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GE 385 Evaluation Report

East Los Angeles College
NSF ATE Grant 1801188

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Executive Summary

0.1 This evaluation report has been prepared by REAP Change Consultants (REAP Change) for the East Los Angeles College (ELAC) A T E grant 1801188 "Filling Skills Gap Through the Geospatial Engineering and Technology Program." ELAC is a community college. The three-year ELAC grant project and its evaluation are funded by t h e National Science Foundation (NSF) Advanced Technological Education (ATE) grant program. The NSF national ATE grant program focuses on award of certificates and grants as a measure of its grants contributing to increases in the skilled workforce in ATE fields. However, ELAC proposed and NSF funded a grant project that seeks to create a pipeline of students from the K-12 educational level to community college and on to either the Land Survey workforce or universities or colleges offering bachelor's or higher degrees in Land Surveying or closely related disciplines.

0.2 The ELAC GSET grant project along with the rest of K-12 and higher education was seriously disrupted by the coronavirus (COVID-19) worldwide pandemic that was first diagnosed in the United States in late January 2020, reached epidemic proportions by mid-March 2020 and is still rampant as this report is being written. ELAC adapted by ordering all academic instruction to go online in mid-March 2020, cancelled all in-person meetings and events and that policy continued throughout the summer and fall of 2020 to present. That seriously disrupted the grant project. The co-PI cancelled all in-person grant-funded activities scheduled in 2020 for K-12 students (i.e., summer "boot camps" in land surveying, participation of high school students entering ELAC's GSET program in the MESA STEM "boot camp," and "CAD bashes').

0.3 The ELAC grant co-Principal Investigator (co-PI), Dr. Gallegos, had already established relationships with multiple educational grant partners, including local Middle Schools and high schools, nearby California Polytechnic State University, Pomona (Cal Poly), and other four-year university partners. He did not want to lose those relationships. His innovative solution was to obtain permission from the ELAC administration to offer a course already approved by the community college online to K-12, college and university students and working adults. The long-established mission of California community colleges includes providing courses to these various types of students, but this is usually done in separate offerings. The innovative nature of this course was that all it would be offered online, using ELAC's Zoom account, live and simultaneously to all three types of students, with homework assignments geared toward different student levels. The Zoom sessions were recorded for asynchronous review later by students.

0.4 The course, General Education 385 (GE 385), is usually taken either as an independent study or special topics course attracting a limited number of students in a term. Because of the online format, the Fall 2020 semester offering was available to a larger group of students, limited mainly by the number of people that the Zoom account could handle. The special topic was an introduction to Bentley software applications used by professional Land Surveyors. Bentley offers a suite of applications, five of which were to be covered in the course. Bentley is a major competitor of Autodesk software applications. The instructors were Tom Lazear, owner of Archway Systems, and three of his sons, as well as Dr. Gallegos. Archway Systems is an industry partner of the ELAC GSET program and has provided Land Surveying equipment for use in the grant Mr. Lazear and his sons are all expert trainers of Bentley software applications. Tom. Lazear has previously worked alongside Dr. Gallegos with K-12 students in other grant-funded activities.

0.5 The utilization-focused and developmental evaluation of this ELAC NSF grant has consisted primarily of online and in-person surveys of courses and events. The evaluation provides information and process evaluation of grant activities, as well as movement toward achieving the output and outcome goals of the grant. The evaluation design for this course included an online "pre-test" Survey Monkey survey mounted

during the first two weeks of the course and a "post-test" online Survey Monkey survey mounted during the last two weeks of class. In addition, Dr. Maack did participant observation of three or four class sessions. Dr. Maack is an applied Anthropologist with over 50 year or computer experience, 46 years of social science survey work, and decades of higher education research and evaluation experience. He has also taught four times as an adjunct higher education faculty member, including once online. A previously developed logic model of the project and prior course evaluation work for this project informed evaluation questions and survey instrument design.

0.6 Bentley software automates typical Land Surveying workflow needs, using a point and click approach that accomplishes specific tasks. While he did not attempt to learn the software, the Bentley software applications and interfaces reminded Dr. Maack of ESRI's ArcGIS computer applications used in GIS computer mapping (which has a relationship to Land Surveying and which he has had several courses). The Bentley suite is complex, sophisticated software requiring knowledge of issues and problems typically encountered in professional applications, field workflows and practice to master and sequence keystrokes and use it efficiently and effectively.

0.7. Based on his prior knowledge and experience, Dr. Maack assumed that it would be important for survey analyses and interpretation of results to be able to distinguish the responses made by at least the three major sub-groups who would be taking GE 385 (i.e., K-12 students, college students, and working adults). The survey instruments (see Appendices A and B) were designed with that breakout analysis in mind and included questions asked of all survey respondents and additional questions appropriate to each of the three sub-groups. This was a prescient design since Pre-test survey results showed that analyzing the entire class on all questions would have been highly misleading due to important skews in the data concerning demographics of the sub-groups, academic and experiences, and reasons for taking the course. While there was a hope of evaluating this course quantitatively and statistically as a "natural experiment," the class size was too small to do that. Only counts, percentages and logical thinking were used in the final evaluation analyses, since the number of class members in each sub-group was too small to produce valid and reliable statistical test results even for non-parametric statistics.

0.8. The exact official enrollment in GE 385 is unknown as of this writing because of administrative problems with enrolling the K-12 students from two Middle Schools and two High Schools that Dr. Gallegos was unable to completely resolve by the end of the course. The best estimate is that there were approximately 63 students taking the class at the beginning of the semester, with some attribution during the 16-week semester. Using proven survey research approaches of Don Dillman that often yields response rates in the 80% or higher range with "captive populations" such as this class, the Pre-test survey ended up with 56 total demographic responses and usually 53 responses to other substantive questions. The Post-test survey had 45 responses available for demographic analyses. After data cleaning and considerable matching efforts[1], REAP Change was able to identify 39 individuals who answered both surveys. That would have been the best group to look at for the best quantitative evaluation of Pre-test/Post-test results since the responses and percentages would be from the same individuals. However, some data anomalies and the small numbers made use of the matched/merged dataset difficult to interpret for variables with three to five response possibilities. No information is available concerning those who stopped attending the class completely during the semester or why some students answered the Pre-test and not the Post-test survey (and vice versa). The small numbers meant that none of the non-parametric statistical testing runs for subgroup analyses yielded valid and reliable statistical results. So in the end the analyses in this report are based primarily on the 53 respondents to the first survey and the 46 to the second survey, logical considerations, and crosstabulations of responses to questions internal to each survey.

[1] Extensive matching efforts used names, IP addresses, association of names from Zoom sessions with e-mail addresses, and Dr. Gallegos' knowledge of his students

0.9. This course evaluation was done entirely from the student perspective. The recruitment strategies for the course were not explored in detail for the evaluation but resulted in a class heavily skewed toward Middle School/High School students. The Pre-test survey useable responses to most questions came from 31 eighth to 12th grade students (59%), 6 College level students (11%) and thirteen Working Adults (30%). Similarly the Post-test survey yielded useable responses to most questions from 29 eighth to 12th grade students (63%), four College level students (9%) and13 Working Adults (38%). None of the College students answering the Pre-test survey were from ELAC, and only one student answering the Post-test indicated that he was a community college student, not necessarily at ELAC.[2]

0.10. This class might have had a much larger enrollment that it did since anyone in the world with internet access and a small enrollment fee might have taken GE 385 if they knew about it and were interested. Marketing to K-12 students was done through the administrators and counselors at two Middle Schools and two High Schools that were already project partners who in turn approached individual students. At least one communication about the course was sent out using e-mail, social media, or a newsletter notice to Working Adults in the Land Survey community. The evaluation did not determine how, whether, and why marketing of the course was done to ELAC and other local colleges and universities, including grant partners. So it is not clear why the GE 385 enrollment of students already attending college was so small.

0.11. Responses to an open-ended question asked of every respondent to the Pre-test survey and other responses to other survey questions revealed that members of the three sub-groups of students had rather different reasons for taking GE 385 (see report paragraphs 3.2, 4.4, and 5.3). The Middle School/High School students thought it sounded interesting or fun or were trying to earn some college credits while still in high school and were exploring career options. The College students were at four-year colleges, mostly already in specific academic programs related to Land Surveying (especially Civil Engineering), seeking bachelor's degrees, and thought the course would provide them with skills that would help them get internships or jobs. The Working Adults were looking for personal or professional development or career advancement either in Land Surveying or related fields, or considering switching fields, and some mentioned specific skill development in the Bentley software applications used in the Land Surveying field.

0.12. As expected, the demographic and academic backgrounds of the three sub-groups of students in the course also differed widely in ways that might affect their response to the course, and that would affect analysis and interpretation of evaluation survey results. Demographic characteristics of the different class members who responded to the Pre-test and Post-test surveys were similar (see paragraphs 2.1 to 2.4. and7.1. to 7.6.). The K-12 students were all teenagers, almost evenly split between Middle School and High School, and almost evenly split between those younger than 15 and those ages15 to 19. This was the only sub-group that had much gender diversity, with an approximately equal split between girls and boys. That finding is a potential positive for the grant focus on increasing the number of girls with skills, certificates, degrees, licenses, and careers in Land Surveying. The body of this report presents and breakouts of differences in responses by gender for K-12 students and discusses possibly important (but not statistically significant) variances in them.

