memo

REAP Change Consultants

To: Humberto Gallegos

From: Stephen C. Maack

CC:

Date: August 26, 2019

Re: MESA STEM Summer Academy Workshops Evaluation Results

Context

Dr. Humberto Gallegos presented workshops on Plane Surveying (Land Surveying) to East Los Angeles College (ELAC), STEM Summer Academy 2019 students between August 5 and 8, 2019. There were 61 students who completed a pre-workshop survey and 51 who completed a post-workshop survey. Based on prior REAP Change Consultants work evaluating the entire ELAC STEM Summer Academy, the starting number is typical of past years. An inquiry of the MESA office staff determined that there were "roughly" 72 students participating in the Academy and that of each cohort, roughly four to five students missed class on any particular day. Therefore, the 61 students surveyed probably represented all from each cohort who were present on August 6 and 7.[1]

Presentation of the workshops themselves and the pre-workshop and post-workshop surveys ran into several problems that resulted in modification of workshop delivery and evaluation "on the fly" and their implementation was not ideal as a result. In particular, the Summer Academy students were divided into two sub-groups[2], with cohort A meeting on Monday and Wednesday and Cohort B on Tuesday and Thursday. Cohort A had 30 students and Cohort B had 31 students. Analysis of the survey results revealed no statistically significant difference between the two cohorts in gender, ethnicity, or pre-workshop mathematical background.

The curriculum therefore had to be truncated from four days of workshops for one group to two days of workshops for two groups. As a result, a Career Research Project, software training in CAD, GIS, BIM and career presentations by public and private agencies apparently

[1] Evaluator speculations related to the 16% loss between surveys are offered later in this report.
[2] This may have been done by MESA staff?

were dropped from the curriculum and so questions about these activities were blacked out on paper copies of the post-workshops survey.

Despite these survey design and delivery issues and the caveats noted above, most students answered most or all of the "closed" (check off response) questions and many gave qualitative responses to the "open-ended" questions.

Overview of Survey Results

Partnering with the ELAC MESA STEM Summer Academy to present a Land Survey curriculum was a positive move on the part of the NSF ATE grant team. For one thing, the workshops reached the target NSF grant audience of women and Hispanics/Latinos/as. Table 1 shows that 44% of the MESA students were women, half of Cohort A ad 39% of Cohort B.

Table 1. Gender Distribution

Pre-Workshop Cohort	Females	Males	Total
A (Monday, Wednesday)	15	15	30
	50%	50%	100%
B (Tuesday, Thursday)	12	19	31
	39%	61%	100%
Total	27	34	61
	44%	56%	100%

Post-Workshop Cohort	Females	Males	Total
A (Monday, Wednesday)	10	15	25
	40%	60%	100%
B (Tuesday, Thursday)	9	16	25
	36%	64%	100%
Total	19	31	50
	38%	62%	100%
Gender not specified			1

As Table 2 shows, over 90% of the students in both the Pre-Workshop survey and the Post-Workshop survey self-identify as Hispanics/Latinos/as/Mexican-Americans, sometimes along

with another ethnicity or race. Given the ethnic makeup of the pre-test group, it is not surprising that all 10 students who took the Pre-Workshop survey and not the Post-Workshop survey self-identified as Hispanics, Latinos/Latinas, or Mexican-Americans. Asian or Asian-American is the next most frequent self-identity. These results are typical of the overall student draw of East Los Angeles College from the surrounding area, which consists of neighbors largely occupied by Latino/a and Asian-American residents. While it is possible to analyze the ethnicity/racial categories further into females and males or by cohort we are not going to present those results here in order to protect identity of individuals.

Table 2. Ethnicity/Race Distribution

	Pre-Workshops		Post-Workshops	
	Number	Pct.**	Number	Pct.**
Hispanic, Latino/a, Mexican American*	57	93%	47	92%
Asian or Asian-American	4	7%	4	8%
White or Caucasian	2	3%	2	4%
Black or African American	2	3%	1	2%
Other	1	2%	1	2%
Total	61	100%	51	100%

* Hispanic or Latino in the post-workshop survey
** Percentages do not add up to 100% because multiple ethnicity/"race" responses were al

Educational Background

The MESA STEM students had almost all (87%) been in 12th grade (i.e., seniors in high school) during the spring term before the summer workshops. That is, most were about to enter college. Three had attended a community college or university the previous spring, one had been in 11th grade, and one not in school at all. Given that distribution, it is not surprising that 97% of the MESA STEM students had a high school diploma (one of whom also had a GED) with none having earned a higher degree.[3]

[3] This is a logical conclusion based on internal evidence from the Pre-Workshop survey. The 11th grader in the previous spring did not answer the question about academic credentials, likely having none listed (likely not yet a high school graduate). One student who had been in 12th grade the previous spring claimed both a "M.A./M.S. degree or post-graduate certificate" and a "Ph.D. or doctoral level degree," but this seems very unlikely for someone who reported being in 12th grade during Spring 2019. That person might have misinterpreted the question to be asking what degree did the student aspire to earn rather than what degree had he or she already earned.

Mathematical Backgrounds

The Pre-Workshop survey asked what mathematics courses the MESA STEM students had passed prior to the workshops. Trigonometry is especially important to understanding plane survey calculations, along with geometry, algebra, and sometimes calculus. The question did NOT ask what the "highest level" of mathematics was that the students had taken since that question might be confusing, but rather asked the students to indicate "yes" or "no" for each type of mathematics. However, some students may have misread or misinterpreted to be asking for the "highest" level of mathematics that they had passed. Some students did not check either "yes" or "no" but left no response about some mathematical subjects. Students are self-reporting that they "passed" the courses to which they responded "yes." Some students may have taken a course in a particular mathematics subject but did not pass it. The responses should not be taken as an indication of proficiency in a particular mathematical subject. The questions or instructions about responding may need to be improved in the future. The Pre-Workshop survey also asked if the students were "learning or reviewing" Geometry or Trigonometry during the Summer Academy and instructed that the respondent should "check all that apply.[4] That question might also have been poorly framed.

Table 3 shows the responses to the question "Which mathematics courses had you passed at any school, college or university **before** starting the STEM Summer Academy?" Table 3 lists the mathematics topics in the order presented in the survey. While 87% of the STEM Summer Academy students had passed Algebra, 84% Geometry, and 82% Algebra 2, only 23% had passed Trigonometry and only 20% Calculus. The logical conclusion is that for over three-quarters of the students taking the Plane Surveying workshops, the more advanced mathematics needed to do land surveying area calculations, such as trigonometry, will be new mathematical territory for them. However, if only simple square, rectangular, or triangular shapes with right angles are discussed in the workshop, at least the 84% who have passed Geometry should find themselves in familiar mathematical territory when calculating areas.

There is no significant difference among males and females in these percentages with one exception. The women were significantly more likely than the men – in fact about twice as

[4] These questions were not asked in the Post-Workshop survey and the evaluation design did not include any way to match up individual pre-Workshop and post-Workshop surveys. In retrospect this may have been a mistake to address in the future since prior math background might be relevant to response to the Land Surveying workshops or future interest in Land Surveying.

likely (55% compared to 27%) -- to have passed a Trigonometry course before starting the STEM Summer Academy.[5] This is a hopeful finding for workshops presented to these MESA STEM Summer Academy students since the NSF grant targets women (most of whom will also be Latinas) and the women are better prepared mathematically to handle Land Surveying.

