" and "strongly disagree" responses were combined. Pearson Chi-Square = 9.109, df = 2, p = .011 with no cells with an expected count less than 5. Cramer's V = .349, p = .011.

[14] Fisher's Exact Test p = .016 when "a great deal" or "a fair amount" are combined and "not very much" to "not at all" are combined.

Table 8 General Workshop Objectives Regarding Land Surveying

To what extend did this land surveying workshop…	A great deal	A fair amount	Not very much	Almost none at all	Not at all
give you a working knowledge of what land surveyors do in the field	22%	63%	13%	1%	
Females	24%	63%	12%		
Males	19%	66%	13%	3%	
Hispanics only (either gender)	21%	64%	13%	1%	
encourage you to learn more about land surveying	18%	44%	30%	6%	3%
Females	12%	46%	29%	10%	2%
Males	23%	45%	26%	3%	3%
Hispanics only (either gender)	17%	49%	25%	6%	3%

Rating of Specific Workshop Elements and Activities

5.1. The survey asked the students to rate 12 specific elements or activities of the workshop on a five point scale from "excellent" to "very poor" and included an "N.A." (Not applicable) column for those who had not been present for that part of the curriculum. Table 9 shows the ratings. Dr. Gallegos reported that five of the originally planned workshop elements either were not delivered as originally planned or did not happen at all.[15] These elements or activities are included in Table 9 with an asterisk (*) next to them. At the least, the students would have had to think about what was really done instead of what was asked about in the survey (e.g., measuring a bridge instead of laying out a house outline?). Since this could have led to confusion about reference or arbitrary ratings, the findings for the items with an asterisk next to them may not be valid and should be interpreted cautiously. Also, students were provided with information about the three software applications (CAD, GIS, and BIM) only through YouTube videos. The ratings of those items refer to the videos rather than to the instructor. The most frequent response for all items in Table 9 was "Good," with the second most frequent response varying between "Excellent" and "Fair," depending on what was being rated. The four best received elements of the workshop had ratings between 65% and 71% "Excellent" plus "Good" which is acceptable but not outstanding in an opinion survey. These included Academic Pathway Information, Career Research Project, Field presentations, and Budget 101. The next seven items had ratings of 51% to 62% "Excellent" plus "Good" and "Fair" ratings between 28% and 33% and "Excellent" ratings between 10% and 22%. These are the parts of the workshop that might be reviewed in an effort to improve them. They include three items with asterisks that may not have occurred as described or originally planned. The three video presentations of software are also in this group.

[15] The survey had asked about "Staking out a building footprint," "Costing out construction of a house," "Field presentations," "Career presentations by public agencies," "Career presentation by private agencies."

Table 9. Ratings of Specific Workshop Elements and Activities[16]

Workshop Elements and Activities Ratings	Excellent	Good	Fair	Poor	Very Poor
Academic Pathway Information	28%	43%	27%	1%	1%
Career Research Project	22%	47%	23%	7%	
Field presentations*	21%	45%	28%	6%	
Budget 101	16%	49%	31%	3%	1%
Costing out Construction of a House*	22%	40%	33%	3%	3%
Career presentation by private agencies*	17%	45%	28%	6%	4%
Introduction to GIS (video)	15%	46%	32%	5%	1%
Introduction to CAD (video)	10%	51%	33%	4%	1%
Introduction to GSET	15%	46%	35%	3%	1%
Introduction to BIM (video)	17%	44%	33%	5%	1%
Career presentation by public agencies*	18%	43%	33%	5%	3%
Staking out a Building Footprint*	16%	38%	38%	6%	1%

Finally, "Staking out a Building Footprint," which was what was done in a recent ELAC MESA workshop as an outdoor hands-on exercise, ranks last, with only 54% "Excellent" plus "Good" ratings, 38% "Fair" and 7% "Poor" or "Very Poor" ratings. The survey reference was not accurate because a substitute outdoor hands-on activity was used instead of the house design, and that might have caused some confusion among respondents. However, apparently the substitute activity did not work as well as other workshop elements. There were no statistically significant variations in these responses by gender or between Hispanics and any others.

Intended Actions as Workshop Outcomes

6.1. Since students took the post-workshop survey at the end of the last day of the workshop it was only possible to measure intentions rather than actual behavior at this time in the project evaluation. A survey questions asked whether "As a result of taking the RHS Land Survey Workshop" students had become interested in eight potential academic or career related actions. The five point scale ranged from "Strongly Agree" to "Strongly Disagree" with a middle point. The results are shown in Table 10. Nine or ten individuals (10% to 11%) of the students who responded to at least part of the post-workshop survey didn't respond to one to all of these questions. The table shows the results of the roughly 90 percent who did reply. The responses were split three ways, often fairly evenly. The most frequent response to each of the questions was the neutral one – neither agree nor disagree (30% to 43% of respondents). Between 26% and 32% disagreed or strongly disagreed that they were interested in one or another of the actions. Between 26% and 36% agreed or strongly agreed on an action item, with more agreeing than strongly agreeing.