0.13. The three sub-groups of students differed in prior mathematical education, as might be expected. Among Pre-survey respondents about 70% of the K-12 students had completed pre-Algebra or Algebra, but only about half had completed Geometry and under one-quarter Trigonometry (greater proportions of girls than boys – see 3.3). Land Surveying depends on geometric, trigonometric, and calculus calculations, as well as algebra. Bentley software mostly does the mathematical calculations, but in one class the trainer took the time to explain the

[2] This individual had identified himself as a "Working Adult" rather than primarily as a "College Student" in the Pre-test survey.

elementary geometric approaching of determining the area of a circle by measuring its radius. A class homework challenge and context involved estimating distance and comparing the estimate to a more precise measurement. That was an elementary problem for some in the class.

0.14 This course failed to attract women and so contributed almost nothing to increasing the potential number of females with skills in Land Surveying. Only two coeds responded to the Pre-test survey and only one to the Post-test. The College students were ages 20 to 24 ("traditional" college-going ages) or 25 to 29. The College students were all mathematically well-prepared for the course, all having passed mathematics courses in algebra, geometry, trigonometry, and calculus.

0.15. Reflecting the general shortage of females in the STEM and technical workforce (which the grant is trying to change over time), only one Pre-survey respondent identified as a female, and none did so in the Post-test survey.

In both surveys the Working Adults overlapped in the 24 to 29 age range with the College students, but the rest were all age 35 or older. As a sub=group the 16 older Working Adult respondents to the Pre-test survey fell between the K-12 and College students but were mostly mathematically well-educated for Land Surveying. All had passed an algebra course, all but one geometry, all but two trigonometry and all except four calculus.

0.16. One of the long-range grant goals is to increase the number of skilled Land Surveyors who are LatinX. ELAC and Cal Poly are federally recognized Hispanic Serving Institutions and the grant partner Middle Schools and High Schools are all in neighborhoods that include large numbers of LatinX people. The GE 385 course generally did well in attracting LatinX people to take it although proportions differed by sub-group. In the Pre-test survey 94% of K-12 respondents identified as LatinX as did two-thirds of the College students (see (2.3). However, only one-quarter of 16 Working Adults identified as LatinX with the plurality (50%) White (including one "Hispanic White) and 31% Asian or Asian American. These ethnicity/"race" breakdowns for different age groups underlines the need to develop a pipeline of K-12 students interested in Land Survey through College and into the workforce.

0.17. As expected, the three sub-groups differed in experience and computer backgrounds. Less than 10% of the Middle School/High School students had any experience with Land Surveying (3.8). Only one or two had used any Bentley or Autodesk suite software applications. This is a potential drawback to their mastering the course contents. Understanding the utility, effectiveness, and efficiency gains from using Bentley applications depends on understanding Land Surveying, its problems, its problems, approaches and workflows. The Bentley applications are professional software solutions addressing Land Survey problems of measurement accuracy, design, calculations, visual display layout, and needs to change designs. The 8th to 12th grade students first had to learn what Land Surveying involves, its terminology, concerns, and workflow before appreciating functionality, appropriate keystrokes and sequencing of actions needed to use the software. What the "digital native" Middle School/High School students had going for them as learners of the technology was that they were used to computers in general, being online, and using visually oriented software. Three-quarters had previously done some computer coding, over half had used computer drawing programs (girls more than boys) and three had used complex computer mapping programs like ArcGIS or QGIS (3.6}

0.18. The experience and computing backgrounds of most of the six College students who answered the Pre-Test survey was more directly appropriate to the course content and focus. All but one had already done Land Surveying a little to a lot. While only two of the six had previously used Bentley's Microstation CAD and/or Open Roads applications, and all had experience using competitor Autocad software and five had also used other Autodesk software (4.6.). They knew about Land Surveying work, workflows, and issues and about similar competitor Land Survey software. Furthermore, all had used computer drawing programs and done computer coding (4.7.) They were well-prepared for the course work by their Land Surveying and computer applications knowledge, including direct work with competitor software.

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0.19. As a sub-group, the 16 Working Adults were even better prepared than the College for taking the course. Coming into GE 385 the Working Adults as a group were ahead of the learning curve because of their prior knowledge of Land Surveying, its workflows, and problems, so should more quickly understand the functionality and utility of the Bentley software. All but one had a little to expert level experience doing Land surveying (5.6.). All except one had used Autocad and all but five Bentley's Microstation CAD. Five had previously used Bentley's Open Road or some other software applications, and eight other Autodesk software. All but one also had used computer drawing programs, and 10 computer mapping programs. While they might need to learn some new terminology and keystrokes for the Bentley software (especially Concept Station and Concept Capture) all but one were already experienced users of some Land Survey software.

0.20. The Post-test survey results revealed that the Middle School/High School students as a group encountered more difficulties than other sub-groups in accessing the online course and using the Bentley software (8.2)[3]. Three K-12 students (cf. one Working Adult) used a cellphone to view class software demonstrations. About 89% of the K-12 students used a laptop computer to access the course (and 18% a desktop computer). The grant co-PI, Dr. Gallegos, made concerted efforts to have grant funded ELAC laptops provided to those K-12 students who needed them and provided technical assistance for downloading and installing the Bentley software. However, there were delays in arranging for delivery or pickup of the lent laptops by K-12 students. As a result only slightly over a third (36%) of the K-12 students had a laptop or desktop computer available to access Bentley software all the time, almost 40% part of the time and 7% none of the time. In contrast, three of the four College students and 83% of the Working Adults had access all the time to a desktop or laptop computer loaded with Bentley software for course use.

0.21. Another problem related to attending an online concerned having a quiet place to watch the live classroom demonstrations, view the recorded Zoom meetings and do the homework. This was a known educational quality issue during the extended COVID-19 pandemic economic shutdown and "stay at home" orders prevalent in Los Angeles County throughout Fall term 2020. The Middle School/High School students fared better than either of the other sub-groups in having a quiet place I which to watch the live Zoom demonstrations during the Tuesday afternoon classes (8.4.). Half of the 8th-12th grade students always had a quiet place available to view the class demonstrations lives (cf. to 25% of College students and 35% of Working Adults). However, an additional 75% of College students and over half (54%) of the Working Adults mostly had a quiet place available to view the class sessions live (cf. to 39% of 8th-12th grade students). At first glance this might seem surprising until one realizes that three of the four College students were working part-time (and the fourth full-time) and 12 of the 13 Working Adults were working for pay full-time while taking the course (and the other Working Adult was working part-time). Seven of the Working adults reported working in the Land Survey field, and four of those had job titles suggesting they would be working outdoors in the field at least at times during fall 2020. Whether working at home (with spouses, children, or roommates in the same space), or at the office the College students and Working Adults might well NOT always have a quiet place available on Tuesday afternoons to watch the class live. On the other hand, concerted attention was given during the pandemic to having quiet class attendance and study space available to K-12 students after most K-12 instruction went online.

0.22. Students could review the recorded Zoom class sessions and/or do their homework asynchronously. The 8th to 12th grade students also fared better than the other sub-groups in this respect (8.4).

0.23. About 43% of 8th to 12th grade students, 46% of Working Adults and 25% of College students could always find a quiet place and time to do the class homework and many of the rest of the sub-groups mostly found a quiet place and time to do class homework. However, five of 28 K-12 students (18%) and two of the 13 Working Adults

[3] All the Bentley application software taught was made available for download for free to all students for this class.

(16%) couldn't never find a quiet place and time to do their homework.

0.24. The Working Adults were the most conscientious in viewing class content sessions either live or in recorded format and the 8th to 12th grade least conscientious (8.5.). Either 92% or all the Working Adults viewed each class session, with the lowest viewing of the LumenRT demonstration. All the four College students viewed sessions on Microstation CAD, Context Capture and Concept Station and three of the four viewed the Course Overview (first) session, LumenRT and Open Roads sessions. In contrast, between 71% and 86% of the Middle School/High School students reported viewing the class sessions live or online. In addition during the class sessions that the evaluator observed live he noticed 8th to 12th grade students being the ones most likely to arrive late for class or leave part way through it. In other words, those with the poorest course related backgrounds, who might benefit most from the demonstrations and presentation of software keystroke demonstrations and examples were least likely as a group to observe class sessions live. As a result, one might expect the 8th to 12th grade students to be the least likely to learn course concepts, terminology, application functionality or keystrokes.

0.25. Indeed, that is what the Post-test survey ta indicates. The 8th to 12th grade students, with little variation between responses of girls from boys, mostly described the course as fun, interesting, and meeting their expectations (10.1.). However, toward the end of the course when asked to rate their understanding of the functionality of each of five Bentley software applications discussed in class the plurality group response on a five-point Likert scale was consistently only "Fair," given by 39% to 46% of the students with some variation by gender depending on the software product (10.3.). One to seven of the Middle School/High School students rated their understanding of application functionality as "Poor" while only two to four of this sub-group would rate their understanding of functionality as "excellent." The application with the worst ratings was LumenRT, which was only viewed by 79% of these students.