Table 3 Mathematics Passed Before the STEM Summer Academy (Total N = 61)

	Yes		No		No Answer	
	Number	Pct.	Number	Pct.	Number	Pct.
Elementary mathematics	52	85%	1	2%	8	13%
Pre-algebra	51	84%	4	7%	6	10%
Algebra	53	87%	2	3%	6	10%
Geometry	51	84%	5	8%	5	8%
Algebra 2	50	82%	3	5%	8	13%
Trigonometry	14	23%	29	48%	18	30%
Calculus	12	20%	32	52%	17	28%
Other – Statistics	4	7%			57	93%
Other - Pre-calculus	4	7%			57	93%
Other - Transition College	2	3%			59	97%

Table 4 shows the responses to the question "Have you been learning or reviewing any of the following during this Summer Academy (check all that apply)?" The question was included because during a prior REAP Change Project that included evaluation of the ELAC STEM Summer Academy, mathematics review or education was added as an optional summer activity. The question was asked in the Pre-Workshop survey so responses to it should not be confused by any Geometry or Trigonometry review or education that Dr. Gallegos might have provided as part of the Land Survey workshops.

[5] Fisher's exact test, Exact Significance = .041, 1-sided

Table 4. Summer Review or Learning of Geometry or Trigonometry

	Yes		No		No Answer	
	Students	Percent	Students	Percent	Students	Percent
Geometry	22	36%	31	51%	8	13%
Trigonometry	20	33%	32	52%	9	15%

It was not determined whether either Geometry or Trigonometry review or education was offered during the ELAC 2019 STEM Summer Academy, although some students might have reviewed or studied the subject on their own or in a college class. However, only about one-third of the STEM Summer Academy students indicated that they were learning or reviewing either or both Geometry and Trigonometry over the summer. Furthermore, over half definitely replied that no, they were not reviewing or learning these mathematical topics.

Again, of interest to the purposes of the NSF ATE grant, females were significantly more likely than men to be reviewing or learning Trigonometry during the STEM Summer Academy, again twice as likely (55% to 27%).[6] The same was not true of Geometry. It is of interest to the NSF ATE grant that these are not just the same women who had already passed a Trigonometry course before the STEM Summer Academy. Among the women there is no statistically significant difference between having previously passed a Trigonometry course, and reviewing or learning Trigonometry over the summer. While 60% of the women who had previously passed a Trigonometry course are reviewing the subject over the summer, 55% of women who had not previously passed a Trigonometry course are learning the subject over the summer. This is not true of the men. In fact, in a statistically significant difference it is mostly the men who had previously passed a Trigonometry course show are reviewing the subject over the summer.[7] That is 56% of men who reported that they had already passed Trigonometry were also reviewing it during the Summer Academy, while only 13% of the men who had not passed a Trigonometry course were learning the subject over the summer. The implication is that the MESA STEM Academy women not only started out ahead of the men in having already learned Trigonometry, as a group women are increasing their percentage lead in learning by taking advantage of summer learning or review of Trigonometry.

[6] Fisher's Exact Test, Exact Significance = .040, 1-sided
[7] Fisher's exact Test, Exact Significance = .042, 1-sided

Did STEM Summer Academy Students Already Know About Land Surveying?
As shown in Table 5, 85% didn't know very much about Land Surveying before the Academy and 90% had never used land surveying equipment previously. In addition, almost two-thirds (62%) agreed or strongly agreed that "Before taking the STEM Summer Academy I wasn't very interested in land surveying." Only about 5% were interested in land surveying before the Academy. The instructor was not "preaching to the choir," so there was a definite opportunity to try to interest students in this area of study and professional work, when most of the students started with little knowledge or experience of it.

Table 5. Prior Knowledge and Interest in Land Surveying

Before taking the STEM Summer Academy I …	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Total
had never used land surveying equipment	34	20	5	1	0	60
	57%	33%	8%	2%	0%	100%
didn't know very much about land surveying	26	26	5	4	0	61
	43%	43%	8%	7%	0%	100%
wasn't very interested in land surveying	20	18	20	3	0	61
	33%	30%	33%	5%	0%	100%

In response to the open-ended question "If you are currently interested in Land Surveying please explain what your interest is and youi goals concerning it at this time" over half (54%) of the students did not respond at all, 28% gave answers that were variations indicating the question was not applicable, or they were not currently interested. That is consistent both the general lack of interest in and knowledge of Land Surveying shown in Table 5.

Ten students (18%) gave more substantive comments shown in Table 6, but their responses added few insights into why the students weren't interested or into what might attract their interest to Land Surveying. The responses show that some of these students, who are new to college, are uncertain about their potential majors or that they might be uncertain about what the question is asking. One "N/A" (not applicable) response stated a preference for another

discipline (bioengineering). Most of the potentially interested students were in Cohort A and had already passed Trigonometry or were studying it over the summer.

Table 6. Some Reponses to Question about Interest in Land Surveying Before Workshops

Comment	Cohort	Gender	Trigonometry
The environment of having to apply skills inside & outside. Also the equipment used.	A	Male	Yes
Mathematics/accounting	A	Female	Yes
N/A (It's interesting but I'm into Bioengr)	A	Female	Yes
N/A (Lecture was cool though)	A	Female	Yes
What some programs to take	A	Male	Yes
My goal is to improve study habits, career choices, fears/phobias, academic problems, decision-making	B	Male	Yes
My courses come with all the math that is needed for this degree	B	Male	No
I am not sure	B	Male	No
Be able to transfer 2 (?) years experience in the field of work that I want to study.	B	Male	No
I would like to know what specific courses I should take and then I would work hard to get there.	B	Female	No

One of the "N/A" (not applicable) responses suggests that there had been a lecture given on Plane Surveying before the Pre-Test was taken, either during the Summer Academy or perhaps earlier? Other students apparently wanted more information before deciding whether they would study Land Surveying.

The next pre-workshop survey question asked anyone currently working in the surveying field to provide their title and what they were doing with land surveying. No student who answered the pre-workshop survey was already working in land surveying.

Summary of Workshop Activities.

During the Land Surveying Workshops the students heard lectures, were introduced to and given instruction in use of land surveying instruments, and engaged in teams in an outdoor

hands-on activity of laying out, staking, measuring, and costing out a house that each team designed themselves. The house could have multiple rooms.

Fewer Students Surveyed after the Workshops

As noted earlier, 51 students (16% fewer than the pre-workshop survey) completed the end of workshop survey that was given on Wednesday, August 8 or Thursday, August 9, depending on the cohort. There were 26 students in Cohort A and 25 in Cohort B who completed the survey at the end of the Land Surveying workshop. The drop wasn't completely even but the difference in numbers was small and not significant. Four fewer students (13%) in Cohort A took the final survey, and six fewer students (19%) in Cohort B did so. Although Cohort B was one student larger than Cohort A at the start of the workshops, it was one student smaller at the end. There was no qualitative evidence gathered from those who did not take the final survey as to why they did not do so. It is also not known if anything noticeably different happened in the Monday and Tuesday workshop activities that might have had a differential impact on attendance on workshop attendance on the last workshop days.

