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REAP Change Consultants

To: Humberto Gallegos

From: Stephen C. Maack

CC: Juan A. Rodriguez

Date: 7/29/2019

Re: STEAM High School ES 100 Post-Class Results

Mr. Rodriguez, the instructor, passed out and collected 17 completed paper surveys from the class at the end of the last day of class, Wednesday, July 24, 2019. He left them in Dr. Gallegos' office at East Los Angeles College (ELAC). Dr. Maack picked them up on July 25, entered the results in Survey Monkey on July 26, then downloaded and analyzed the results in SPSS. This is the final report of evaluation results concerning the STEAM High School ES 100 Summer 2019 class.

Overview

This ES 100 course reached its intended audience in terms of ethnicity and gender. In the mid-class ("pre-test") survey all but one of the respondents identified as Hispanics/Latinos/Latinas (with one person checking "other" and one person specifying African-American/Hispanic) and six (35%) of the students identified themselves as females. In the end of class ("post-test") survey, two students chose to mask both their gender and ethnicity by either not answering the questions or by giving answers that were not helpful for analysis purposes. Nevertheless, the end of class survey clearly included four females (24%) and 10 males (59%) out of the 17 students, as well as 15 Hispanics or Latinos/Latinas.

The results from the final survey can reliably be attributed primarily to the impact of the class itself. Based on retrospective pre-class questions in the mid-class survey, the majority of students (59%) of strongly agreed and over one-third (35%) agreed that before taking the course they didn't know very much about land surveying. Also, in the earlier survey 70% of the students strongly agreed and the rest agreed that they had never used land surveying equipment before the class. In addition, 35% of the students strongly agreed and 41% agreed

that before taking the course they weren't very interested in land surveying, with the rest (24%) neutral about that.

Student Ratings of the Course

Students rated the course on average 3.5 out of 5 stars (with 5 stars being best). Although sample size precludes a determination of statistical significance, women appeared to be less favorable to the course than men. Three women rated it three stars (with the fourth not rating it at all). In contrast, one-third of the men rated it three stars, 56% rated it four stars, and one man gave it the highest, five star rating.

Overall 82% of the class agreed or strongly agreed that the course was fun and 71% that they enjoyed the course. The rest of the students were neutral on these factors, except for one student disagreeing about enjoying the course. Since half were neutral on the matter, the four women were statistically significantly less likely to agree that the class was fun.[1] In contrast, 70% of the men agreed and 30% strongly agreed that the course was fun.

Table 1 compares student ratings of various aspects of the course.

Table 1. STEAM Student Ratings of ES 100 Course (N=17)

	Excellent	Good	Fair	Poor	Very Poor	Total
Guest speakers	9	6	2			17
Field work exercises	7	7	3			17
Tools training	2	11	4			17
Overall course content		11	6			17
Principles behind surveying		9	6			15
Mathematics review	2	3	9	1	2	17
Instructor's teaching style	1	1	11	2	2	17

Similar to the mid-course survey, the top student ratings go to guest speakers (88% excellent or good), field work exercises (82% excellent or good), and training in surveying tools (77%

[1] Phi = .675, p = .041; Cramer's V = .675, p = .041

excellent or good). In this kind of a survey it is common to see two-thirds to three-quarters of respondents giving a program or course the top two ratings. So this class did exceptionally well with its guest speakers, field work exercises and tools training.

The next best student ratings concerned overall course content (65% "good" ratings) and teaching of principles behind surveying (60% "good"). None of these top five categories had any "poor" or "very poor" ratings.

However, both the Mathematics review and Instructor's teaching style received three or four "poor" or "very poor" ratings. The most frequent rating of these two categories was "fair" (53% for the Mathematics review, and 65% from the Instructor's teaching style). Since 30% of the students rated the Mathematics review as "excellent" or "good," it ranked higher overall than the Instructor's teaching style (12% "excellent" or "good" ratings). Unfortunately, the open-ended comments (see Table 2) yielded little specific information about the Instructor's teaching style, although comments about teaching made up half of the responses to the question "What can we do to improve this course if it is offered again at a high school?" Analysis using a crosstabulation found no apparent correlation between ratings of teaching style and ratings of the Mathematics review. The small number of students in the class and large number of categories make the Pearson chi-square statistic unreliable.