0.26. The 8th to 12th grade student self-rating of ability to use each software application was even lower overall (10.3.). While 43% to 53% of the group rated their ability to use each of the five Bentley software applications as "Fair," five to seven would rate their usage ability as "Poor," even as only one or two more (five to eight, depending on the application) would rate their usage ability as "Good." Each of the Bentley applications received a "Very Poor" ability to use rating from one of the students in this sub-group, always a male. Only one student rated her ability to use Microstation CAD as "Excellent" by the end of the course, and two females rated themselves as "Excellent" in ability to use Context Capture and Concept Station. The worst usage rating went to LumenRT, with one-quarter of the students rating their ability to use it as "Poor'.

0.27. While there were only four College students who responded to the Post-test survey, their ratings of understanding of functionality was better than that of the 8th to 12th grade students (11.7.). This might be because most were already familiar with Land Survey issues and related software before the course started? For each of the five Bentley products one or two of the four students always gave an "Excellent" rating (Microstation CAD and Open Roads functionality best understood). Concept Capture had one "Poor{ rating each regarding understanding of functionality and Lumen RT two "Poor" ratings (least well understood).

0.28. As with the 8th to 12th grade students, College student ability to use the software was self-rated lower than understanding of functionality (11.7.). Only the ability to use Concept Station and Open Roads received an "Excellent" rating from one College student, although ability to use MicrostationCAD received "Good" ratings from three students (and the fourth rated his ability as "Fair."). However, ability to use Open Roads received one "Poor" rating, context Capture and Concept Station each were two each and LumenRT three "Poor" ratings.

0.29. Given that over half of the Working Adults who answered the Post-test survey were already working in Land Surveying jobs, it is not surprising that this sub-group posted the highest self-ratings in understanding the functionality of the software presented (12.5.). About 62% to 92% rated their understanding of the Bentley

software understanding as "Good" by the end of the course. The lowest rating went to LumenRT and the highest to Open Roads. The Working Adults consistently stated in open-ended comments that the course met or exceeded their expectations, with several picking out specific Bentley applications for mention (12.4.).

0.30. As with the other sub-groups of the class the Working Adults rated their ability to use the various Bentley software products lower than their understanding of functionality of the applications (12.6.). However, overall Working Adult ratings of their ability to use the software was higher than those of other sub-groups. This is understandable because the Working Adults as a group possessed the most knowledge and experience with competitor Autodesk software and some of the Bentley software applications before starting the course. The most common Working Adult rating of ability to use any of the Bentley applications was "Good," (46% to 69% of respondents) and the second most frequent rating was "Fair" (31% to 38%) Three Working Adults (23%) rated their ability to use Microstation CAD "Excellent" as did two for Context Capture and one for Concept Station. Lumen RT and Open Roads had no "Excellent" users and LumenRT was worst rated overall (two "Poor" ratings).

0.31. The GE 385 course was mostly not successful in moving 8th to 12th grade students, and especially not girls, toward Land Surveying. At the end of the course, as at the beginning, the most common response to each of five goal or intent indicators remained the neutral "neither agree nor disagree" (10.5.). If anything the course turned more people against Land Surveying more than toward it. For example, in the Post-test six students (24%) checked that they "Disagree" and five (20%) "Strongly Disagree" that one of their long-term goals is to obtain a Land Survey license, compared to three (12% -- all boys) who "Agree" with that statement. Similarly 32% (8 students – 5 girls and 3 boys) 'disagree" that they intend to become a professional Land Surveyor, and another 20% (all boys) "Strongly Disagree" with that statement, compared to one boy who agrees with it. The course also turned more 8th to 12th grade students against having a long-term goal or becoming a licensed Civil Engineer or designing construction projects than toward those intents. The one positive for grant goals for this sub-group of students is that nine (2 girls and 7 boys) or 36% "Agree" that "I have other career plans in which Land Surveying can be a useful skill" and one girl strongly agreed with that statement. Many students at this age are still exploring what they might want to be when they grew up, enter the workforce, and seek a career. It simply may not work to push them toward a specific career at that age but does seem to be effective to tell and show them how Land Surveying can be a useful skill to have in several STEM careers and construction design.

0.32. Nor was GE 385 successful in increasing interest of 8th to 12th grade students in Land Surveying education – courses, certificates, degrees – or internships (10.6.). In response to a series of seven questions about additional Land Survey related education the most frequent answer from 46% to 69% of the students (usually 54% of more) was consistently "Not Sure." Again this course seemed to turn more students against than toward Land Surveying. More 8th to 12th grade students consistently responded "No" (6 to 11, more often boys than girls) than responded "Yes" (with the number of boys saying "Yes" always greater than or equal to the number of girls).

0.33. Similarly GE 385 as taught succeeded in convincing only one College student in agreeing that he had a long-term goal of obtaining a Land Surveyor license and becoming a professional Land Surveyor (11.8.). However, three of the College students strongly agreed that they intended becoming Civil Engineers, all four that they intended to design construction projects and two strongly agreed and one agreed that he had "other career pans in which Lad surveying can be a useful skill." For these College students it seems that the argument that Land Surveying knowledge and skills are useful to have in several careers is a stronger argument than one for obtaining a Land Survey license or becoming a professional Land Surveyor. Job related skills development is most important.

0.34. Nor was the course successful in moving the four College students toward more courses, certificates, or degrees in Land Surveying at any university level (11.9). Only one College students (25%) was interested in seeking a college certificate or an internship in Land Surveying and none wanted an Associate degree in the field. However, two (half) had become interested in seeking a bachelor's degree in "a field related to Land Surveying" and one a

Master's degree and/or PhD in such a field. One or two of the others responded "No" although three were "Not Sure" about an Associate degree in Land Surveying.

0.35. The greatest interest in additional education in Land Surveying came from the Working Adults. However, contrary to grant goals, this was not for higher education certificates or degrees of any sort. Only one of the 13 Working Adults who answered the Post-test survey responded "Yes" to seeking a college certificate, Associate or Bachelor's degree, although two were interested in a Master's degree in a field related to Land Surveying (12.8.). In contrast, six or seven Adult Workers responded "No" to each of those certificates or degrees. These were already people who mostly already had Bachelor's degree and over half were already working in Land Surveying jobs. What Adult Workers wanted was more continuing education courses related to Land Surveying. More than three-quarters (7752%) were interested in such courses at ELAC and 62% at Cal Poly, offered either online or in person (12.9). Lower proportions were interested in online or in person at two grant partner universities and half (54%) if offered online by another university. This presents an opportunity for ELAC and/or Cal Poly to offer additional continuing education courses to increase the skills of people already in the Land Survey workforce.

0.36. Considering the entire set of findings, REAP Change recommends against offering this online course again to a mixed educational level group of students or using ELAC NSF grant funds. Additional specific evaluator conclusions and specific recommendations concerning the course are made in paragraphs 13.1 to 13.3.

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Report and Evaluation Context

1.1. This evaluation report has been prepared by REAP Change Consultants (REAP Change) for the East Los Angeles College (ELAC) ATE grant 1801188 "Filling Skills Gap Through the Geospatial Engineering and Technology Program." The grant project and its evaluation are funded by the National Science Foundation (NSF) Advanced Technological Education (ATE) grant program. Dr. Stephen Maack, owner and lead consultant of REAP Change, did the evaluation instrument design, data collection using Survey Monkey online surveys and some participant observation during Zoom classes, analyses and reporting writing for the report.

1.2. The NSF funded ELAC grant project has a long-term goal of creating a pipeline of people from middle school through community college (notably at ELAC), into four-year universities and into the Land Survey workforce, as well as helping current workers in the Land Survey workforce become licensed as professional Land Surveyors. Achieving this long-term goal will take time and it will not be possible to fully evaluate its outcome success until well after the three-year grant period is completed. A more specific ELAC grant project goal is to add more women and Hispanic (LatinX) people to the Land Survey profession.

1.3. Partly using NSF grant funds, ELAC offered course GE 385 in fall term 2020 as a response to the Coronavirus (COVID-19) pandemic that severely disrupted the ELAC NSF grant project. A particular impact of the COVID-19 pandemic has been the shutdown of all in-person classes and in-person activities at ELAC from about mid-March 2020 to present. As a result, the in-person high school "boot camps" and courses that Dr. Gallegos, co-principal investigator (Co-PI) of the grant, held in Summer 2019 were not possible in Summer 2020, as planned. The high school "boot camps" and high school courses in Land Surveying had been the most successful aspects of the project in 2019 in educating females and encouraging them toward an interest in and future involvement with Land Surveying education, certificates, degrees and eventually licensure.

1.4. As part of the grant-funded project effort, Dr. Gallegos had previously established good relations with counselors and other administrators at two Middle Schools (Ellen Ochoa Middle School and Animo Compton Middle School) and two High Schools (Oscar De La Hoya Animo High School and Marie and Eva Stern MASS High School) that are among the feeder schools to ELAC. Because of the COVID-19 pandemic, in 2020 the grant project lost all possibility of holding Summer Land Surveying related "boot camps" with the high schools and in person "CAD bashes" with students and parents at Middle Schools and High Schools, as planned in the grant project . Rather than giving up completely on continuing grant efforts to interest Middle School and High School students in Land Surveying, Dr. Gallegos obtained permission from the ELAC administration to include such students in a course already approved at ELAC, General Engineering (GE) 385. It is common practice in California for community colleges to allow High School age and even younger students to take community college courses before they graduate from High School. The idea is to expose younger students to higher education and allow them to earn some college credits to give them a head start should they seek higher education degrees or certificates later at the community college or four-year college level.