[16] Table 9 is sorted from the largest percentage of "Excellent" plus "Good" responses to the smallest, then for ties by percentage "Excellent" then by percentage "Good," largest to smallest.

Table 10. Post-Workshop Interest in Taking Land Surveying Related Actions

As a result of taking the RHS Land Surveying workshop I have become interested in:	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
taking one or more land survey courses in high school	11%	25%	38%	23%	3%
taking land survey related courses at a commuity college or university	14%	22%	34%	28%	3%
obtaining a community college certificate in land surveying	10%	23%	37%	25%	5%
earning an Associate degree in land surveying	14%	16%	42%	22%	6%
earning a B.A. or B.S. degree in land surveying	13%	23%	35%	24%	5%
becoming a professionally certified land surveyor	14%	13%	43%	25%	5%
pursuing land surveying as a career	14%	15%	38%	26%	6%
becoming a Civil Engineer	14%	27%	30%	23%	6%

6.2 Over one-third (36%) of the incoming ninth grade RHS students did express an interest in taking one or more land surveying courses while in high school. A similar percentage (36%) had become interested in taking land survey related courses at a community college or university. While one-third (33%) might seek a land surveying certificate, and 30% an Associate degree in land surveying from a community college, only about a quarter (26%) had become interested in pursuing land surveying as a career, 27% in becoming a professionally certified land surveyor, compared to 41% who increased their interest in becoming civil engineers.

6.3. As shown in Table 11, after the workshop the RHS females were less interested than the RHS males in taking the follow-up actions. When the scale was recoded into three categories ("Strongly Agree plus Agree," "Neither Agree nor Disagree," "Disagree plus Strongly Disagree") it was possible to do valid and reliable statistically testing by gender for the entire population and, among Hispanics, for Latinas versus Latinos. Females were always statistically significantly less likely than males to express interest in engaging in each of the academic or career related actions, with one exception. While females were markedly less interested than males (and among Hispanics, Latinas than Latinos) in taking one or more land surveying related courses in high school, the difference was not statistically significant at the .05 level of significance.

Table 11. Gender Differences in Post-Workshop Interest in Land Surveying Related Actions

As a result of taking the RHS Land Surveying workshop I have become interested in:		Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
taking one or more land survey courses in high school [17]	Females	5%	20%	44%	29%	2%
	Males	19%	32%	32%	13%	3%
taking land survey related courses at a commuity college or university [18]	Females	5%	10%	44%	39%	2%
	Males	26%	32%	23%	16%	3%
obtaining a community college certificate in land surveying [19]	Females	2%	15%	39%	39%	5%
	Males	16%	32%	35%	13%	3%
earning an Associate degree in land surveying [20]	Females	5%	10%	46%	34%	5%
	Males	23%	26%	35%	10%	6%
earning a B.A. or B.S. degree in land surveying [21]	Females	5%	15%	39%	37%	5%
	Males	19%	32%	32%	13%	3%
becoming a professionally certified land surveyor [22]	Females	5%	7%	44%	39%	5%
	Males	23%	23%	39%	13%	3%
pursuing land surveying as a career [23]	Females	7%	5%	41%	39%	7%
	Males	20%	30%	33%	13%	3%
becoming a Civil Engineer [24]	Females	5%	22%	34%	32%	7%
	Males	23%	32%	26%	13%	6%

In Table 11 the plurality response in each row is highlighted in yellow and the next most frequent response in a light gray, except when there is a tie for most frequent. For both genders the neutral "Neither Agree nor Disagree" response is typically the most common, but among males it was sometimes "Agree," and among females it was sometimes "Disagree" with the second most

[17] After recoding to a three-point scale, Pearson Chi-Square = 5.952, df = 2, p =.051 with no cells having an expected count less than 5. Cramer's V = .288, p = .051. Since the probability is not less than .05, is it not statistically significant.
[18] After recoding to a three-point scale, Pearson Chi-Square = 15.001, df = 2, p =.001 with no cells having an expected count less than 5. Cramer's V = .456, p = .001. The correlation is moderately strong and statistically significant at the .001 level.
[19] After recoding to a three-point scale, Pearson Chi-Square = 9.987, df = 2, p =.007 with no cells having an expected count less than 5. Cramer's V = .372, p = .007. The correlation is moderately strong and statistically significant at the .01 level.
[20] After recoding to a three-point scale, Pearson Chi-Square = 10.567, df = 2, p =.005 with no cells having an expected count less than 5. Cramer's V = .383, p = .005. The correlation is moderately strong and statistically significant at the .01 level.
[21] After recoding to a three-point scale, Pearson Chi-Square =9.359, df = 2, p =.009 with no cells having an expected count less than 5. Cramer's V = .361, p = .009. The correlation is moderately strong and statistically significant at the .01 level.
[22] After recoding to a three-point scale, Pearson Chi-Square =11.647, df = 2, p =.003 with no cells having an expected count less than 5. Cramer's V = .402, p = .003. The correlation is moderately strong and statistically significant at the .01 level.
[23] After recoding to a three-point scale, Pearson Chi-Square =13.604, df = 2, p =.001 with no cells having an expected count less than 5. Cramer's V = .438, p = .001. The correlation is moderately strong and statistically significant at the .01 level.
[24] After recoding to a three-point scale, Pearson Chi-Square =6.195, df = 2, p =.045 with no cells having an expected count less than 5. Cramer's V = .293, p = .045. The correlation is moderately strong and statistically significant at the .05 level.