Looking at a series of crosstabulations it appears that the four women often tended to choose the middle "fair" rating for each of these factors, while male ratings accounted for most of the variations toward the positive or the negative. However, the only statistically significant difference by gender is that all four women rated the "Guest speakers" as good while 80% of the men rated them as "excellent" (with one "good" and one "fair" rating by men)[2]. On other top rated factors (field work exercises, tools training) as well as on the middle and bottom rated factors (i.e., mathematics review and instructor's teaching style) there were no statistically significant differences by gender in the ratings.

[2] Phi = .849, p = .006; Cramer's V = .849, p = .006.

Table 2. Student Suggestions for Improving the Course (N=16 responses)

overall teaching
better teaching methods
Teach the class better
Improve teaching style
the teaching could be better
The teaching could become smoother
smooth teaching
smoother teaching
make it more understandable for new kids
focus more on the mathematics behind surveying
make sure it is to everyone's math standard
move it for a more appropriate grade range
I think it is good as it is, just to be a little more extended
ice cream
don't include me in it
I Don't Know

Mathematics Analyses

The mathematics review had also not been rated very well in the mid-course survey so the end of-course survey included additional questions probing on mathematics related matters. Overall the responses related to mathematics should be considered in the context of the grade levels of the students. The end-of-class survey confirmed the earlier finding that most of the summer course students (82%) were between their eighth and ninth grades. However, two (12%) were between their 10th and 11th grades.

Table 3. Self-Reported Student Grade Level in Fall 2019 (after the class)

9th grade	14	82%
11th grade	2	12%
Not Available	2	6%

Given these grade levels the distribution of mathematics courses passed before summer 2019 (see Table 4) is not surprising. All of the students who had completed Geometry had also completed Algebra, but not vice versa. Almost two-thirds (65%) had never taken a Geometry course. We know from the mid-class survey that only one student of the 17 had completed Trigonometry, which is a key mathematical basis for land surveying calculations.

Table 4. Self-Reported Student Mathematics Courses Passed

Neither Algebra nor Geometry	2 (12%)
Algebra Only	9 (53%)
Algebra and Geometry	6 (35%)

Therefore, for almost two-thirds of the class what was billed as a "mathematics review" was in effect an exposure to new mathematical concepts. While it is not clear exactly what was reviewed, even geometric formulas, much less trigonometric formulas, would have been new mathematical information for many students. Since Trigonometry builds on and extends Geometry theory, exposing students who had not yet taken Geometry to Trigonometry is like asking them to extend their mathematical ability two grade levels beyond their prior knowledge of mathematics. This is underlined by the fact that the two students about to enter the 11th grade in the fall both had taken Geometry and Algebra (and one had taken Trigonometry), and were statistically significantly more likely than those entering 9th grade in the fall to have that level of mathematical training.[3]

Mr. Rodriguez told the evaluator that he knew about the low level of mathematical backgrounds of many of the students, which was why he had undertaken a math review during the course. In addition to the direct question rating the mathematics review, the end-of-class survey included questions to gauge student reactions to the review and to learning about how much mathematics is essential to doing surveying work.

Table 5 shows that after the review almost half (47%) of the students agreed or strongly agreed that they understood the mathematics needed for the course. However, 29% of the students disagreed that the review had learned sufficient mathematics after the review that were needed for the course. That included half of the students (one of two) who had not even taken Algebra, one-third of those who had taken Algebra but not Geometry, and one-sixth (one student) of students who had taken both Algebra and Geometry.