1.5. Three aspects of GE 385 as taught at ELAC in the fall semester 2020 are innovative and creative. First GE 385 is listed on the ELAC course catalogue as an independent study course, which means that it usually involves individuals or only a few students engaged in study of a topic of their choosing, often in a tutorial or small group setting. However, in Fall 2020 ELAC allowed the course to be offered to as many students as wanted to sign up. The special topic of GE 385 was an overview, demonstration, and training in specialized Bentley software. Bentley offers a suite of computer software applications used by professional land surveyors. Second, as true of all courses offered by ELAC since mid-March 2020, GE

385 could only be offered online in the Fall 2020 term. This meant that students needed to have internet access and a computer if they were to try out using the Bentley software instead of just watching demonstrations of it (which could be done on a cellphone). The grant project lent some ELAC laptops to Middle School or High School students who needed them and arranging for students to install Bentley applications on the laptops. The third and most innovative aspect of that Fall 2020 GE 385 offering is that for the first time ever the class was taught to a mixed group of students ranging in age and experience from teenagers in Middle School and High School, through community college/college students to adults interested in or already working in Land Surveying or other fields. The trainers and Dr. Gallegos had prior experience training in this software to students at each of these levels, but never previously to all of them at once.

1.6. GE 385 provided a "natural experiment" kind of situation and the course evaluation approach taken was designed to compare responses of the three major subgroups of the class, i.e., Middle School/High School students, College students, and Working adults. The evaluation methodology used a "pre-test/post-test" design consisting of an online Survey Monkey survey mounted the first two weeks of class for a "pre-test" of backgrounds, knowledge, interest in the course and intentions of students at the beginning of the class, and a "post-test" Survey Monkey survey mounted just before Thanksgiving and left open through the last day of class. The "pre-test" survey instrument is provided in Appendix 1 and the "post-test" survey in Appendix 2.

1.7. The "pre-test" survey had 57 demographic responses and 53 usable responses to most other questions and the "post-test" survey had 46 demographic and 45 usable responses to most other questions. The exact class enrollment is not clear because of administrative difficulties encountered in enrolling the Middle School and High School students, but toward the beginning of the class Dr. Gallegos was contacting about 63 students by e-mail to provide them with Zoom links and other course information. Logically then, the pre-test and post-test survey counts may indicate response rates around 85%, assuming attrition of students during the semester.

1.8. To achieve these high assumed response rates REAP Change used the standard approaches of survey guru Don Dillman of sending out an invitation by e-mail with reminder requests every two to three days over two weeks. In addition, Dr. Gallegos introduced Dr. Maack as the evaluator during the first Zoom class and allowed him to explain the evaluation process. When Dr. Maack attended later Zoom classes he was able to associate student names with e-mail addresses and ask students through private chat messages to complete the pre-test or post-test surveys if automatic Survey Monkey tracking of responses indicated that they had not yet done so. He also created a second link to the Pre-Test survey on the last class session before it closed and several students used that link but did not provide their names or e-mail addresses (a tactical error by the evaluator). After cleaning up both the pre-test and post-test surveys to fill in missing names as much as possible,

1.9. The class size and number of survey responses were too small to allow for valid and reliable statistical tests. However sub-setting the survey data to analyze separately Middle School/High School student, College students, and working adult student responses separately provided better evaluation insights than just analyzing the entire class as one group of students. While there were few women in the college or working adult groups to analyze responses by gender, the table below break out differences between female and male responses of K-12. The fairest look at differences in responses between the beginning and end of the course comes from exploration of the 39 matched students who completed both the pre-test and post-test surveys, but that ended up not being a fruitful line of evaluation inquiry because of small numbers in the three sub-groups with responses distributed across questions with three to five category response possibilities. The report analysis therefore includes separate looks at the responses of the 55 students who responded to the first survey and the different group of 47 students who replied to the second survey, with breakouts by student types (K-12, College, Working Adult).

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Pre Test (Beginning of Class) Survey Results

Overall Pre-test Survey Results.

2.1. Over half of the GE 385 students were Middle School/High School students (in grades 8 to 12). For reasons that are not clear, none of the students identified specifically as ELAC students (full-time or part-time), but the online course attracted six College students from other colleges or universities, including grant partner California State Polytechnic University Pomona (Cal Poly). The other 16 students identified themselves as working adults (whether employed or not)

.

Table 1. Pre-test Survey Respondents by Student Type[4]

	Grades 8 to 12	ELAC	Other College	Working Adults	Class Total
Total class responded to survey	32 59%	0	6 11%	16 30%	54 100%

2.2. Only the Middle School/High School students had enough female respondents to warrant further exploration of gender differences in specific question responses by student type. This underlines the current lack of women in Land Surveying at the college or workforce levels.

Table 2. Pre-test Survey Student Type by Gender

Student Type/ Student Gender	Grades 8 to 12	ELAC	Other College	Working Adults	Class Total
Females	16 50%		2 33%	1 6%	19 35%
Males	16 50%		4 67%	15 94%	35 65%

The long-range ELAC NSF grant approach of trying to develop a pipeline of future potential college students into Land Surveying may be a wise one. Thanks to the help of Counselors, teachers, and administrators at the grant project partner Middle Schools/High Schools, half of the class students at this level are young women (girls). However, more project recruitment effort may be needed to increase interest in Land Surveying among females attending ELAC and other colleges or universities in taking Land

[4] In this report the modal (most frequent) value in a row or column is highlighted in yellow and the second most frequent in a light blue. While there were 55 respondents to the Pre-test survey, and it was possible to identify demographics and student type for 54 of them, including two who stopped responding to the survey questions before reaching student type specific questions. Therefore we provide demographics for the 54 students whose student type and demographics are both known but later tables show 53 total responses to student type specific questions and a gender breakdown for 8th to 12th grade students of 16 females and 15 males (total 31). This as an anomaly in the completeness of student survey question responses and survey design.

Survey courses. Only one Working Adult female took the class.

2.3. One of the grant goals is to attract more Hispanics (LatinX) people into Land Surveying and the class did well in that regard among K-12 and College students. This is partly attributable to ELAC being an officially recognized Hispanic Serving Institution and its feeder schools are in areas known to have large numbers of LatinX residents. There are lower proportions of LatinX students in this class from the Working Adult sub-group. The class has attracted LatinX students who are already doing or interested in Land Surveying but there are fewer of these already working in that field than there ae in the general population of working adults.

Table 3. Pre-Test Survey Student Type by Ethnicity*

Student Type/ Student Ethnicity, "Race"	Grades 8 to 12	ELAC	Other College	Working Adults	Class Total
White	1			8	9
	3%			50%	17%
LatinX	30		4	4	37
	94%		67%	25%	69%
Asian or Asian American	1		2	5	8
	3%		33%	31%	15%
American Indian/Alaska Native	2				2
	6%				4%
Total Choices Checked	34		6	17	56
	106%		100%	106%	104%

* Respondents to the Ethnicity/"Race" question could choose multiple responses. Column percentages are of 32 Middle School/High School students (Grades 8 to 12), 6 College students, 16 Working Adults, and 54 total respondents.

It is a success indicator for the NSF grant project that 94% of the Middle School/High School students, two-thirds of the College level students and one-quarter of the Working Adults in this class identify themselves as LatinX. It is typical of the current ethnic mix in Land Surveying and related fields as disciplines that the largest ethnic group of Working Adults taking the class are Whites. Only the Working Adult sub-group includes enough students to try to look for differences in responses between Whites and Non-Whites, but LatinX people, not all non-Whites, are the target for the grant and the number of LatinX people is too small to justify a comparison of LatinX/Non-LatinX responses.

2.4. Age is associated with student level and the age distribution in the class matches expected age distributions by student type with only a small overlap in the ages of class members who identify primarily as "College students" and those who identify themselves primarily as "Working Adults". The Working Adults have the largest spread in age range and the oldest students, which underlines the urgency of increasing the number of younger people entering the aging Land Survey workforce and discipline. It is common practice at and a key function of California community colleges to provide professional development or continuing education classes to increase the skills, knowledge and abilities of California adults who are already in the workforce. As designed GE 385 can serve as such a class, providing additional computer skills and knowledge related to Land Surveying to those

already working in Land Surveying or related fields, or those interested in exploring the discipline. Therefore the wide age range of "Working Adults" in this class is not unusual and consistent with NSF ATE national grant program goals of increasing the number of skilled individuals in the Land Survey workforce.

Table 4. Pre-test Survey Student Type by Age Group

Student Type / Student Age Group	Grades 8 to 12	ELAC	Other College	Working Adults	Class Total
Under 15	17 53%				17 31%
15 to 19	15 47%				15 28%
20 to 24			2 33%		2 4%
25 to 29			4 67%	4 25%	8 15%
30 to 34					0
35 to 39				4 25%	4 7%
40 to 54				3 18%	3 6%
55 to 65 or older				5 31%	5 9%
Totals	32		6	16	54

Pre-test Results for Middle School and High School Students

3.1. This section concerns the 31 Middle School/High School students who responded to the Pre-test survey questions by student type. As explained above these 31 students included 16 girls and 15 boys, and 29 of the 30 LatinX students of this type. The 29 LatinX students were almost evenly split by gender, with 15 girls and 14 boys. While the survey did not ask the students to identify their schools, the age ranges shown in Table 4 (17 under age 15 and 15 are between 15 and 19 years old) suggests that there is nearly an even split between Middle School and High School students in the class. The distribution of these students by self-reported grade levels in Fall 2020 are given in Table 5 below. If the Middle Schools end at 8th grade and the High Schools include grades 9 to 12 then about a quarter of the students (and a third of the girls) are in the last grade of Middle School and the rest of the students are High School students. This is consistent with the self-reported age ranges. With some variations the percentages of girls and boys at different class levels is similar, but the counts are too small to draw definitive conclusions.