frequent responses for males always toward disagreement with the action. In terms of percentages the differences are stark. For example, over half (52%) of the males, compared to under one-fourth (24%) of the females are interested in taking one of more courses while in high school. There were 44 females and 33 males who answered the question, so that translates into 10 females and 16 males – a class of 26 - if all followed through and took the next class offered.

6.4. At the community college or university level, an even larger percentage of the males (58%, 18 men) but a smaller proportion of females (15% or 6 women) agreed or strongly agreed that they were interested in taking land surveying courses. Fifteen males (48%) and seven females (17%) were potentially interested in obtaining a community college certificate in land surveying. Slightly fewer students (15 males, 48% and 6 females, 15%) might seek an Associate degree in land surveying. A few more (16 males, 52% and eight females, 20%) would potentially be interested in a baccalaureate degree in land surveying.

6.5. In terms of career options, the greatest interest was in becoming a Civil Engineer (17 males, 55% and 11 females, 27%). That was apparently a more interesting career option than pursuing land surveying as a career (15 males, 50% and 5 females, 12%). However, one fewer student was interested in becoming a certified land surveyor (14 males, 45% and 5 females, 12%).

6.6. It is probably not surprising that a series of gamma statistical tests revealed very strong statistically significant correlations at the .001 level of significance between the amount of agreement or disagreement with the statement "I'm interested in land surveying" and the amount of agreement or disagreement with the eight potential actions shown in Tables 10 and 11. Perhaps more interesting is that another series of gamma statistical tests at the .01 level of significance revealed weak to strong correlations of responses to the statement "I'm interested in a career where I often get to work outdoors" and each of the eight potential actions.

Qualitative Findings

7.1. The survey included three open-ended qualitative questions focused on the functioning of the workshop, viz., "What did you like best about the workshop?"; "What did you like least about the workshop?"; and "What was okay about the workshop but could have been better?" The results appear verbatim in Tables 12, 13, and 14 with a breakdown by gender and organization of related comments.

Table 12. What Students Liked Best About the Workshop

Females (N=44)
Going outside
The outdoor activities (2)
Going outside to see the view of the field
I liked that we also spent some time outside.
I liked the outdoor activities
I liked when we went outside
I liked that you get to be outdoors for land surveying
the walking
The Field work
The actives
What I like about it was the activities we did together
getting to know class of 2023
Getting to meet new people (2)
Meeting new people (2)
that we got to meet new people
We got to meet other people
we got to work with other people
the people
seeing my friends and the lecture
I liked best about these workshops is that we were able to work with friends
Me and my team interacting and working together.
I like that my friends were with me and that we didn't do much work.
I didn't have to do any work
learning new skills
That we got to learn about stuff we may have never heard of.
The teachers
I like that their chairs and how we learned about different careers
I liked how the teacher kept teaching us things about college and jobs.
I like that we got to learn new careers for example land surveying
Learning about what my dad does which is engineering.
the room scanner
The laser scanner for the room. Also the video's.
was fun
When we did fun activities
I enjoyed the tour

Table 12. What Students Liked Best About the Workshop (continued)

Females (continued)
When they taught us on finances and budgeting
The movie was cool
Nothing
Nothing
No answer (2)

Males (N = 33)
The work
Work
working with friends
We had to work with each other.
Interacting with other students
That I got to meet new friends
The people cause there nice
the people cuz they were nice
When I had volunteered to help
The hands on portion for us.
I liked the different activities
the activities
When we did some of the outdoor activities
we got to go outside and do the races.
I liked when we got to go outside
The walking
One thing I liked was we got to visit all places in ELAC.
The videos
I liked the videos that we got to watch.
Documentary
The show and how to get a good job
How the machine was moving on it's own.
Diversity
Everything
Everything

Table 12. What Students Liked Best About the Workshop (continued)

Males (continued)
Nothing (2)
nothing realy
non?
don't know
No Answer (3)

No Gender indicated (N=11)
Making the bridge
the learning
learning how to do certain stuff
we got to see a lot of new things
that it was a bigger class
What I liked best about the workshop is meeting new people.
Meeting new people
Nun
No Answer (3)

7.2 About one-quarter (25%) of the females reported that the best part of the workshop involved going outdoors and engaging in activities. On the one hand this is surprising since females were statistically significantly less likely than males to be interested in a career where one often gets to work outdoors.[25] Why then did a large proportion of females mention the outdoor activities were the ones that they liked best about the workshop? The answer may lie in the second thing that women most frequently mentioned about the workshop. For about 20% of the females the best things about the workshop involved meeting and interacting with new people. This may have been the first time that the students of the class of 2023 who were interested in STEM had been together. Females often especially value relationships. This workshop included outdoor activities working with others and forming teams. Several female students specifically mentioned likely working together with friends. Learning about other careers such as land surveying and what one young woman's father did in his work as an engineer together constitute the next most frequently mentioned category for females.