[3] Phi = -.488, p = .051; Cramer's V = .488, p = .051

Table 5. Student Reactions to Mathematics and Surveying in ES 100

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Totals
After the review I understood the mathematics needed for the course	2	6	4	5		17
	12%	35%	24%	29%		100%
The mathematics presented in this course were too advanced for me to understand	1	7	4	4	1	17
	6%	41%	24%	24%	6%	100%
With more education I'm sure I can master the mathematics needed in surveying	5	11	1			17
	29%	65%	6%			100%
I'm not interested in pursuing surveying because it requires so much mathematics	1	2	10	3	1	17
	6%	12%	59%	18%	6%	100%

Responses to this question could logically reflect both prior student math background, student facility with mathematical understanding, and how the review sessions were taught. Overall there was no statistically significant correlation between math background and having enough mathematical understanding after the review for the course. One-quarter of all students were neutral about whether after the review their mathematical knowledge was sufficient for the course once the review had been done. Those giving the neutral response included half of those (i.e., one student) with not even Algebra in their math background, 11% (one student of nine) who had only taken Algebra, and one-third (two of eight) students who had taken both Algebra and Geometry. Because of the small number of students in the class and the lack of a statistically significant correlation between prior mathematical courses and responses it isn't completely clear how much individual student ability and how much the teaching and learning during the Spring 2019 class contributed to this distribution. However, it does appear

that the students with less robust mathematical backgrounds struggled more with having sufficient mathematics to fully master the course content.

Were the mathematics presented in this course simply too advanced for the students to understand? Almost half (47%) of the students agreed or strongly agreed that this was the case (second line in Table 5). Almost one-quarter were neutral on the matter and 30% disagreed or strongly disagreed. There was no statistically significant difference in response to this question by prior mathematics background. If the mathematics review was effective with at least some of the students, and students answered both questions honestly, there should be a negative correlation between the question about understanding mathematics needed for this course and this question. Indeed, as shown in Table 6 there is such a negative correlation, and it is statistically significant.[4] It appears that for over half of the students after taking this class it was possible to understand the mathematics presented, especially with the help of the mathematics review, even as the students also understood that more advanced mathematics are needed to do professional level surveying work.

Table 6. Correlation of Understanding Mathematics Needed for the Course and Mathematics Being Too Advanced for the Student to Understand

	The mathematics in this course were too advanced for me to understand					
After the review I understood the mathematics needed for the course	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Totals
Strongly Agree				2		2
Agree		2	1	2	1	6
Neither Agree nor Disagree		2	2			4
Disagree	1	3	1			5
Strongly Disagree						
Totals	1	7	4	4	1	17

The next question shown in Table 5 concerns student self-confidence in being able master the mathematics needed to do land surveying if one has additional mathematics education. This

[4] Bamma = .747, $p < .001$

question is relevant to the purposes of the grant since if a student learned from the course how much mathematics are important to land surveying, but doesn't think that she or he can master the mathematics needed, then she logically would be discouraged from pursuing land surveying after this course. The students are quite confident that they can eventually master the mathematics needed for land surveying. Almost two-thirds (65%) "Agreed" that "with more education I'm sure I can master the mathematics needed to do surveying" and 29% "strongly agreed," with only one person neither agreeing nor disagreeing. There were no statistically significant differences in response to this question by either gender or prior math background. The course exposure to survey mathematics was not a block for most students to pursuing surveying further. With time and education these students feel that they could master the mathematics needed to do surveying. Overall the course did not discourage students from pursuing surveying because of the level or amount of mathematics that surveyors use, [5]

The final mathematics related question was one of preference. While almost all of the students felt that they could master survey mathematics, did they want to pursue a field that requires so much mathematics? The question was approached in the negative: "I'm not interested in pursuing surveying because it requires so much mathematics." About 17% of the students strongly agreed or agreed that a field requiring so much mathematics would discourage them from pursuing it. Almost a quarter (23%) of the students disagreed or strongly disagreed with the statement – i.e., having to learn more advanced mathematics would not discourage them from pursuing professional surveying. However, the most common answer, given by nearly six out of ten (59%) of the students was to neither agree nor disagree. The mathematics of Trigonometry is arguably easier than calculus or Fourier transformations. Given that these students are at a STEAM campus and most STEM careers require a good amount of mathematical training, this might have been the answer that one expected students to make. Students attending this high school might not be afraid of having to learn more advanced mathematics in order to do work professionally in any STEM field, including surveying.