Table 5. Pre-Test Survey of K-12 Students, Gender by Grade Level

Grades Students were in during Fall term 2020	Females		Males		Total	
8th grade	5	33%	3	20%	8	27%
9th grade	2	13%	3	20%	5	17%
10th grade	3	20%	5	33%	8	27%
11th grade	2	13%	1	7%	3	10%
12th grade	3	20%	3	20%	6	20%
Total Answered the Question	15	100%	15	100%	30	100%
No Answer	1				1	

3.2. The open-ended responses that these students took the class are shown in Table 6 (below and on the next page). The number and variety of responses is similar for both girls and boys. The responses fit into four broad categories, shaded in the table in light gray, with little difference in the opinions of the boys and girls in each category.

Table 6. Pre-test Survey, Reasons Why Middle School/High School Students Took GE 385

	What is your gender?	
Why are you taking this course at this time?	Female	Male
Because I thought it would be fun		1
because it is fun and helpful	1	
I thought I would be interested and sounds fun		1
I have lots of free time and also I wanted to try something new.	1	
I am taking this course because it seems interesting.		1
I am taking this course because it was offered at my school, and it sounded interesting.		1
I am taking this course because my middle school introduce me to this course and suggested that I should take it.		1
Im taking this course because its an interesting topic, i thought it was a good opportunity too.	1	
I am taking this class because the last time I took this class I loved it so yea.	1	
I am taking this course because i took rhis class last year and i thought it was fun.	1	
It was offered by my school and since I had taken a college class before, I wanted to see if this one was similar since I enjoyed the last one.	1	
I am taking this course because I have taken similar courses and want to take a new one.		1
I am taking this course at this time so I can get a certificate for taking 2 courses of college class.	1	
I am taking this course because I think this is a great opportunity for me and it will help me do well in college.	1	

Table 6 Continued

Why are you taking this course at this time?	What is your gender?	
	Female	Male
Need credit		1
For the knowledge and college credit. Although I not good with software, engineering and designing I want to try new things and this might help me in the future so why not take this opportunity.		1
I want to learn a new technology that may help me in the future. I also hope to get more credit on my GPA, this will be useful to when I graduate this year.	1	
I am taking this course to better my understanding of what I want to do in the future.	1	
Im looking in at career choices and I'm trying this out.		1
I am interested in business and corporations, I believe that as the world advances a lot of technology will play a part in the change of how business runs	1	
I want to explore my interests in STEM Fields.	1	
Why I am taking this course is so that I can further explore courses that involve engineering which maybe a future college Degree		1
I want to learn more about engineering and land surveying. And this course is going to help me learn and improve my education as well.		1
i want to learn more about using 3d tools for engineering and its a skill i want to master		1
I wanted to take this course cause I was interested in engineering and wanted to see what I could learn in it.	1	
I wanted to take this engineering course so I can see what it is about and to see if I like it for my future career.	1	
I'm taking this course because engineering really interest me and it will help me in my future career.	1	
I'm taking this course to learn more about design because I'm aiming to become an Engineer and it's important for me to learn design and the types of programs I may use		1
Yes!		1
To get better information on how to buy my own house and what makes a good house.		1
TOTAL RESPONSES	**15**	**15**

The first set of responses is simply that the course was available, sounded fun and interesting, and sometimes someone at the school had recommended that they take it. The second set of reasons concerns the possibility of earning college credits before entering college and improving one's grade point average. The third set of responses has to do with exploring potential career or academic interests, especially in STEM or engineering, but only one person specifically mentions Land Surveying. The final small category is a catchall for other reasons. The last comment is of potential interest since during the 2019 Summer Roosevelt High School "boot camp" held in person at ELAC a class exercise related to land surveying had been for small groups of students to layout and measure the footprint of a house of their own design and do a rough cost estimate for that size house. It is conceivable that the student who made the final comment had heard from one of his peers about that exercise and wanted to try it. In

fact in order to better tailor the course to appropriate grade, experience and age levels Dr. Gallegos created separate, simpler exercises for the 8th to 12th grade students that included a virtual exercise of using the Bentley computer software to lay out the footprint of a house, measure and cost out estimated building costs.

3,3, To better interpret the ability to understand Land Surveying software the survey asked the 8th to 12th grade students to indicate what level of mathematics they had completed to date. Some aspects of Land Surveying involve simply measuring and counting, but more advanced work involves understanding geometry, trigonometry and even calculus. The software does the calculations but do these students understand what is happening "behind the scenes" and the value in time savings of not having to do the calculations manually?

Table 7. Pre-test Survey Mathematical Education of Middle School/High School Students by Gender

Mathematics Courses Passed to Date	Yes		No		Not Available		Total Answers		No Answer
Arithmetic	23	77%			7	23%	30	100%	1
Females	11	73%			4	27%	15	100%	
Males	12	86%			2	14%	14	100%	
Pre-Algebra	21	70%	2	7%	7	23%	30	100%	1
Females	10	67%	2	13%	3	20%	15	100%	
Males	11	73%			4	27%	15	100%	
Algebra	21	70%	2	7%	7	23%	30	100%	1
Females	9	60%	2	13%	4	27%	15	100%	
Males	12	80%			3	20%	15	100%	
Geometry	14	47%	6	20%	10	33%	30	100%	1
Females	8	53%	3	20%	4	27%	15	100%	
Males	6	40%	3	20%	6	40%	15	100%	
Trigonometry	7	24%	7	24%	15	52%	29	100%	2
Females	4	28%	4	29%	6	43%	14	100%	
Males	3	20%	3	20%	9	60%	15	100%	
Calculus	1	4%	11	39%	16	57%	28	100%	3
Females			8	62%	5	39%	13	100%	
Males	1	7%	3	20%	11	73%	15	100%	

Table 7 provides an overview of 8th to 12th grade student capabilities as a sub-group in each type of mathematics. Interpreting it is complicated by considering whether particular schools even offer courses in all these types of mathematics. For example, Middle Schools are unlikely to offer trigonometry or calculus courses, and not even all High Schools offer courses in those more advanced types of mathematics. The data is time bound. While educational research indicates that girls are less likely than boys to take more advanced mathematics, the distribution of girls and boys by grade level would influence the gender breakouts shown above. Finally, the sample may be biased toward students more interested in STEM related fields, and so more focused on mathematical education. We notice in Table 7 that four girls and three boys reported having passed Trigonometry. Considered overall, for the majority of 8th to 12th grade students taking GE 385 the most advanced type of mathematical education they had undertaken was either Pre-Algebra or Algebra. Under half of the students (more girls than boys) had completed a geometry course. Geometric concepts might be foreign to half the students.

3.4. One of the trainers understood this limitation. In one class session a trainer demonstrating a feature of one of the Bentley software explained how one can determine the area of a circle by measuring its radius or diameter and let the software do the calculating. The lack of a full understanding even of Geometry (much less Trigonometry or Calculus) slowed down the teaching and may have been a learning limitation for some of the 8th to 12th grade students. Fortunately, the computer software itself does the mathematical calculations so the students did not need to know the mathematical formulae or theories behind what they were seeing on the computer screen. Middle School/High School students could concentrate on learning the point and click nature of the Bentley software and see the results. However, they might not understand the value of letting the software do the calculation work.

Table 8. Pre-test Survey. 8th to 12th Grade Student Prior Knowledge and Use of Land Surveying and Related Software by Gender

	Not at all familiar		Heard of it, Haven't used or done It		Used or did it a little		TOTAL RESPONSES	
	Num.	Pct.	Num.	Pct.	Num.	Pct.	Num.	Pct.
Land Surveying	20	65%	8	25%	3	10%	31	100%
Females	9	56%	6	38%	1	6%	16	100%
Males	11	73%	2	13%	2	13%	15	100%
Microstation	17	55%	13	42%	1	3%	31	100%
Females	8	50%	7	44%	1	6%	16	100%
Males	9	60.%	6	40%			15	100%
Open Roads	23	79%	6	21%			29	100%
Females	13	93%	1	7%			14	100%
Males	10	67%	5	33%			15	100%
Concept Station	28	90%	3	10%			31	100%
Females	15	94%	1	6%			16	100%
Males	13	87%	2	13%			15	100%
Context Capture	29	94%	2	7%			31	100%
Females	15	94%	1	6%			16	100%
Males	14	93%	1	7%			15	100%
Other Bentley Software	26	84%	4	13%	1	3%	31	100%
Females	13	81%	2	13%	1	6%	16	100%
Males	13	87%	2	13%			15	100%
Autocad	24	77%	5	16%	2	7%	31	100%
Females	13	81%	1	6%	2	13%	16	100%
Males	11	73%	4	27%			15	100%
Other Autodesk software	24	77%	5	16%	2	7%	31	100%
Females	11	69%	3	19%	2	12%	16	100%
Males	13	87%	2	13%			15	100%

3.5. As shown in Table 8, most 8th to 12th grade students taking GE 385 were starting from a virtual ground zero about the Bentley software and its functionality, and only one or two had any experience using it (or doing Land Surveying). The few students who had at least heard of Land Surveying or any of the Bentley software applications had little experience with them. No more than 40% of the students in this sub-group had heard of Microstation CAD and only about 10% to 20% of the students (three to six individuals) had heard of the other Bentley software products. While more girls than boys had heard of (but not done) Land Surveying and had heard of (but not used) Bentley's Microstation CAD software, more boys than girls had heard of the competitor Autocad software.