7.3 Males also frequently mentioned the outdoor activities, meeting new friends, and mentioned that people were nice. However, the most frequent response related to "work," or "the work" (12%) and activities (9%) related to land surveying work. About 9% of the males, compared to about 5% of the females mentioned the videos. Two females compared to one male thought the best

[25] With "Strongly Agree" and "Agree" combined and "Disagree" and "Strongly Disagree" combined Pearson Chi-Square = .7.363, df = 2, p = .025, no cells have an expected count less than 5; Cramer"s V = .313, p = .025. Only 36% of females agreed or strongly agreed that they were interested in a career where one often gets to work outdoors, compared to 64% of males and 31% of females disagreed or strongly disagreed (compared to 9% of males),

thing about the workshop was the automated laser scanner measuring a room, moving on its own.

7.4. Those who answered the third survey question about the best thing about the workshop but not the eleventh question about gender (or specified "Other" or "Prefer not to answer" about gender) focused on meeting new people in a big class. Their other responses were somewhat ambiguous other than "Making the bridge," which may have been an outdoor activity.

7.5. Table 13 shows the responses to the question "What did you like least about the workshop?"

Table 13. What Students Liked Least About the Workshop

Females (N = 44)
It was not instresting
I dislike how it was a little boring 101.
I didn't like that it was just about land surveying because I'm not very interested in that
I'm not interested in this career
that it was about land surveying
That I was intrested in the job. I wish it was a better job.
the math part
I least liked the math.
I disliked the math part, I was confused.
the counting
I disliked how we'd do stuff outside since it was hot.
the fact to take place in the outside heat
The Heat
going outside and working
the lecture
The talking
What I dislike about it was too much talking.
The inturaptions
To sit and watch videos
I did not like the videos
The videos
I least liked the walking.
that we had to be walking a lot.
Staying indoors
When we had to stay in the room for an hour.
The work
The writing
the grouping

Table 13. What Students Liked Least About the Workshop (continued)

Females (continued)
the food
The confusing parts.
the length
the last class
waking up early
Most of it
Nothing
Nothing I enjoyed the most part of it.
nothing much
Something that I dislike that
IDK (2)
No Answer (4)

Males (N=33)
It was hot while we were outside
The hot sun.
The sun cause it was hot
The sun cuz it's hot lol
One thing I didn't like was we couldn't stay inside since it was hot outside.
That I got tans for being outside a lot
The lectures
The 1 hour talks
the talking
I didn't like all the talking
long talks
It wasn't very exciting
kind of boring
Math
The counting
the teacher
not being as active in the first day
that we had to do much work
That I wasn't helped
I have no like

Table 13. What Students Liked Least About the Workshop (continued)

Males (continued)
I liked the workshop
Everything
Have no clue
don't know
I don't know
non?
Nothing (2)
Nothing
nothing at all
No Answer (3)

No Gender Indicated (N=11)
the heat outside and walking too much
Walking
What I like the least about the workshop was the presentation.
Math
I'm not interested in this field
Nun
Nothing (2)
No Answer (3)

7.6. Five females (about 11%) found that the workshop was boring, several adding that they were just not interested in land surveying or land surveying as a career. One was interested in land surveying but didn't like the nature of the work she experienced. About 9% of the females (4 people) did not like the mathematics part of the workshop, one admitting to being confused. Another four disliked going outside, mostly because it was hot, compared to two who didn't like remaining inside. Three disliked the lectures or "the talking" with one mention of interruptions. Another three disliked the videos. Two disliked walking a lot.

7.7. About 18% of the males (6 people) disliked being outside in the hot sun. Four males (about 12%) disliked the long (one hour) talks (lectures). Two found the workshop boring and two disliked the math. The males frequently answered variations of "don't know" (4) or "nothing" (4).

7.8. The students who did not indicate their gender reiterated points made by the others, including two "nothing" responses.

7.9 Table 14 shows the responses to the question "What was okay about the workshop but could have been better?"

Table 14. Okay About the Workshop but Could Have Been Better

Females (N = 44)
The activity
More activities
We could've done more activities.
Be more active
The work could've been more fun
They could've put on more fun games.
The games
More Field work
Being able to interact more with new people
I could've talked to more people.
The chances of getting to know my peers
we should've chosen to be in whichever group.
that we shared out
The lectures.
long lectures
the presentation
The presentation.
Talking about other jobs
It would have been best if they would have talk about other jobs
The job could've been better.
the career
The seating when both classes got together
The space in the room
space in room
the length
longer break
The project thingy (there wasn't enough time)
The explanations can be better.
more expanitions
The directions/instructions.
the lunch
The lunch

Table 14. Okay About the Workshop but Could Have Been Better (continued)