The numbers are small and there was no statistically significant difference in prior knowledge or interest in Land Surveying or in trigonometry knowledge before the workshops. The loss of a few additional students in each cohort on their last day of the Summer Academy is consistent with the pattern observed by MESA staff of about five fewer students failing to show up on any day. The MESA Summer Academy ran from July 15 to August 9, 2019. This was the last week of the workshop. The students had been exposed to multiple STEM disciplines during the Summer Academy. If students who were generally not interested in land surveying on the first day were not excited by the lecture or other indoor activities, some may have decided simply to skip their last days. However, without additional evaluative inquiry there is simply no evidence that the last day no-shows were more or less interested in land surveying because of their partial participation in the Land Surveying workshops.

Responses to the Land Surveying Workshops

In an attempt to gauge overall student response to the Land Surveying workshops the first question of the post-workshops survey was a standard, normed marketing question: :"How likely is it that you would recommend the land surveying workshop to a friend or colleague?" The respondent was presented with a scale of 0 to 10 with 0 indicating "Not at all Likely" and 10 indicating "Extremely likely." To norm the responses, people choosing scores of 0 to 6 are called "Detractors," those who rate the service or product 7 or 8 are called "Passives" and

those rating it 9 or 10 are called "Promoters." A Net Promotor Score (NPS) is calculated by subtracting the percentage of all customers doing the rating who are Detractors from the percentage who are Promoters, with Passives only entering into the total count of customers. The value of a Net Promoter Score ranges from -100 to + 100, with a positive NPS generally deemed good, a NPS of +50 excellent, and anything over +70 exceptional. "The primary objective of the Net Promoter Score methodology is to predict customer loyalty (as evidenced by repurchase and referral) to a product, service, brand, or company."[8]

NPS scores vary across different industries and it isn't clear what the comparable industry would be for the ELAC STEM Summer Academy Plane Surveying Workshops. While over one-third (35%) of the post-Workshop survey takers did not respond to the question at all, Survey Monkey calculated the overall NPS for the workshops as +3 with 30% "Promoters" (10 students rated the workshops a 9 or a 10), 27%% "Detractors" (9 students rated the workshops between 0 and 6) and a plurality 42% "Passives" (14 students rated the workshops a 7 or 8). Overall, the workshops fall in the "good" range, but only barely.[9]

Table 7. Net Promoter Score Details by Cohort

Rating	Cohort A	Cohort B	Overall
0 to 6 (Detractors)	6	3	9
	37.5%	17.6%	27.3%
7 or 8 (Passives)	5	9	14
	31.3%	52.9%	42.4%
9 or 10 (Promoters)	5	5	10
	31.3%	29.4%	30.3%
Total Question Respondents	16	17	33
	100%	100%	100%
NET PROMOTER SCORE	**-6.3**	**11.8**	**3.0**
No Rating	10	8	18
	38.5%	32.0%	35.3%
Total Survey Respondents	26	25	51

[8] https://en.wikipedia.org/wiki/Net_Promoter_Score.
[9] For comparison, the overall average NPS of 162,268 Organizations that used Survey Monkey was 37.

As shown in Table 7 it appears that whatever was done with Cohort B (NPS +12) was better received in terms of convincing students to recommend the Land Surveying workshop to their friends than whatever was done with Cohort A (NPS of -6). Although the numbers are small, it appears that Cohort B would be more likely to recommend Land Survey workshops to their friends and colleagues (NPS = 11.8) than Cohort A. While Cohort A had a somewhat greater proportion of question respondents than Cohort B (39% compared to 32%) and also a slightly greater proportion of Promoters giving a rating of 9 or 10 (31% compared to 29%), it also had twice as large a proportion of potential Detractors (38% compared to 18%). The majority of Cohort B raters (53%) are Passives who awarded the workshops only a 7 or an 8 rating. These are decent ratings, but according the NPS methodology not high enough to make it especially likely that the students would recommend the workshops to their friends. Why this might be so will be explored during statistical analyses of the other post-workshop survey questions and might be considered in relation to self-reflections by the instructor about what differed (if anything) in the delivery of the curriculum to the two cohorts, or their reactions to it.

Ratings of Workshop Activities

Table 8 shows student ratings of six (6) workshop activities rank-ordered from those best rated to those less well-rated.[10] The instruction was to rate the workshop activities "in relation to increasing your interest in land surveying."

Table 8. Workshop Activity Ratings

Activity	Excellent	Good	Fair	Poor	Very Poor	N
Field presentations	44%	46%	8%	3%		39
Budget 101	37%	49%	10%	4%		49
Staking out a Building Footprint	34%	48%	18%			50
Costing out construction of a house	33%	53%	14%			51
Academic Pathway Information	27%	51%	22%			49
Introduction to GSET	25%	54%	21%			48

[10] The survey was originally designed to measure reactions to 12 workshop activities and to be completed on the internet. However, it was presented on paper and six of the questions were crossed out manually. See the Caveats and Potential Biases section later in this report for comments on the potential impact of this change in survey design and delivery method

In general the activities of the workshop were well-received. None were rated "very poor" by anyone and the only "poor" ratings were for Field Presentations and Budget 101. However, those providing "poor" ratings were definitely outliers in the response distribution. Field Presentations was the best received activity with a very commendable 90% "Excellent" or "Good" rating. That rating was followed closely by Budget 101 (86% "Excellent" or "Good"), Costing out construction of a house (86%) and Staking out a Building Footprint (81% "Excellent" or "Good"). As a rule of thumb in an opinion survey such as this one, activities with over 80% positive ratings in the top two categories are performing those activities effectively. When two-thirds to three-quarters of respondents give an activity the top two ratings that typically indicates that there are few to no serious problems with it. This is the case of provision of Academic Pathway Information (79% "Excellent" or "Good") and Introduction to GSET (also 79% "Excellent" or "Good").

There are no statistically significant differences at the .05 level of significance in responses by cohort to any of these activities. However, noticeable skews in the distribution of responses suggest that the instructor might have done a better job with Cohort B in providing academic pathway information and to some extent in staking out a Building Footprint. The differences are a matter of degree with noticeably greater percentages of students in Cohort A rating the activity "Fair" while greater percentages of students in Cohort B rated the activity "Good."

Table 9. Skewed Ratings by Cohorts of Activities

	Excellent	Good	Fair	N
Academic Pathway Information*	27%	51%	22%	49
Cohort A ratings	24%	40%	**36%**	25
Cohort B ratings	29%	**63%**	8%	24
Staking out a building footprint**	34%	48%	18%	50
Cohort A ratings	31%	42%	**27%**	26
Cohort B ratings	38%	**54%**	8%	24

* Pearson Chi-square p = .064, df = 2, no cells with expected values less than 5; Cramer's V = .335, p = .064

** Pearson Chi-square p = .231, df = 2, but not reliable because 33.3% of the cells have expected values less than 5; Cramer's V = .242, p = .231

The ratings are for the most part confirmed by the open-ended comments in response to three questions. What did you like best about the plane surveying part of MESA STEMSA? What did you like least about the plane surveying part of MESA STEMSA? What was okay about the plane surveying part of STEMS but could be improved (specify how could it be improved)? About 90% of the students responded to the first, 88% to the second, and 82% to the third question. The results are shown in Tables 10, 11, and 12, sorted by Cohort and then by similarity of responses with each line representing one person's response except as noted.