[5] One of the LADWP land surveyors who were guest speakers the day the pre-test survey was gathered had talked during a field demonstration about using "your trigonometric functions". The evaluator told him on the side that many of the students had not yet taken Geometry. He then told the evaluator about how he had not been especially good in mathematics in high school or college and had come to land surveying late, in his 30s. He said that he learned Trigonometry then and now used it regularly in his land surveying work as a professional. The evaluator encouraged him to share the story with the high school students since it might encourage some. He polled the students on their math backgrounds then told his story. After that the LADWP guests demonstrated measuring height and spoke simply about addition, subtraction, and measuring feet in tenths instead of inches. That was a level of mathematics that all the students could understand.

There was no statistically significant difference in responses on this question by gender or by prior mathematical background.

Future Interest in Land Surveying

Table 7. Student Interest in Land Surveying

As a result of taking this course I have become interested…	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Totals
…in taking a second course in land surveying in high school		8	6	1	2	17
		47%	35%	6%	12%	100%
…in obtaining a community college certificate in land surveying		5	8	2	2	17
		29%	47%	12%	12%	100%
…in taking land surveying related courses at a community college or university		5	7	2	3	17
		29%	41%	12%	18%	100%
…in earning an Associate degree in land surveying		4	8	2	3	17
		24%	47%	12%	18%	100%
…in earning a B.A. or B.S. degree in land surveying		4	8	2	3	17
		24%	47%	12%	18%	100%
…in becoming a Civil Engineer		4	8	2	3	17
		24%	47%	12%	18%	100%
…in becoming a professionally certified land surveyor		3	10	1	3	17
		18%	59%	6%	18%	100%
…in pursuing land surveying as a career		2	11	1	3	17

12%	65%	6%	18%	100%

This report is part of an evaluation of NSF – ATE Award No. 1801188 that is designed to increase the number of people, especially women and Hispanics, pursuing land surveying as a field of study, college or university certificate or degree, professional certifications and as a career. Based on mid-class survey results, before starting the summer ES 100 class these students had little to no knowledge of what is involved with land surveying, how it is done, what equipment is used, how the equipment works, what the work of a professional land surveyor involves, how to enter the field, how much it pays, and so forth. Has this one summer class contributed to the interest of those who took it in land surveying?

The answer is shown in the responses to Table 7. The interest after the course in land surveying might best be described as lukewarm. The ES 100 course is just an introduction to land surveying for students in high school, however it did not excite students enough about land surveying for anyone to "strongly agree" that the course interested them in any of the follow-up actions listed in Table 7. However, just under half (47%) of the students agreed that they are interested in taking a second course in land surveying in high school. While all or almost all of these will be Hispanics (since almost all of the population is Hispanic), it is only males who agreed that they were interested in taking a second land surveying course while in high school. Contrary to grant goals, no female student agreed that she was interested in taking a second course in land surveying in high school – and one female student disagreed (while one male student strongly disagreed). This is a statistically significant difference in responses.[6] The survey offers little clue as to why the difference by gender appeared.

Agreement dropped to 29% of students interested in taking land surveying related courses at a community college or university, or in obtaining a community college certificate in land surveying. After the course just under one-quarter (24%) are interested in earning an Associate degree or a B.A. or B.S. degree in land surveying. An equal percentage (24%) of the students are interested in becoming Civil Engineers, but only 18% are interested in becoming a professionally certified land surveyor and only 12% in pursuing land surveying as a career. Again contrary to grant goals it was always males and never females who agreed that they were interested in taking land survey related courses at a community college or university, obtaining a community college certificate or a B.A. or a B.S. in land surveying. One of the four

[6] Phi = .859, p = .016; Cramer's V = .859, p = .016.

female students (25%) did agree that she was interested in becoming a Civil Engineer (compared to three of 10 (30%) of the men, which is not a statistically significant difference).