Females (continued)
nothing much
Nothing, everything was good except the heat.
Mostly everything
Everything
I don't know
IDK
No comment
No Answer (5)

Males (N = 33)
land survey
More career options
The work the work
The Activities
the morning activities
more activities
Where we did race thing
The points what we had to find
The seating when two classes came together.
It could have been fun
The lectures
that the instructions could have been more clearer
the student
The muchten! (? muchlen?)
the whole workshop was okay
The workshop had no flaws
The workshop was good and there should be no changes
what could have been better was probably nothin cuz I enjoyed it.
Nothing
Nothing (2)
I don't know (4)
I really don't know.
No Answer (7)

Table 14. Okay About the Workshop but Could Have Been Better (continued)

No Gender Indicated (N=11)
Changing the topic
I think the tour was okay but could improve
I was easy to hear but could have had more up to date sources
The speech. Could have been shorter
this one teacher she looked like she hated the kids
IDK
Nothing. It was good!
No Answer (4)

7.10 The most frequent female responses were not specific and came from 12 people (27%) who responded with variations of "nothing," "everything," "I don't know," "no comment," or did not respond at all. The most frequent substantive responses focused on activities (8 females, about 18%) with clarifications that they could be greater in number, or more fun. Five females (11%) focused their recommendations on interactions, favoring interaction with more people, specifically new people, sharing out, and allowing the students to choose the group with which they wanted to interact (perhaps in teamwork?). Two females thought the job or career could be better and two others wanted information on more jobs or careers. One cannot be sure from this comment, but there might have been a misconception that the workshop would focus on a greater variety of STEM careers rather than just on land surveying? Three females spoke of a space issue, apparently inside when "both classes" met together and there may not have been enough chairs. Three others brought up time related issues by vaguely mentioning "the length," or more specifically wanting longer breaks and more time for the "project thingy." Three females (one each) would have liked more explanations, better explanations, or more instructions. Finally, two indicated that the lunch was okay but could have been better.

7.11. Over half (58%) of the males gave non-specific responses when they replied with variations of "nothing" (7 people, 21%), "I don't know" (5 males, 15%) or gave no answer at all (7 people, 21%). Three males (9%) thought the land survey work or career could be better. Three made vague references to "the activities," but one focused more specifically on the "race thing" and another on the "points what we had to find." One person each mentioned fun, the lectures, clarity of the instructions, and "the student."

7.12. Similar to the males, six (55%) of those who did not specify gender gave non-specific responses of "IDK" (I don't know), "Nothing" or no answer at all (4). The specific topics for improvement mentioned by this sub-group related relate to "Changing the topic," the tour, how up to date sources were, and shortening the "speech" (presumably a lecture?). A somewhat disturbing reference relates to the purported personal behavior of a teacher was "this one teacher she looked like she hated the kids." The reference is confusing since I thought that both workshop instructors were males and the feminine "she" is used. The reference is somewhat disturbing if true since the person who wrote it indicated a non-Hispanic minority ethnic identity.

Discussion and Evaluator Conclusions

8.1. The Roosevelt High School workshop experienced implementation problems related to the number of students (around 100) being led by only two instructors. Not everything went according to plan. The survey misrepresented in its questions what was really done, was not pre-tested, and in retrospect might have been better organized. The survey was delivered on paper rather than over the internet as intended, which resulted in some questions about the results. Data entry by hand may have resulted in data entry errors and did include some judgment about which response to enter when there were multiple checks on the same response line. The sample was not random and the number of respondents to the pre-workshop survey was smaller than the number who responded to the post-workshop survey. Therefore the results presented above and the comment below should not be projected to the entire student body or presented as representing more than the opinions, rankings, and responses of those Roosevelt High School students that participated in this workshop. The results and conclusions also include known and unknown biases from the methodology implementation and should be viewed cautiously.

8.2. Nevertheless, quantitative and qualitative findings, especially those of the 88 out of the 101 who attended the last net do represent a large sample of workshop participants. Those students indicated that despite the implementation problems, some of which they pointed out in the open-ended comments, the workshop was generally well-received. Many students enjoyed the workshop, thought it was fun, and gave it ratings that were in the middle to most positive side of the scale range. The questions about workshop specifics were usually good or fair rather than excellent. From a student perspective the summer 2019 Roosevelt High School workshop did not completely fall apart. The overall star rating of 3.5 out of 5 stars for the "ideal" workshop (whose characteristics were not specified) seems like a fair and reasonably honest reflection of what happened, given internal logical consistency of most student responses.

8.3. From the perspective of the NSF ATE grant goals, the workshop did a good job of reaching Hispanics. That might be expected because the vast majority of the RHS ninth grade students identified themselves as Hispanics or Hispanics plus one other ethnic group. Despite the small number of non-Hispanics, it was possible to tease out a few instances in which Hispanics responded more favorably (from a grant perspective) than non-Hispanics. ATE grant goals for high school students could be met either by focusing outreach and workshop efforts on groups such as this one that include large proportions of Hispanics, or by presenting workshops in such a way that Hispanics respond at least as favorably or more favorably as other ethnic groups to land surveying. A bit of both approaches appears to have happened with this workshop.