Table 10. Best about the Plane Surveying Part of MESA STEM Summer Academy

Cohort A (Monday and Wednesday)
The outdoor activities
The out side /outside/ building home
Building
The building part
Building a house layout
making rooms
gave me knowledge on houses
I liked the building and working in teams.
we get to use our own imagination at building our own house.
We had to work with what we had so it was fun.
working as a team
Playing with my team.
The collaborations
working together
Having to plan out with different people
working to stake house together
That I got to interact with other kids and more hands on
Hands-on
Figuring out the measurement
Staking for the house
Stats (?)
physical plane
N/A
No answer, 3 of 26 (12%)

Cohort B (Tuesday and Thursday)
What I liked best about this was the physical activity to give the idea of what this is.
The hands on experience
I loved the hands on Activity
outings {?} Activities
the activity
Activity
hands-on
I got to get hands on work
Being able to work in groups & get a feel of experience
Working w/ others
What I like was the planning and measuring the model house
I liked how I was able to make my own room sizes and how to design the house
Designing
I got to be creative
Having imagination
the way it was easily understandable
It was understandable.
I got the feel as to how plane surveying works.
learning new things
It's fun.
It was a fun experience, and you get to have an opportunity
Everything was good and informing
It was alright
No Answer 2 of 25 (8%)

As shown in Table 10, students in both cohorts most frequently mentioned the outdoor activity of laying out a house footprint as the best part of the workshops. Specific aspects mentioned about that activity were that it was hands-on, creative, imaginative, yet applied. That it involved teamwork in both planning and doing the staking of the outline was largely perceived as enjoyable, fun, even play. Cohort A students especially seemed to enjoy the teamwork interaction. Cohort B students mentioned how the Land Surveying workshop was understandable. One student put it this way: "Being able to work in groups & get a feel of

experience." Another may have summed it all up well for both groups: "What I liked about this was the physical activity to give the idea of what this is." The ATE project should definitely keep the hands-on activity as a part of future MESA land-surveying workshops. The hands-on activity of deciding on and staking a house outline as a team effort, complete with rooms sized however the group wants, works well.

Table 11. Liked Least about the Plane Surveying Part of MESA STEM Summer Academy

Cohort A (Monday and Wednesday)
The weather
Hot outside
hotness!
I liked the whole activity although it was a little bit hot.
We have to be outside.
The limited space we had to work within
Lack of space
Lack of space/other groups
People coming on to my property
The neighbors atking along (? tagging along?)
Planing /planning?/ it out
doing the calculations and measurements
Calculating
Imperfect calculation
Math
Measuring
listing /listening/ to lecture
that since it isn't my major or interest I struggled a bit understanding the work
N/A except having people on staff(?) stuff (?)
N/A 2 of 26 (8%)
Nothing
Jon (?)
No Answer 3 of 26 (12%)

Cohort B (Tuesday and Thursday)
The weather, a little hot for me
when it's hot
The heat
The sun
the sun & bugs
It's outside
Working out
Staking
The part I didn't like was trying to get the steaks /stakes/ in a straight line.
All the annoying little measurement
Active
Cleaning up
The team work everyone was put through.
How few of the professers were unorganized
I didn't dislike anything
It was all good
Nothing
N/A 5 of 25 (20%)
No Answer 3 of 25 (12%)

As shown in Table 11, however, some aspects of the workshops, including the hands-on outdoor activity, ran into a few problems. The most common dislike for both cohorts A and B was the weather, especially in relation to the outdoor activity. It was apparently hot both days during the outdoor field activity, with the sun shining in one's eyes, and bugs to contend with when outside. Of course working outside in all kinds of weather is part and parcel of the life of a land surveyor and if a person doesn't like such work it is perhaps best that he or she learn that through a controlled experience before entering the profession. From the perspective of ATE grant targets uncomfortable weather during an outdoor hands-on workshop activity could be a negative factor that discourages students from taking land surveying courses and eventually entering the profession. There is little that the project staff can do to control the weather.

Project staff may, however, want to think about some of the other least liked things that students mentioned in terms of how the teaching and learning experiences could help students overcome their dislikes. These might include tricks or helpful ways for laying out stakes in a straight line, or help with learning necessary math and calculations. The complaints about space being too small for the size and number of teams simultaneously trying to lay out house outlines of their own choosing has both physical and social dimensions to consider. For example, in terms of physical space ATE NSF project staff might try to find a larger plot of land on which to work, stake out lot limits ahead of time or otherwise require student teams to build within certain outside parameters (e.g., maximum square feet for the house, or outer walls of the house a certain distance from lot lines, such as might be required by zoning regulations in a real life home building situation). Socially there appears to have been some problems with what might be viewed as "trespassing" or simply unaware walking of members of one team on another team's carefully laid out or planned house outline. A few students noted these kinds of behaviors as a problem. That kind of a problem might be addressed in advance through discussion of "ground rules" regarding courtesy, consideration, and expected behavior during the hands-on exercise.

Table 12 shows answers to the open-ended question about what was okay about the workshops but could have been better. Overall 82% of the students gave some substantive response to this question, although for many the answer was a variation on "N/A" (15%), "nothing" (8%) or "everything was good." Those kinds of responses are to be expected for generally well-received workshops. The most common suggestions from Cohort A centered around making sure that there was enough string for staking out house footprints (some students apparently ran out of string), and finding more land. In other words, as students in Cohort A put it, "Be prepared" and "Plan better." One student in Cohort A desired more detailed instructions (about what was not specified) and another recommended changing "the learning system" (but did not say concerning what or in what ways).

Table 12a What Was Okay but Could be Improved about the Plane Surveying Workshops

Cohort A (Monday and Wednesday)
I did not like that we did not have enough string.
more tape
More tape (?)
having more ribbon
More materials
More space and land.
More land
the land
plan better
Being more prepared.
the learning system
More detailed instruction
everything is great in my opinion
Everything was good
I think its great
N/A 4 of 26 (15%)
Nothing 2 of 26 (8%)
No Answer 5 of 26 (19%)

Comments from Cohort B were similar but had some additional thoughts (and contradictory recommendation from students). Resources (supplies and land) for the house footprint activity were again mentioned as a problem by Cohort B students. This time there were references to tape or "more tape to identify walls." However, one person commented "not everyone got tape." If creating the house footprint is a group project does everyone need tape or is that reference to measuring tapes? Measuring tape also may be the reference of the student who commented "To get more tape to measure rooms." The need for more land on which to do the outdoor hands-on activity was also mentioned once. Teamwork matters received mention by Cohort B students in relation both to intragroup dynamics (how people

should work together on a multi-person team) and intergroup team dynamics (interactions among different teams).