3.6. Their lack of familiarity with Land Surveying and Land Survey related software should not be taken as implying that the Middle School and High School students are all neophytes in using specialized computer software. In fact, as shown in the next table 40% (both girls and boys) have done at least a little computer coding and about one-third (including 40% of the girls and 30% of the boys) claimed a moderate amount of such experience. Less than a quarter of these students (a fifth of the girls and over a quarter of the boys) had no computer coding experience at all. In addition, almost half of these students (including over half of the girls and 40% of the boys) had a little experience and an additional 10% had a moderate amount of experience using computer drawing programs. However about nine out of every 10 students had previously never used computer programs as complicated as the Bentley software, such as ArcMAP or QGIS computer mapping programs.

Table 9. Pre-test Survey. 8th to 12th Grade Student Prior Experience Using Other Kinds of Software

Do you have any prior experience with the following:	Not at All		A little		A moderate amount		A lot		Sub-Total	Not Sure		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	N	Pct.	N
doing computer coding	7	23%	12	40%	10	33%	1	3%	30			30
Females	3	20%	6	40%	6	40%			15			15
Males	4	27%	6	40%	4	27%	1	7%	15			15
using computer drawing programs	12	41%	14	48%	3	10%			29	1	3%	30
Females	5	36%	8	57%	1	7%			14	1	7%	15
Males	7	47%	6	40%	2	13%			15			15
using complex computer mapping (GIS) programs like ArcMAP or QGIS	27	93%	1	3%			1	3%	29	1	3%	30
Females	14	93%	1	7%					15			15
Males	13	93%			1	7%			14	1	7%	15

3.7. How pre-disposed are Middle and High School students to Land Surveying, Civil Engineering or other disciplines in which Land Surveying is a useful skill to know and have? The survey asked directly in five retrospective pre-test questions about student interest before starting the course in September 2020. If most students were previously interested in Land Surveying Civil Engineering, or another field like construction management before even starting the GE 385 class then the class is "preaching to the choir" and it may just be considered as a skills-building class for this sub-group of students. Otherwise it will be especially relevant in the post-test survey to analyze whether learning more about Land Surveying related computer software is a good way to attract Middle School or High School students in that academic and career direction.

3.8. The responses to the five pre-test survey retrospective questions are shown in Table 10. The primary conclusion from analysis of this table is that these young people are mostly still exploring their academic and career options. That is probably to be expected of teenagers. Six out of ten (more girls than boys) neither agreed nor disagreed that one of their long-term goals was to obtain a Land Survey license. However, about one out of six of the young students, including one of five girls, agree that they have set obtaining a Land Survey license as a long-term goal. Similarly almost six out of ten of these young students neither agreed nor disagreed that they intended to become Land Surveyors. Only one out of ten (two people) agreed or strongly agreed that that was their intention. It is a small plus for the project that the only one who strongly agreed is a girl.

Table 10. Pre-test Survey, 8th to 12th Grade Student Career Goals

BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements?	Strongly Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
One of my long-term goals is to obtain a Land Surveyor License.	1	3%	4	13%	18	60%	5	17%	2	7%	30
Females	1	7%	2	13%	10	67%	1	7%	1	7%	15
Males			2	13%	8	53%	4	27%	1	7%	15
I intend to become a professional Land Surveyor	1	3%	2	7%	17	57%	8	27%	2	7%	30
Females	1	7%	1	7%	8	53%	4	27%	1	7%	15
Males			1	7%	9	60%	4	27%	1	7%	15
I intend to become a licensed Civil Engineer	1	3%	7	23%	15	50%	7	23%			30
Females	1	7%	3	20%	8	53%	3	20%			15
Males			4	27%	7	47%	4	27%			15
I intend to design construction projects.	3	10%	8	27%	12	40%	6	20%	1	3%	30
Females			6	40%	6	40%	3	20%			15
Males	3	20%	2	13%	6	40%	3	20%	1	7%	15
I have other career plans in which Land Surveying can be a useful skill	5	17%	11	37%	10	33%	4	13%			30
Females	1	7%	5	33%	9	60%					15
Males	4	27%	6	40%	1	7%	4	27%			15

3.9. What, then, motivates these students to take a course focused on learning about Bentley software applications specifically designed for use by professional Land Surveyors? The start of an answer lies in the responses to the last three questions of Table 10. More of the Middle School and High School students are interested in learning about Land Surveying related software because Land Surveying is an ancillary skill to other work or careers that they are considering pursuing. For example over a quarter of these students, both girls and boys, agreed or strongly

agreed that they intend becoming licensed Civil Engineers. Over one third (37%) strongly agreed or agreed (more girls than boys) that they want to design construction projects, for which an understanding of Land Surveying would be an important skill to have. Three boys (but no girls) strongly agreed that they intended to design construction projects. Summarizing, over half (54%), strongly agreed (one-quarter of the boys but only one girl) that they have "other career plans" in which Land Surveying can be a useful skill. We analyze the end=of-course survey results later in this report to see whether the exposure to Bentley software increased the proportion of Middle School/High School students interested specifically in Land Surveying as a profession rather than a skill used in other professions.

3.10. While many of these students are exploring career plans other than that of becoming professional Land Surveyors, what is the extent of their interest in academic courses, certificates or degrees in Land Surveying? The answers to several related survey questions comes from analysis of Table 11.

Table 11. Pre-test Survey, 8th to 12th Grade Student Interest in Land Survey Courses, Certificates or Degrees

	Yes		Not Sure		No		TOTAL
At this time are you interested in seeking:	N	Pct.	N	Pct.	N	Pct.	N
Additional Courses in Land Surveying	6	20%	19	63%	5	17%	30
Females	3	20%	11	73%	1	7%	15
Males	3	20%	8	53%	4	27%	15
An Internship (paid or unpaid) in Land Surveying	10	33%	14	47%	6	20%	30
Females	6	40%	7	47%	2	13%	15
Males	4	27%	7	47%	4	27%	15
A multi-course college certificate in Land Surveying	9	30%	15	50%	6	20%	30
Females	5	33%	8	53%	2	13%	15
Males	4	27%	7	47%	4	27%	15
An Associate Degree in Land Surveying	3	10%	18	60%	9	30%	30
Females	2	13%	10	67%	3	20%	15
Males	1	7%	8	53%	6	40%	15
A Bachelor's degree in a field related to Land Surveying	5	17%	17	57%	8	27%	30
Females	3	20%	9	60%	3	20%	15
Males	2	13%	8	53%	5	33%	15
A Master's degree in a field related to Land Surveying	6	20%	17	57%	7	23%	30
Females	4	27%	9	60%	2	13%	15
Males	2	13%	8	53%	5	33%	15

Again we find that about one-half to 60% of the young Middle School and High School students are unsure about their academic plans related to Land Surveying but larger proportions of boys than girls (often twice as many) responded "no" to the possible academic futures listed. Although the numbers are small, this might be a positive indicator for the NSF grant project interest in attracting more females to Land Surveying courses, certificates and degrees. Although the numbers are small, one in five girls and boys were interested before GE 385 started in taking additional courses in Land Surveying. A greater proportion of girls (40%) than boys (27%) were interested in a paid or unpaid internship in Land Surveying. Three out of every ten students expressed an interest in a multi-course

college certificate in Land Surveying (and ELAC offers two such certificates). However, only 10% of these teenagers are interested in an Associate degree in Land Surveying. The academic sights of some of these students may be set beyond the community college level since 17% (20% of the girls and 13% of the boys) are interested in the possibility of earning a Bachelor's degree in a field related to Land Surveying and 20% (twice as many girls as boys) are interested in seeking a Master's degree in a field related to Land Surveying. Such Bachelors and Master's degrees might include not only Land Surveying itself, but also Geospatial Engineering or Civil Engineering – degrees offered at ELAC NSF grant partner universities. While small numbers of students are involved, these pre-course results are positive for the potential building of a pipeline of students interested in Land Surveying to attend ELAC and four-year universities and colleges offering Land Survey related certificates and degrees. An evaluation question explored later is whether academic interest in Land Surveying courses and related certificates and degrees increases among students taking this course, remains the same, increases or decreases Middle School and High School students from further pursuit of Land Surveying courses, or related degrees and career paths.

3,11, Given the general lack of clear Land Surveying academic or career interest seen in the two tables above, one might wonder how much these teenage students understand about Land Surveying as a career. In California both Land Surveying and Civil Engineering are state licensed professions. The survey asked three questions checking on prior teenage student knowledge of what it takes to obtain a license in either of these professions and whether one can obtain dual licenses as a Land Surveyor and a Civil Engineer. (The answer to the latter question is "Yes" one can hold dual licenses simultaneously.)