8.4. The workshop did a good job transmitting a great deal or a fair amount of working knowledge about what land surveyors do in the field to 85% of the students. On the other hand, workshop participation only encouraged 62% of the students a great deal or a fair amount to learn more about land surveying. About two-thirds (66%) of the students strongly agreed or agreed that they would recommend the workshop to another student, and 66% that they enjoyed the workshop but that did not translate into an interest in land surveying. Overall, as the workshop ended only 15% of students strongly agreed or agreed that they were interested in land surveying. These students were interested in STEM careers, but 22% disagreed or strongly disagreed that they were

interested in a career (such as land surveying) in which they frequently get to work outdoors and 30% were neutral on the matter. As shown in Chart 3 the percentage of students in the pre-workshop survey who strongly agreed that they were interested in a STEM career dropped from 28% to 17% while the percentage agreeing was similar, those in the middle (neutral) category rose from 28% to 38%, those who disagreed rose from 7% to 14% while those strongly disagreeing remained nearly nil at 1%. The number of students in the pre-test and post-test were not the same, so the changes appearing in Chart 3 are not definitive evidence that the workshop led to decrease in interest in land surveying among those already interested. Rather, along with the finding about having learned a fair amount or a great deal about what land surveyors do, the workshop might be perceived as providing a "reality check" for the young students, and helping some make up their minds about land surveying as a future academic or career option.

8.5. The relatively small sample size, lack of a control variable to measure the amount of prior interest in land surveying, and use of five-category ordinal opinion variables resulted in many technically invalid or unreliable statistical tests, even when variable categories were summarized to three ordinal measurement points. It does appear, however, that there may be weak to strong and possibly significant correlations between enjoying the workshop, viewing the workshop as fun, being interested in land surveying, and agreeing or strongly agreeing that the workshop interested students in eight academic or career related behavioral actions related to land surveying shown in Table 10. However, correlation is not causation and enjoying the workshop, considering it fun, and being interested in land surveying are themselves correlated with each other. This multicollinearity and the use of non-parametric statistics appropriate for a non-random sample make it difficult and time-consuming to test whether enjoying the workshop or viewing it as "fun" were stronger predictors of interest in behavioral changes toward land surveying in the direction proposed by the ATE grant. One way to view the results is that making the workshop fun or helping students enjoy it might be an appropriate or even necessary but insufficient cause of interest in behavioral actions in the directions favorable to the ATE grant results. For each behavioral change, overall the majority of students remained neutral to negative. Dr. Gallegos might wish to set "success" standards for how much interest he hopes to achieve in similar workshops in the future.

8.6. The outcome measurements should also be interpreted cautiously in terms of size, the time factor, and that intended future behavior rather than actual behavior is being measured. For example, as a result of participating in the workshop, 36% of the students agreed or strongly agreed that they were interested in "taking one or more land survey courses in high school." Numerically that means that 29 RHS students might take at least one land surveying course while attending high school, but the survey didn't ask whether they would be interested in taking such a course in their freshmen, sophomore, junior, or senior years. Nor did it probe whether they would take only one or actually would want to take more than one land survey course in high school. Some might change their minds or run into scheduling difficulties or become interested in something else. The interpretation of the results becomes more difficult as one moves over time to community college course taking (while still in high school or not?), university course taking, certificate and degree plans, entering land surveying as a career or becoming a certified land surveyor.

8.7. Several survey results suggest to the evaluator that Dr. Gallegos may want to reflect on how he is approaching females in this kind of a workshop and whether that approach will succeed in

meeting the ATE grant goals for attracting more women into land surveying as an academic discipline and ultimately a career. There were more females than males among the RHS students. In this group females and males were equally interested in STEM careers. However, as shown in Table 7, after the workshop females were statistically significantly less likely than males to be interested in land surveying. Although the Pearson Chi-Square test was not valid or reliable because of the small number of cases, in the pre-workshop survey a crosstabulation of gender with interest in land surveying showed no important percentage differences between females and males. That is, 50% of females were agreeing or strongly agreeing that they weren't very interested in land surveying, 40% neutral, and 10 percent disagreeing or strongly disagreeing, compared to 57% of males agreeing or strongly agreeing that they weren't very interested, 29% neutral and 12% disagreeing or strongly disagreeing that they weren't very interested. The post-workshop group is not the same as the pre-workshop group, so the percentages aren't strictly comparable, and the question wording changed from the negative in the pre-workshop survey to the positive in the post workshop survey. However, what we observe is that the percentages of females who were interested in land surveying remained about the same in the pre-workshop and post-workshop surveys – about 10%. On the other hand, the percentage of males interested in land surveying nearly increased 10 points from 14% in the pre-workshop survey to 24% in the post-workshop survey. And in the post-workshop survey there is a statistically significant difference between females and males in land survey interest while before the workshop there was not. The logical conclusion at a minimum is that the workshop did better at moving males than females toward an interest in land surveying.