Table 12b What Was Okay but Could be Improved about the Plane Surveying Workshops

Cohort B (Tuesday and Thursday)
Supply allocation can be improved. not everyone got tape
I would have provided more tape to identify walls.
Resources such as more tape and location
To get more tape to measure rooms
working with others
Working with the team
The team work, caluation /calculation?/
The /comment on Room? shit between the groups
The calculation. Activity & teamwork.
Measuring
The classroom time. For more active individual
Be ready next time with more information
It was semi-understandable
More inside example
They could give another project.
Shorter
nothing it was alright
NA. It's all good.
N/A 3 or 25 (12%)
No Answer 4 of 25 (16%)

One comment made it sound like there perhaps might have been some competitive "trash talking" going on between groups that was done in an upsetting way? Do students need to be reminded about or given ground rules for peaceful, respectful intragroup or inter-group interactions when working in tight quarters? Other suggestions from Cohort B included the recommendation that the instructor "be ready next time with more information" (about what was not specified). Another student wrote that "It was semi-understandable" but offered no

insights into what was less understandable or how to make the material more understandable to him or her. Cohort B students suggested that measuring or calculations instruction was okay but could be better. Sometimes student recommendations were contradictory. One student called for more "inside examples" (inside the classroom?), while another apparently called for less classroom time for more active individuals. One student proposed giving another project to students (whether this is a second project or a different kind of project is unclear). Another called for the workshops to be "shorter" (daily or as a whole is not clear) A facilitated discussion with MESA Summer Academy students might serve to clarify somewhat ambiguous student comments about what might be done to improve the workshops.

Knowledge Outcomes of the MESA STEM Summer Academy Land Surveying Workshops

The survey asked several questions designed to measure progress toward meeting NSF grant goals. First the survey asked two questions directly related to an increase of knowledge about land surveying and about whether the workshops encouraged students to learn more about land surveying. The results are shown in Table 13.

Table 13. Short-term Outcomes of the MESA Land Survey Workshops

To what extent did the Plane Surveying Workshop …	A great deal	A fair amount	Not very much	N
give you a working knowledge of what surveyors do in the field	50%	48%	2%	46
encourage you to learn more about land surveying	39%	54%	7%	46

Approximately 10% of the final survey takers did not answer one or both of these questions for reasons that are unknown. As shown in the pre-workshop survey most of the students taking the workshops had little to no prior knowledge about land surveying or understanding of it as a profession. One would therefore expect some increase in knowledge. However, half of the students reported that the workshop increased their "working knowledge of what surveyors do in the field" a "great deal," and most of the remaining half reported that the workshop

increased their knowledge "a fair amount." The instructor and the curricular activities were successful in increasing knowledge of most students about what land surveyors do in the field. The workshop and its curriculum also encouraged over half of the students "a fair amount" to learn even more about land surveying, and encouraged nearly four out of ten students "a great deal" to do that. There are no statistically significant differences by cohort or gender in either of these results. However, women are more likely than men (57% to 36%) that the workshop encouraged them "a great deal" to learn more about land surveying. Although not a significant difference, more than half of the women who participated in these workshops are interested in learning more about land surveying.

These are positive results for the ELAC NSF ATE grant since part of its purpose is to interest students, especially women and Hispanics, in land surveying and encourage them to enter the profession. Increasing knowledge of land surveying and leaving them wanting to learn more is a first step in that direction. Presenting future land surveying workshops to ELAC STEM Summer Academy students is worth repeating as a future NSF ATE grant activity. Project leaders might want to consider follow-up activities that reach out specifically to women who took the 2019 STEM Summer Academy Land Survey workshops in order to provide additional information about land surveying.

The ELAC NSF ATE grant also supports additional actions to increase the number of land surveyors. Measurement of this outcome can be viewed from short-term, medium-term and long-term academic and professional perspectives. Unlike in some professions the movement from academic to professional status is not necessarily linear. That is, a student would not have to obtain a community college certificate or degree, or go on to obtain a baccalaureate or a Master's degree in order to participate in some land surveying activities or even become a land surveying professional. This is an applied field in which gaining skills, abilities and experience in operating sophisticated survey equipment are also important. Different levels of professional certification require passing state or federal certification exams, meeting experience requirements, and paying a fee. Taking courses on land surveying and in mathematics such as trigonometry certainly helps in gaining theoretical and practical knowledge needed to pass the certification exams. Land surveying certification can be added to certification as a civil engineer. While becoming a certified civil engineer requires a B.S. or higher academic degree, land surveying knowledge, skills, and abilities can be acquired at the community college level and demonstrated without even a community college certificate or an Associate degree in the field. There are multiple pathways for entering the field.

The ELAC NSF ATE grant project is addressing the shortage of land surveyors and the need for more women and Hispanics in the field using several approaches. The MESA STEM Summer Academy is just one of them. The MESA STEM Summer Academy only exposed students to Land Surveying over a two-day period, which is clearly too short an amount of time over which to measure actual progress in academic and professional pursuits. Therefore a series of the post-workshop evaluation survey questions used a metric of increased interest to evaluate outcomes of the workshops. Students were asked "As a result of taking the STEMSA Land Surveying workshop I have become interested in…" and then presented eight potential steps that a student coming into college might take. The steps are discussed below starting with community college level academics, moving to four-year university or college academics, and ending with three professional career related questions. Given that the workshop and survey takers are mostly just entering college, these can also be viewed as short-term, medium-term, and long-term outcomes.

Short-Term Outcomes: Community College Interests

The three short-term, community college level interests that the workshops might have sparked are taking ELAC courses in land surveying, obtaining an ELAC certificate in land surveying, and earning an Associate degree in land surveying. The first two of these are currently eminently achievable and accessible for ELAC students. While ELAC does not yet have an Associate degree offering in Land Surveying that is a direction in which the GSET department is moving. These are realistic options for students entering community college.

Chart 1 shows the distribution of student responses to the three community college prompts. While the chart shows numbers of respondents, the discussion uses percentages. Over half (52%) of the workshop participants strongly agree or agree that the Land Surveying workshops have become interested in taking Land Surveying courses at ELAC because of the workshop. About one-third (34%) strongly agree or agree that they have become interested in obtaining an ELAC certificate in Land Surveying. Over one-quarter (28%) "Strongly Agree" or "Agree" that they have become interested in obtaining an Associate degree in Land Surveying (not currently offered at ELAC). There are no statistically significant differences by cohort or by gender in any of these findings.[11]

[11] Because of the skew in the data toward the middle "neutral" category and the small number of "disagree" or "strongly disagree" responses, the "strongly agree" and "agree" categories were combined, as were the "disagree" and "strongly disagree" categories so that there was enough N for reliable and valid statistical results.