Table 12. Pre-test Survey, 8th to 12th Grade Student Knowledge of Land Survey and Civil Engineering Licensure

	Yes		Not Sure		No		TOTAL
At this time do you understand the steps needed to:	N	Pct.	N	Pct.	N	Pct.	Number
Obtain a Land Surveyor license	7	23%	15	50%	8	27%	30
Females	3	20%	8	53%	4	27%	15
Males	4	27%	7	47%	4	27%	15
Obtain a Civil Engineering license	6	21%	16	55%	7	24%	29
Females	3	20%	8	53%	4	27%	15
Males	3	21%	8	57%	3	21%	14
Can one be both a licensed Land Surveyor AND a licensed Civil Engineer?	11	37%	18	60%	1	3%	30
Females	7	47%	8	53%			15
Males	4	27%	10	67%	1	7%	15

3.12. Table 12 shows that about half of the teenage students were not sure about the steps needed to obtain a Land Surveyor license or a Civil Engineering license and about another quarter definitely answered "No," they did not know. This is not a surprising finding for teenagers who indicated earlier in the survey that their career and academic goals were unclear or not firmly established. Even more, 60% (including over half the girls and two-thirds of the boys) were unsure if the same person can be licensed as both a Land Surveyor and a Civil Engineer and one person answered in the negative, which is the wrong answer. However, over one-third of the students, including almost half of the girls but just over one-quarter of the boys, knew even at the beginning of the course that a person could become licensed in both professions at the same time.

Pre-Test Survey Results for College Students

4.1. The beginning of course survey asked some of the same questions of every survey taker, then asked a question that branched to additional specific questions depending on whether one viewed oneself primarily as a Middle School/High School student, or as a community college or four-year college student taking an ELAC course, or as a working adult taking a community college course. The objective of the branching was to ask some questions that were more appropriate for some types of students than for others;

4.2. Surprisingly, even though GE 385 is an ELAC community college course, none of the college students identified themselves as community college students. All six class attendees who answered the Pre-test survey classified themselves as students from other colleges or universities taking an ELAC course. As detailed at the beginning of this report that included only young women and four young men, all either in a "traditional" undergraduate college going age range of 20 to 24 or a typical undergraduate age range of 25 to 29. Two-thirds of these college students self-identified as LatinX and two as Asian or Asian American.

4.3. None of the demographic findings are unusual if the students taking the virtual course are all from the Los Angeles region. These are ethnicities typical of students attending Cal Poly Pomona or other nearby four-year colleges and universities. ELAC, Cal Poly Pomona and some other local universities or colleges are officially designated by the federal government as "Hispanic Serving Institutions." The Pre-test survey did not ask if the College students were attending local universities or colleges, but because so few attended, we suspect that they were. Higher education students with internet access anywhere in the United States (or the world), might have taken the GE 385 internet course if they had learned about it, were interested, knew English and paid the enrollment fee.

4.4. The primary reasons that students signed up for this class concerning Bentley software related to internship or future job related knowledge and skills. The college student viewpoint was basically that if they learned Bentley software the chances of obtaining internships or jobs would increase. Some also had a hope of obtaining certification from Bentley in the use of that software.

Table 13. Pre-test Survey, Reasons Why College Students Took GE 385

Why are you taking this course at this time?
I want to be competent with the software being provided as well as strengthening my resume with the addition of a certification from Bentley
I want to receive the Bentley certification because it will create more job opportunities for myself
For the certification and potential job opportunities
To get and /sic/ understanding of the software the civil engineers use
By taking this course I have better chance to get internship or job
Because most internships require to know how to use Microstation

4.5. These college students are well-prepared mathematically for Land Survey related courses. All have passed courses in not only Algebra and Geometry, but also in Trigonometry and Calculus. The implication is that they would be better able than Middle School/High School students to appreciate the mathematics done automatically by the Bentley software, the measurements needed to let the software do the calculations and the time savings of not having to do Land Survey calculations by hand or with an electronic calculator.

4.6. All but one of the College students were also at least a little familiar with Land Surveying While half of this group of students were not familiar with any of the Bentley software products, one-third had a moderate amount of prior experience using the Microstation CAD and Open Roads applications and half knew about but had not yet used the Concept Station or Context Capture o applications. Two of these six students had a little or a moderate amount of experience with other Bentley software. In addition, all had a little to a great deal of experience using Autocad software, a direct competitor to Microstation CAD, and all but one had used other software in the Autodesk suite of products. In other words the College students were already somewhat familiar with Land Surveying, seeking to expand their knowledge of the major competing software products used in professional land surveying applications. They saw a competitive job related advantage in doing so.

Table 14. Pre-test Survey. College Student Prior Knowledge and Use of Land Surveying and Related Software

BEFORE starting this course in September 2020, how familiar were you with the following?	Not at all Familiar		Heard of it, Haven't used or done It		Used or did it						TOTAL
					a little		a moderate amount		a great deal		
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Land Surveying	1	17%			1	17%	2	33%	2	33%	6
Microstation	3	50%	1	17%			2	33%			6
Open Roads	3	50%	1	17%			2	33%			6
Concept Station	3	50%	3	50%							6
Context Capture	3	50%	3	50%							6
Other Bentley Software	3	50%	1	17%	1	17%	1	17%			6
Autocad					2	33%	3	50%	1	17%	6
Other Autodesk software			1	17%	3	50%	2				6

4.7. In addition to their prior experience with Land Survey specific computer software, all the College students had a little or more prior experience doing computer programming and a moderate amount to a lot of experience with computer drawing programs. Five out of six claimed no prior experience with complicated computer mapping programs. The prior computer experience of these six college students should position them well to understanding the functionality of Bentley software and help in mastering the specific keystrokes needed to use the applications.

Table 15. Pre-test Survey. College Student Prior Experience Using Other Kinds of Software

Do you have any prior experience with the following:	Not at All		A little		A moderate amount		A lot		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
doing computer coding			3	50%	3	50%			6
using computer drawing programs					3	50%	3	50%	6
using complex computer mapping (GIS) programs like ArcMAP or QGIS	5	83%	1	17%					6

4.8. The emphasis of the college students on learning new job related skills is underlined by several other beginning of the class survey findings. As seen earlier, these students are adults in the college-going age range, but none of them had yet earned any baccalaureate degree. All were working either full-time or part-time while attending college. One-third (2) reported that they did in fact have current or prior full-time experience working for pay in Land Surveying or as a paid or unpaid intern in Land Surveying or a related field. All but one already had experience using Autocad, another major software product used in Land Surveying. These were students motivated to take the course to improve current or future job prospects by learning more about other major Land Surveying software.

4.9. This conclusion is underlined by analysis of Table 16.

Table 16. Pre-test Survey, College Student Career Goals

BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements?	**Strongly Agree**		**Agree**		**Neither Agree Nor Disagree**		**Disagree**		**Strongly Disagree**		**TOTAL**
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
One of my long-term goals is to obtain a Land Surveyor License.	2	33%	1	17%	1	17%	1	17%	1	17%	6
I intend to become a professional Land Surveyor	2	33%			2	33%	1	17%	1	17%	6
I intend to become a licensed Civil Engineer	5	83%							1	17%	6
I intend to design construction projects.	4	67%	1	17%					1	17%	6
I have other career plans in which Land Surveying can be a useful skill	3	75%	1	25%							4

Half of the College students agreed or strongly agreed that before starting the course they had a long-term goal of obtaining a Land Surveyor license, and one-third intended to become professional Land Surveyors. However, even more - five out of six - intended to become licensed Civil Engineers. Civil Engineering is a career in which having knowledge of and computer skills in using Land Surveying software can be an advantage, and a Land Surveyor license a definite plus. Two-thirds of the College students strongly agreed that they intended to design building and one more agrees. Having Land Surveying skills for related careers is the primary motivator.

4.10. Before starting GE 385 the College students as a group were also interested in additional courses and certificates, but not necessarily degrees, in Land Surveying. Five of the six college students were interested in taking additional courses in Land Surveying and in a paid or unpaid internship in Land Surveying (either or both of which would improve their job qualifications and resumes). While most (four) were unsure about seeking an Associate degree in Land Surveying and two were not interested in that, most (four) were interested in obtaining a certificate in Land Surveying. Half were interested in earning a Bachelor degree in "a field related to Land Surveying," and two were unsure, but the question phrasing might be ambiguous. That is, this finding might mean a B.S. degree in Civil Engineering with a "Geospatial Engineering" specialty, such as that offered at the ATE grant project partner Cal Poly Pomona. Only One student was definitely interested in seeking a Master's degree in a field related to Land Surveying.

Table 17. Pre-test Survey, College Student Interest in Land Survey Courses, Certificates or Degrees

At this time are you interested in seeking:	Yes		Not Sure		No		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N
Additional Courses in Land Surveying	5	83%			1	17%	6
An Internship (paid or unpaid) in Land Surveying	5	83%	1	17%			6
A multi-course college certificate in Land Surveying	4	67%	1	17%	1	17%	6
An Associate Degree in Land Surveying			4	67%	2	33%	6
A Bachelor's degree in a field related to Land Surveying	3	50%	2	33%	1	17%	6
A Master's degree in a field related to Land Surveying	1	20%	2	40%	2	40%	5

4.11. Finally, almost all (five out of six) of these job and career oriented students had already determined the steps needed to obtain a Civil Engineering license but only half understood the steps needed to obtain a Land Surveyor license. Nevertheless, five out of six did understand at the beginning of the class that one simultaneously can be both a licensed Land Surveyor and a licensed Civil Engineer.