8.8 As shown in Table 11 and discussed with that table, females were always statistically significantly less likely than males to agree that they were interested in taking any of the academic, certificate, degree or career actions related to land surveying, with one exception. RHS females were not significantly less likely than males to be interested in taking one or more land survey courses while still in high school. While the workshop did not help convince the young women entering ninth grade to take any of the later steps toward a land surveying career, there is still a chance to influence the roughly 25% of RHS females if they do follow up and take a land surveying course while in high school. Ten RHS females compared to 16 males agreed or strongly agreed that they were interested in such a course, with 18 more females and 10 males neutral on the matter. With appropriate outreach and encouragement there is still an opportunity left to equalize male and female interest in land surveying at RHS in numbers if not percentages.

8.9. Based on post-workshop (but not pre-workshop) survey results, RHS counselors may need to work with the females interested in STEM to get them up to speed with the males in taking mathematics courses. As discussed concerning Table 5, post-workshop survey analyses revealed that RHS females were significantly less likely to have passed Geometry yet compared to their male peers, both in the overall student group and when Latinas are compared to Latinos. Unlike the experience with the summer 2019 STEAM land surveying course, prior knowledge of geometry could not be shown to have a significant correlation with responses to the workshop or to the potential future actions related to land surveying[26]. This may be because of how Dr. Gallegos used mathematics in the workshop to teach and talk about land surveying, and what was

[26] Even after reducing categories from five to three, the crosstabulations with the two-category previously took/hadn't taken geometry often ran into small N problems that made statistical test results invalid or unreliable. However, there was little skew evident in the percentage responses by Geometry background.

learned from the STEAM course experiences. Nevertheless, it was females more than males were the people who in open-ended comments mentioned mathematics as something they didn't like about the workshop or thought could be better. Both the level of prior mathematical knowledge that is optimal for a land surveying course in high school, and what mathematics relevant to land surveying should be presented in a high school land surveying course curriculum need further exploration. However, we can assume from the recent evaluation of the ELAC MESA STEM Summer Academy land surveying workshops that few students will have passed trigonometry by the time that they graduate from high school. In order to maximize the number of high school students exposed to land surveying it is probably too much to expect knowledge of trigonometry as a pre-requisite for taking a high school level land surveying course. Whether one could introduce some trigonometry into such a course, or perhaps work to have the high school or perhaps ELAC offer a concurrent trigonometry course to students studying a second land survey course while still in high school might be a matter for further discussion.

8.10, While it is clear from the RHS post-workshop survey that females were less likely than males to be interested in land surveying or in any of the follow-up actions related to land surveying (other than taking land surveying courses in high school), why that is the case is less clear. The results of comparing male and female reactions to or ratings of the various elements of the workshop were often unreliable or invalid because of small numbers of cases. So reliable evidence of statistically significance is rare for this survey, but simple examination of the percentages shows that there are no important variations in ratings of how the workshop was run. The qualitative responses are somewhat ambiguous but a close look at them gives a few hints on how the workshop might be modified in the future in order to get better outcomes from females. First, as explained in paragraph 4.4 below Table 7, women are significantly less likely than men to be interested in a career where they often get to work outdoors. One option might be to focus more on land surveying actions that can be undertaken indoors. However, the women did like activities and hands-on experiences, including those outdoors. So one approach might be to go outdoors when it was less hot, perhaps in the morning rather than the afternoon? Another option might be to stress the teamwork that often goes into land surveying. The RHS females responded well to interacting with others and wanted more of that, including during the outdoor experiences. So an approach might be to stress more the teamwork needed in good land surveying. Another might be to have land surveying activities or games, indoors as well as outdoors, whose resolution and successful implementation or outcome depended on cooperation rather than competition.

8.11. The open-ended comments indicated a like for being active and engaging in hands-on work and a dislike or listening to lectures and (more for females than males) passive watching of videos. The co-PIs might act on these comments by attempting to include even more activities, games, and engaging in more active than passive teaching techniques when transmitting knowledge. Other ideas include considering how much information needs to be transmitted about land survey related software during a workshop. Finally, the demonstrating of an automated laser scanner to measure a room was a hit, so demonstrations using advanced land surveying technology might be appropriate to keep in future workshops.

APPENDIX A. Roosevelt High School 2019 Pre Workshop Su8rvey

Roosevelt High School Beginning of Workshop

You are requested (but not required) to take this brief survey before you start the Roosevelt High School summer workshop about plane surveying. All answers are voluntary. They will not affect any grade, and you can stop completing the survey at any time. There will be a follow-up survey at the end of the workshop. Answers from both surveys will be analyzed, summarized and reported out anonymously so we can improve the workshop and make reports to the National Science Foundation, the funder. By continuing this survey you agree to those uses of your responses and that you are responding voluntarily. Thank you for your participation.