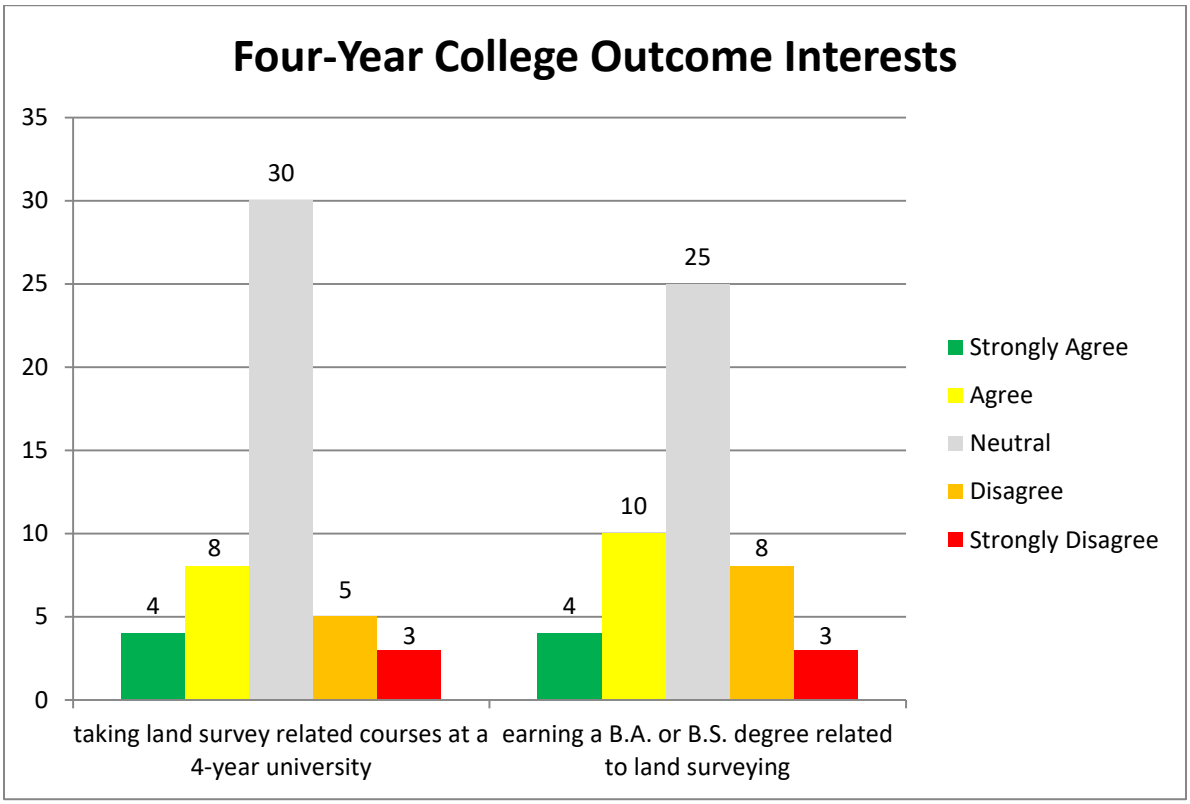
Chart 1. Interest in Community College Actions Related to Land Surveying
s of the grants of the grant

That the STEM Summer Academy workshops have been successful in sparking interest in over half of the students in Land Surveying courses is a positive sign for the goals of the ELAC NSF ATE grant goal of interesting students in Land Surveying. This is movement in the right direction. The trick will be to get students to actually sign up for ELAC Land Surveying courses over the next two years of the grant and encourage them to obtain ELAC Land Surveying certificates for which their course passing will make them eligible.

Medium-Term Outcomes: Four-Year College Land Surveying Interests
The ELAC NSF ATE grant includes goals not only concerning community college land surveying outcomes, but also transfer to four-year college or university and outcomes related to land surveying at four-year institutions. The grant has established partnerships with four-year institutions, notably California State Polytechnic University, Pomona and others, that offer land serving courses or land survey related baccalaureate degrees. The grant project includes working out articulation agreements with Cal Poly, Pomona and several four-year universities to give students credit for ELAC land survey courses. For these grant goals to be achieved (except for the articulation agreements), students have to be interested in transferring to four-year universities or colleges and seeking certificates or degrees at those institutions. To what extent did the STEM Summer Academy land surveying workshops spark such interests? The answers are shown in Chart 2.

Taking the land survey workshops in the ELAC STEM Summer Academy resulted in strong agreement or agreement of interest in taking land survey related courses at a four-year college or university for just under one-fourth (24%) of the students. Over one-fourth (28%) expressed an interest in obtaining a four-year land survey related baccalaureate degree.

Chart 2. Interest in Four-Year College Actions Related to Land Surveying



There were not any statistically significant differences between the cohorts or by gender in response to these two questions.[12] However, the male students were three times as likely (36% compared to 12%) to agree or strongly agree that the workshops led them to become interested in taking land survey related courses at a four-year university or college. In that respect the

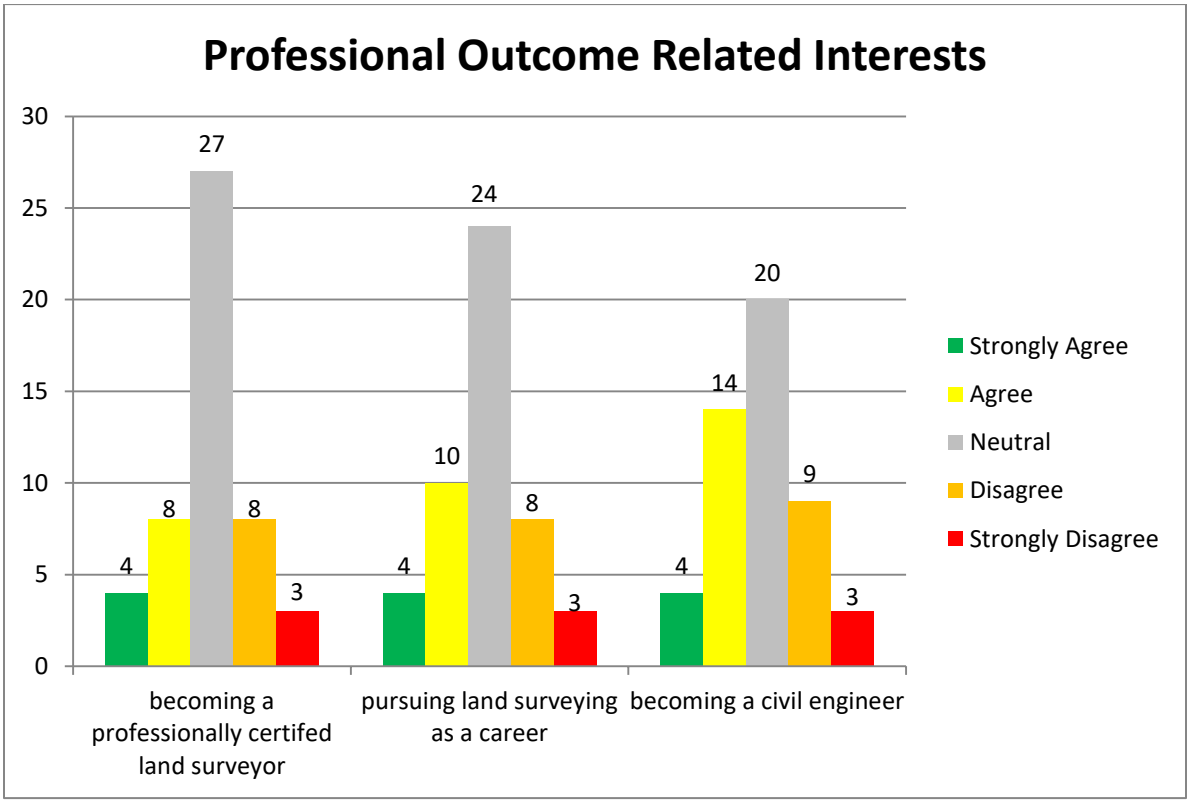
[12] See note 9 for comments on the significance testing procedure. One skew in the distribution suggests that Cohort A students as a group were less likely to be interested in land survey courses at the four-year college level. While 76% of Cohort A were "Neutral" and 12% "Agreed" that they had become interested, another 12% "Strongly Disagreed." In contrast, 44% of Cohort B students rated their interest as "neutral," 20% "Agreed," and 16% "Strongly Agreed" that the workshops had interested them in four-year university courses in land surveying, compared to 20% who "Disagreed" (but not strongly). Since the numbers are small, the statistical values for this skew are neither reliable nor valid. This finding might relate to another skewed distribution that was not statistically significant at the .05 level but was valid and reliable. In that distribution only 64% of Cohort A students compared to 92% of Cohort B students rated "Academic Pathway Information" as "Good" or "Excellent," with the rest rating the presentation of that information as only "Fair." We cannot tell from the student survey data if there a difference in how the Academic Pathway was presented, or simply in student interests.

workshop was not notably successful in encouraging women to transfer to take four-year university courses or degrees related to land surveying. Nevertheless, 20% of the women compared to 36% of the men agreed or strongly agreed that they were interest in obtaining a land survey related baccalaureate degree (e.g., civil engineering – see below).