Other than possibly taking a second course in land surveying in high school, students were most likely (47% to 65%) to neither agree nor disagree that they are interested in taking any of the following steps related to land surveying as a field. Also, almost one-quarter (24%) to 30% of the students "disagreed" or "strongly disagreed" that they were interested in taking part in the follow-up actions. Those students decided against taking those other actions that potentially lead them into land surveying. That is the opposite of the intent of the grant.

Conclusions and Evaluator Recommendations

Between eighth and ninth grades many American students are still exploring what they want to do with their lives and eventual careers. Not everyone can be expected to want to become a land surveyor. So a positive way to look at these results is that the course at least helped students make up their minds about land surveying, a field new to them, about which they had little to no prior knowledge or experience. Most students enjoyed the course and thought it was fun.

There is room for improvement in future ES 100 courses. The overall course content and learning about the principles of surveying were considered good to fair, but one might work toward higher ratings in the future. From a student perspective the course did especially well in providing guest speakers viewed as excellent or good, field work exercises and training in use of surveying tools. Those teaching approaches should be kept as part of the course. The instructor's teaching style was least well-received, although the students weren't clear about what was wrong with it or how it might be improved (other than the vague comments that it should be "smoother"). Teaching styles could be explored more fully using approaches other than surveying (e.g., self-reflection, discussion among professionals, observation by a master teacher, or focus groups with students to probe on their qualitative reactions to teaching styles and their favored learning styles).

While the mathematics instruction was not as well-rated as other aspects of the curriculum, it was clearly needed because of the large proportion of students who had not previously taken Geometry. The review appeared to help many, but not all, students understand enough mathematics to make sense of the course curriculum. Professional land surveyors use

Trigonometry frequently in their calculations, a subject that only one of the students had studied. When asked direct all but one student felt that they could master that level of mathematics with more education. The amount of mathematics review presented and how it was presented did not appear to scare away students from pursuing surveying, and almost all students were confident that they could eventually master more advanced mathematical skills needed to do surveying, neither did what was taught nor how it was taught especially encourage students to continue learning more about plane surveying. Both how survey related mathematics is taught and what parts of it are aught could be sensitive for influencing students between 8th and 9th grades in continuing interest in plane surveying. Dr. Gallegos and Mr. Rodriguez may want to reflect on what mathematics was taught, how it was taught and might be taught in the future. Also, consider those questions squarely in the context of whether the ES 100 course will be offered in the future to some mathematically underprepared students about to enter the 9th grade or to better prepared students, or at a higher grade level.

Some of the things missing from the evaluation are clear standards for what constitutes "success" for the ES 100 course. For example, should the fact that 47% of the students agreed that they were interested in taking a second course in land surveying while in high school, but no one strongly agreed be considered a success? Are eight students definitely interested in taking a second land surveying course while in high school are a "success" and enough volume to justify offering a second course in surveying at this high school? If not then should there be an attempt to attract more students to take the ES 100 or should the focus be on trying to increase the percentage of those in this first class who are so eager to move on to a second land surveying course in high school, or both of those approaches?

The STEAM High School ES 100 summer class left the female students mostly giving neutral responses about taking future actions that would move them closer to land surveying certificates, degrees, or professional careers. Is that "good enough" to declare course success? Are six women in the class out of 17 enough to declare "success" for grant purposes? What might be done with this course to interest students more in land surveying?

Are 24% to 29% of the students (always male) agreeing that they are interested in academic or professional land survey related action after high school enough to declare "success" or not?

Finally, it is important not to lose sight of a key focus of the grant program. These students are almost entirely Hispanics (Latinos/Latinas) and one key goal of the grant program is to

increase the numbers of Hispanics becoming interested in land surveying. Whatever the level of course success, it is starting to interest some male Hispanics in land surveying.