1. To what extent do you agree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I'm interested in a science, technology, engineering or math career	○	○	○	○	○
I'm interested in a career where I often get to work outdoors	○	○	○	○	○
Before participating in this summer workshop I wasn't very interested in land surveying	○	○	○	○	○
Before participating in this workshop I didn't know very much about land surveying	○	○	○	○	○
Before participating in this workshop I had never used land surveying equipment	○	○	○	○	○

2. Why did you take this workshop this summer?

3. What mathematics courses had you passed **before** starting this workshop?

	Yes	No
basic mathematics (addition, subtraction, multiplication, division)	○	○
pre-algebra	○	○
algebra	○	○
geometry	○	○

Other (please specify)

4. What grade will you be in during the fall term?

- ○ 9th grade
- ○ 10th grade
- ○ 11th grade
- ○ 12th grade
- ○ Other (please specify)

5. When will you graduate from high school?

- ○ 2020
- ○ 2021
- ○ 2022
- ○ 2023
- ○ Other (please specify)

6. What is your gender?

- ○ Female
- ○ Male
- ○ Other
- ○ Prefer not to answer

7. With which of the following ethnic/"racial" groups do you identify youself (check all that apply)?

- [ ] White or Caucasian
- [ ] Black or African American
- [ ] Hispanic or Latino/a
- [ ] Asian or Asian American
- [ ] American Indian or Alaska Native
- [ ] Native Hawaiian or other Pacific Islander
- [ ] Other (please specify)

APPENDIX B. Roosevelt High School 2019 Post Workshop Su8rvey

Roosevelt High School End of Workshop

You are requested (but not required) to take this brief evaluation survey as you end the Roosevelt High School (RHS) summer workshop about land surveying. All answers are voluntary. They will not affect any grade, and you can stop completing the survey at any time. Answers from this survey will be analyzed, summarized and reported out anonymously so we can improve the workshop and make reports to the National Science Foundation, the funder. By continuing this survey you agree to those uses of your responses and that you are responding voluntarily. Thank you for your participation.

1. How would you rate this workshop overall (one star on the left being worst, 5 stars best)?

2. To what extent do you agree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I would recommend this workshop to another student	○	○	○	○	○
I enjoyed this workshop	○	○	○	○	○
This workshop was fun	○	○	○	○	○
After this workshop I'm more interested in a science, technology, engineering or math career	○	○	○	○	○
I'm interested in a career where I often get to work outdoors	○	○	○	○	○
I'm interested in land surveying	○	○	○	○	○

3. What did you like best about the workshop?

4. What did you like least about the workshop?

5. What was okay about the workshop but could have been better?

6. To what extent did this land surveying workshop...

	A great deal	A fair amount	Not very much	Almost none at all	Not at all
give you a working knowledge of what surveyors do in the field	○	○	○	○	○
enourage you to learn more about land surveying	○	○	○	○	○

7. Please rate the following activities of the workshop in relation to increasing your interest in land surveying.

	Excellent	Good	Fair	Poor	Very Poor	N.A.
Introduction to GSET	○	○	○	○	○	○
Academic Pathway Information	○	○	○	○	○	○
Career Research Project	○	○	○	○	○	○
Budget 101	○	○	○	○	○	○
Staking out a building footprint	○	○	○	○	○	○
Costing out construction of a house	○	○	○	○	○	○
Field presentations	○	○	○	○	○	○
Introduction to CAD	○	○	○	○	○	○
Introduction to GIS	○	○	○	○	○	○
Introduction to BIM	○	○	○	○	○	○
Career presentation by public agencies	○	○	○	○	○	○
Career presentation by private agencies	○	○	○	○	○	○

8. As a result of taking the RHS Land Surveying workshop I have become interested in ...

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
taking one or more land surveying courses in high school	○	○	○	○	○
taking land survey related courses at a community college or university	○	○	○	○	○
obtaining a community college certificate in land surveying	○	○	○	○	○
earning an Associate degree in land surveying	○	○	○	○	○
earning a B.A. or B.S. degree in land surveying	○	○	○	○	○
becoming a professionally certified land surveyor	○	○	○	○	○
pursuing land surveying as a career	○	○	○	○	○
becoming a Civil Engineer	○	○	○	○	○

Other (please specify)

9. What mathematics courses had you passed **before** starting this workshop?

	Yes	No
basic mathematics (addition, subtraction, multiplication, division)	○	○
pre-algebra	○	○
algebra	○	○
geometry	○	○

Other (please specify)

10. What grade will you be in **during the fall term 2019**?

- ◯ 9th grade
- ◯ 10th grade
- ◯ 11th grade
- ◯ 12th grade
- ◯ Other (please specify)

11. What is your gender?

- ◯ Female
- ◯ Male
- ◯ Other
- ◯ Prefer not to answer

12. With which of the following ethnic/"racial" groups do you identify youself (check all that apply)?

- ☐ White or Caucasian
- ☐ Black or African American
- ☐ Hispanic or Latino/a
- ☐ Asian or Asian American
- ☐ American Indian or Alaska Native
- ☐ Native Hawaiian or other Pacific Islander
- ☐ Other (please specify)