Long-term Outcomes: Interest in Land Survey and Land Survey Related Professions

Chart 3 shows the distribution of student responses to three questions related to those working in land surveying or in the related professional field of Civil Engineering. Because of the extensive use of surveying in Civil Engineering one can become dual certified in land surveying and in engineering, which allows one to contract for services as both a civil engineer and a land surveyor who can pinpoint lot boundaries.

Chart 3. Long-Term Outcomes: Interest in Land Surveying and Related Professions



Just under one-quarter (24%) of the student who took the post-workshop survey agreed or strongly agreed that they had become interested in becoming a professionally certified land

surveyor as a result of the MESA STEM Academy Land Surveying Workshops. Over a quarter (28%) agreed or strongly agreed that they had become interested in pursuing land surveying as a career as a result of the workshops. Even more, over one-third (36%) agreed or strongly agreed that they had become interested in becoming a Civil Engineer as a result of the workshops (whether or not they were interested in becoming professionally certified as a land surveyor). There were no valid and reliable statistically significant differences by cohort or by gender in these responses.[13]

However, students in Cohort B (Tuesday and Thursday) were three times as likely (36% compared to 12%) to have become interested in becoming a professionally certified land surveyor. In both cohorts the most common response was "neutral" and there were few (24% in Cohort B versus 20% in Cohort A) who "disagreed" or "strongly disagreed" about interest in becoming a professionally certified land surveyor. Was there something slightly different about what happened on Monday and Wednesday as opposed to what happened on Tuesday and Thursday that influenced a larger proportion of Cohort B to become more interested in becoming professionally certified as a land surveyor?

Caveats and Potential Biases

Cohort B would have potentially had the potential benefit of Professor Gallegos having already taught the curriculum content the day before. Did Dr. Gallegos change his teaching approach on Tuesday or Thursday based on his experiences on Monday and Wednesday?

More students than expected did not respond at all to the first question on the post-workshop survey, which is a standard, normed marketing question. The use of the normed Net Promoter Score (NPS) metric might have been inappropriate and may need rethinking. The question asked about "the land surveying workshop" although the STEM Summer Academy is only presented to a select group of students who are usually at a specific point in their lives (i.e., for most students just before attending college) while the NPS may best measure consumer preference when a consumer and his friends or colleagues could seek out and obtain a good or service at any time that they might be thinking of obtaining it. It might have been

[13] See footnote 9 for further information on how statistical significance was determined. One skew in the distribution indicates that women may have become more interested than men in becoming a land surveyor because of the workshops. The statistical tests are not valid or reliable because of the small numbers involved. However, about one-third (33%) of the women "Agreed" or "Strongly Agreed" that the workshops has interested them in pursuing land surveying as a career, compared to just over one-quarter (26%) of the men. The majority of women (56%) and the plurality of men (45^) were "neutral" on that matter, but 29% of the men compared to just 11% of the women "disagreed" or "strongly disagreed."

more appropriate to ask about the likelihood that a person would recommend Land Surveying as a certificate, degree, or licensed/certified profession to a friend or colleague, rather than ask specifically about the workshops. The question might have been modified to say "friend or fellow student" rather than "friend or colleague," although then it would no longer be benchmarked because of the change in question wording. It is not clear to whom or to what service/product to compare the NPS results, although using the NPS metric did point to potential differences in the experiences of Cohorts A and B that can be further explored. Therefore using a benchmarked question at all might not be helpful for comparison.

The loss of some students by the post-workshop survey is typical and completion of both surveys was voluntary. Further qualitative inquiry would be needed to determine why about 16% of the students did not complete the post-workshop survey. It might be useful to discuss with MESA staff ways to lower the day to day dropout rates, including whether offering the Land Survey workshops earlier in the Summer Academy might be a better idea. That had been the original plan, but if the Land Surveying workshops were given earlier the curriculum would have been delivered in a more dispersed fashion with other content presented in between. The best tradeoffs of curriculum delivery, timing of the workshops in relation to the rest of the STEM Summer Academy, numbers of workshop days, and class (cohort) size needs further discussion and consideration.

Even when students provided opinions about planned items in the curriculum that were dropped, the student responses were not entered into Survey Monkey and so are not analyzed in this report. No year to year comparison will be possible on those items next year.

Both the pre-workshop and post-workshop surveys were designed to be completed online, but that was not possible for technical reasons. As a result, Dr. Gallegos copied, passed out and collected paper copies of the survey, and Dr. Maack manually entered the results in Survey Monkey. Dr. Maack takes full responsibility for overall survey design, typographic and data entry errors and would handle the situation differently in the future if given sufficient advance warning. The matter of some potential bias because of changing from an online to a paper survey needs further discussion to see if these biases can be avoided in the future.

Some students in Cohort A may not have seen, and so not answered, questions about their mathematical backgrounds and grade levels that were on the reverse side of double-sided paper surveys. Some students may not have answered questions on the paper copies of the

post-workshop surveys that were just above or below questions whose numbers and content were blacked out with bold marker stripes because they were not to be answered.

Some students did not respond to the first prompt on question two of the post-workshops survey, which had a typographic error of "Introcution to GSET" instead of "Introduction to GSETT." There is also a typographic error in one of the prompts in Question 7 where "related" was missing an "a" so the question read "…earning a B.A. or B.S. degree related to land surveying." In the future all evaluation surveys will be field tested before use.

A few students marked more than one response to some of the paper survey questions. This is not possible on an online survey when the question is set up to allow only one response. The question instructions may not have been clear. Sometimes students crossed out one of their responses but sometimes not. In a few cases, then, Dr. Maack made an "executive decision" about which response to enter in Survey Monkey and in the course of doing so may have introduced small biases favorable to the project. Use of online surveys in the future would avoid this bias.

Finally, two qualitative answers to the pre-workshop survey suggest that the survey might have been passed out on the first day after a lecture, which might have slightly confused responses to one or two of the pre-workshop questions, but would not have biased post-workshop survey results. Ideally a 'pre-workshop:" survey should be completed before right at the beginning, before anything else happens in the workshops.

Overall Discussion and Conclusions

Although Professor Gallegos, the co-Principal Investigator for the ELAC NSF ATE grant and instructor during the ELAC STEM Summer Academy Land Survey workshops has presented similar workshops in the past, to some extent these were an experiment. As discussed previously, not everything went according to plan both in the curriculum offered, the workshop delivery, and the evaluation. The findings therefore should be interpreted cautiously, but do provide some insights into what worked and consideration for areas in which to improve future such workshops, and their evaluation.

The pre-workshop survey revealed what was expected. Before taking the workshops most students had limited to no knowledge of land surveying as a profession, what lands surveyors did, or how to use land surveying equipment. Doing the workshops was definitely an

opportunity to familiarize the NSF ATE target groups with land surveying and entice their interest in activities, courses, and action within the profession. The outcomes of the workshops for the most part can be attributed to the activities and curriculum of the workshop itself rather than to prior information, knowledge or skills of the participants about land surveying.

While the demographics of the ELAC STEM Summer Academy participants are largely outside the control of the NSF ATE grant staff,[14] from an NSF grant perspective this was an appropriate group to whom to introduce land surveying. Almost all of the students who participated in these workshops in both Cohort A and Cohort B self-identified as Hispanics/Latinos/Latinos or Mexican Americans. That is the target ethnic ("racial") group for the grant, so the workshops reached the intended grant target group. Because of the ethnic makeup of the overall population, any positive (or negative) outputs or outcomes of the NSF ATE grant activities with the MESA STEM Summer Workshop can be viewed without question as having reached the intended grant ethnic target.

Whether the female representation (44% in the pre-workshops survey; 38% in the post-workshop survey) is sufficiently large is a matter for reflection. These are, however, notable proportions of females for any STEM program, and larger than found in the current professional surveyor population.

From the perspective of the NSF grant goals, positive findings are that the female students are more likely than the male students to have already taken or were in the process of learning trigonometry, the math discipline most relevant to land surveying area calculations. This puts them in a better starting position to pass any land surveying courses they take. However, it is not something that can be attributed to the Land Surveying workshops themselves. It is something to consider in future activities to involve women in land surveying activities.

The ELAC STEM Summer Academy Land Surveying workshops were very well-received by the 2019 students, with special praise for the outdoors hands-on activity (despite hot weather). This hands-on experience was typical of real-life land surveying situations in that it required teamwork, measurement, calculations, and creativity. While there were some problems during the workshops, especially in regards to the outdoor, hands-on building footprint

[14] MESA or other ELAC staff do the recruiting, admission, and registration for the Summer Academy. NSF ATE grant staff were not involved in 2019.

surveying exercise, the students provided a number of comments and recommendations that should be helpful for delivery of similar workshops at future ELAC STEM Summer Academies.

Closer coordination with MESA staff about what to expect should allow the NSF Grant staff to improve workshop delivery in the future, especially in regards to making sure that there is sufficient equipment (tape and string) and land on which to do the team exercise. Reading between the lines, a student comments suggest that the NSF ATE grant staff may want to consider providing more "ground rules" or direction concerning appropriate inter-team and intra-team behavior during the hands-on exercise. Any problems that might have arisen this year, though, appear to have been relatively minor, given the widespread student appreciation for the hands-on exercise. This works and it (or a similar exercise) should be kept as a feature of future such workshops.

The workshops did well in providing knowledge about land surveying to students and left most wanting to lean more. Based on student responses, over 90% said that they had gained "a great deal" or "a fair amount" of working knowledge about what surveyors do in the field. Similarly over 90% reported that the Land Surveying workshops encouraged them "a great deal" or "a fair amount" to learn more about land surveying. Since recruitment into taking and passing land survey courses, certificates, degrees, and professional certification tests are key grant purposes, this is the first step.

Since the two workshops were held over a short two=day period each, this wasn't sufficient time in which to measure actual action toward taking land survey courses, getting certificates or degrees, much less transferring from community college to a four-year institution. Nor could we necessarily expect short workshops to result in students quickly entering the land survey profession. So the evaluation looked for was the level of agreement that the workshops had interested the students in taking various academic or future professional actions related to land surveying. Although some of the actions are sequential (e.g., one has to take courses in land surveying before obtaining a certificate, Associate or B.A./B.S. degree in land surveying), others are not. There are multiple paths into becoming a professional land surveyor, and one can work in some jobs in the land surveying field without becoming a professional land surveyor. It is the kind of an applied skilled field that one can enter and then advance over time to various levels of professionalism and certification.

Students most frequently provided a "neutral" response regarding their interest in their taking the academic and professional actions specified in the eight questions about land surveying. For many of the students, taking the workshops alone may not have been enough to convince them to take actions related to their future life directions. These were, after all, mostly young adults who had just left high school and weren't yet in college, still exploring what they wanted to do with their lives. Not surprisingly then, the most immediately appealing interest was the most immediately achievable one -- taking ELAC courses in land surveying. The workshops had interested over half (52%) of the students in doing that. Going in two days from close to zero knowledge about land surveying to over 50% interested in taking courses in the field is notable. The students might not take land surveying courses immediately, but this finding bodes well for the future efforts of the NSF ATE grant and land survey course enrollment at ELAC.

A lower proportion of students (about one-third) agreed or strongly agreed that they were interested in obtaining an ELAC certificate in land surveying. This is at least a start in an appropriate direction favoring grant purposes. In general many community college students need convincing that it is worth their while to put the effort needed to taking specific courses, file an application and pay a fee in order to obtain any community college certificate. The lower percentage interested at the moment in seeking a land surveying certificate is therefore not surprising. Similarly, just over a quarter (28%) of the students agreed or strongly agreed that they had become interested in an Associate degree in land surveying, but such a degree is not currently offered at ELAC.

Just under or just over a quarter of the students agreed or strongly agreed that the Land Survey workshops had them interested in taking land survey courses at a four-year college or university, earning a baccalaureate in a degree related to land surveying, or becoming a certified land surveyor. Such actions would be taken, two, three or more years from now and that may be too far away to plan for many of the students.

Nevertheless, 29% agreed or strongly agreed that the workshops had spurred an interest in pursuing a career in land surveying. An even larger proportion, almost four out of ten (36%), agreed or strongly agreed that the workshops encouraged their interest in becoming a Civil Engineer. While Civil Engineers work with land surveyors, not every certified Civil Engineer

is also a certified Land Surveyor, so this finding is somewhat tangential to the core purposes of the NSF ATE grant.[15]

In relation to the ELAC NSF ATE grant it may seem discouraging that there were no valid and reliable statistically significant differences in responses of females and males on the post-workshop questions. However, it is important to consider in this regard what the standards are for "success" of this grant for women. Should the evaluation be measuring process (actions) or outcomes, or both regarding women? Does the PI expect women to be singled out for special interventions and encouragement during the project period? Or is the expectation that women simply be treated equally and hopefully respond at least equally or better than their male counterparts to project activities encouraging taking land evaluation courses, obtaining appropriate certificates and degrees, transferring, passing certifying tests, etc.? If the latter, this grant activity has been successful since there are few to no statistically significant differences in response between the women and the men. If that is the case, simply increasing the number of women involved with the NSF ATE grant should increase the number of women involved in taking land survey courses, earning land survey certificates and degrees, and entering the profession at rates similar to the male students. It might just be a matter of recruiting more women into the NSF ATE grant activities at the outset. If it is the former, what is the nature of the special intervention or encouragements that women should be receiving, and by how much are they expected to differ from the men in interest, certificates, degrees, actions taken to enter the profession, etc.? What kind of evidence should the evaluation be looking at and attempting to measure?

[15] The question was included partly because Dr. Gallegos, the instructor and grant PI, is himself a certified civil engineer although not yet dual certified as a Land Surveyor. He is working toward dual certification. In future surveys it might be better and more NSF grant appropriate to ask about interest in dual certification as a Land Surveyor and a Civil Engineer.