Table 18. Pre-test Survey, College Student Knowledge of Land Survey and Civil Engineering Licensure

At this time do you understand the steps needed to:	Yes		Not Sure		No		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N
Obtain a Land Surveyor license	3	50%	1	17%	2	33%	6
Obtain a Civil Engineering license	5	83%			1	17%	6
Can one be both a licensed Land Surveyor AND a licensed Civil Engineer?	5	83%	1	17%			6

Pre-Test Results for Working Adults

5.1. The 16 "Working Adults" in the class who responded to the survey were by far the oldest sub-group of the class. Although one-fourth were in the 25 to 29 year old age range, overlapping with the College students, their median age was 40. With only one woman included in the sub-group, they were less gender diverse than the college students. However they were the most diverse sub-group in terms of race/ethnicity with half self-identifying as White, one-quarter as LatinX, and 31% as Asian or Asian American, allowing for multiple identifications.

5.2. All can appropriately be referred to as "Working Adults" since all were working for pay while attending the class and 14 were employed in full-time jobs. While half (8) had current or prior experience working as an employee or paid or unpaid intern in Land Surveying or a related field, only two indicated that they were currently licensed as Land Surveyors and one as a Civil Engineer.

5.3. The Working Adults were seeking continuing education at a community college in order to increase their skill sets, keep or advance in their jobs, or qualify for different careers. The Working Adults gave the following open-ended responses to the question "Why are you taking this course at this time?" To produce Table 19 the open-ended question was crosstabulated with another question on prior Land Surveying experience. Those without prior experience in Land Surveying viewed the class as qualification for a job or position, certification in GIS (at Rio

Hondo College, a different community college near ELAC) or continuing pursuit of a STEM related degree or for reasons tangentially related to Land Surveying such as "to learn architectural and civil drafting design." The stress of Working Adults on job/career related reasons does not necessarily mean it is in Land Survey jobs. The attraction of the GE 385 class is broader than that.

Table 19. Pre-test Survey, Reasons Why Working Adults Took GE 385

	Prior Experience in Land Surveying?	
Why are you taking this course at this time?	**Yes**	**No**
Work advancement.	1	
To improve my knowledge and come up in my career.		1
For career development.	1	
For Professional Development and to gain additional skills for my current job.	1	
For continuing education in my professional field	1	
skill set update		1
Learn new software skills	1	
For experience.	1	
Learn more about and how to use the Bentley products introduced in the class.		1
Because this is only class offer Openroad and opensite		1
Availability	1	
To qualify for a job/position.		1
For GIS Certificate		1
I'm taking this course to fulfill a requirement for a certificate of achievement in GIS at Rio Hondo college		1
Have some exposure to other design programs and eventually continue to peruse a degree in Stem		j1
I would like to learn architectural and civil drafting/design.		1

5.4. To explore this topic more fully, Working Adults were asked about nine specific reasons that a person might take this course and allowed the respondents to specify an "Other" specific reason. As shown in Table 20 the most frequent response (88%) from the specific reasons is "continuing personal/professional improvement" and the second most frequent response (50%) is simply curiosity to gain skills in use of the Bentley tools. However, having such skills is a job requirement for 44% of the Working Adults, and a way to get more pay for 44%. Five each were looking for a lateral career change or a vertical career advancement, although three were trying to enter a different field. Four (about one-third) wanted to get licensed as a Land Surveyor, which would be an advancement for those already working in land surveying jobs. Two (who were perhaps already working in land surveying) wanted to do less work in the field (as people entering the land surveying profession do) and more in the office. The "other" response was from a person who views Bentley software as a complement to ArcGIS Pro, which is ESRI's latest basic computer mapping software.

Table 20. Specific Reasons Working Adults Might Have Taken GE 385

Are you taking this course for any of the following reasons (check all that apply)	Checked	Percent of 16
continuing personal/professional improvement	14	88%
curiosity to learn how to use the Bentley tools	8	50%
job requirement to have skills in using the Bentley tools	7	44%
to get more pay	7	44%
for a lateral career change	5	31%
for vertical career advancement	5	31%
to get licensed as a Land Surveyor	4	25%
to enter a different field	3	19%
to be able to get out of the field and work more in the office	2	13%
Other (Learn to use other software to compliment /sic/ ArcGIS Pro)	1	6%

5.5. Working Adults were only slightly more likely than the college students to need to hone or perfect their mathematical skills, although that could help some. All had successfully passed Algebra courses, all but one Geometry, all but two Trigonometry, and all but four (three-quarters) had passed Calculus.

5.6. Almost all of the Working Adults already had some experience with Land Surveying. As shown in the table on the next page, all but one had at least a little experience with Land Surveying and over half (55%) reported "a great deal" or "expert" level experience in it. Also, only two were not at all familiar with Autocad, while half had used it "a great deal" or indicated that they were "expert in it." About a quarter used other Autodesk suite software "a great deal" or were "expert in it." The logical deduction is that for most the educational interest was more specifically in learning the competitor Bentley software, and most saw competitive job advantages for themselves in doing that. This is a different set of motivations than the 8th to 12th grade students who were largely just exploring career possibilities, and the College students who were trying to secure internships or jobs.

5,7. However, as shown in Table 21 at the beginning of the course the knowledge and experiences of the Working Adults with Bentley software products was limited. Almost a third (31%) had heard of but not used Microstation CAD and none considered themselves expert in it although one-quarter reported having used it "a great deal." However, one-quarter were not at all familiar with Open Roads, the majority (56%) not at all familiar with Concept Station, nearly two-thirds (63%) not at all familiar with Context Capture. Over one-third (37%) were not at all familiar with other Bentley software (not taught in this course) and almost another third (31%) had heard of such software but not used it. This was a lower rate of knowledge or familiarity than with "Other Autodesk software" frequently used in Land Surveying. About 19% were not familiar at all and almost one-third (31%) knew of but had not used it and the rest were evenly split in experience in have used Other Autodesk software "a little," "a moderate amount," "a great deal," or viewed themselves as "expert in it." Like most of the other students in the class, then, other than in relation to Microstation, most of the Working Adults were starting with little or no understanding of the keystrokes needed to use Open Roads, Concept Station, or Context Capture, although many had at least a little understanding and experience with competitor Autodesk software also geared toward Land Surveyors' need for specialized software that did land surveying tasks more efficiently and effectively than could be done manually. These computer applications save labor time and so money in Land Surveying and related fields.

Table 21. Pre-test Survey. Working Adults Prior Knowledge and Use of Land Surveying and Related Software

BEFORE starting this course in September 2020, how familiar were you with the following?	Not at all Familiar		Heard of it, Haven't used or done It		Used or did it a little		Used or did it a moderate amount		Used or did it a great deal		Expert in It		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Land Surveying			1	6%	5	31%	1	6%	6	38%	3	19%	16
Microstation			5	31%	5	31%	2	13%	4	25%			16
Open Roads	4	25%	7	44%	4	25%			1	6%			16
Concept Station	9	56%	5	31%	1	6%			1	6%			16
Context Capture	10	63%	5	31%	1	6%							16
Other Bentley Software	6	38%	5	31%	2	13%	2	13%	1	6%			16
Autocad	1	6%	1	6%	2	13%	4	25%	4	25%	4	25%	16
Other Autodesk software	3	19%	5	31%	2	13%	2	13%	2	13%	2	13%	16

5.8. Perhaps because Land Surveying involves visual representation of field data in the form of drawings and maps, and because many were familiar with Autocad, all but one of the Working Adults reported having a "moderate amount" (40%) or "a lot" (53%) of experience using computer drawing programs. CAD programs are sophisticated drawing programs and Land Surveying software includes measurement, area calculation and cost estimating tools. The Bentley application demonstrations that the evaluator observed often used a point and click approach to drawing, adding features to and modifying 2-D or 3-D images, measuring lengths and areas, and some applications included tools that allowed tilting, rotating, or cross-sectional views of the images and included motion.

Table 22. Pre-test Survey. Working Adults Prior Experience Using Other Kinds of Software

Do you have any prior experience with the following:	Not at All		A little		A moderate amount		A lot		TOTAL	
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.
doing computer coding	9	56%	5	31%	1	6%	1	6%	16	100%
using computer drawing programs	1	7%			6	40%	8	53%	15	100%
using complex computer mapping (GIS) programs like ArcMAP or QGIS	5	33%	4	27%	4	. 27%	2	13%	15	100%

While one-third had no experience using complicated computer mapping software programs that provided similar 2-D or 3-D image creation and manipulation, over one-quarter (27%) of the Working Adults had "a little" experience with that type of program, and 40% had "a moderate amount" (27%) or "a lot" (13%) of experience with GIS, including a person employed as a GIS analyst. The relevance of experience with complex computer mapping programs is familiarity with an interface using multiple tools on one ribbon with different functions as well as the zooming, scale change, and panning features of GIS software that end users of computer generated maps might have experience doing. However, over half (56%) of the Working Adults stated that they had no experience doing computer coding.

5.9. Larger proportions of the much younger 8th to 12th graders and college students had experiences with computer coding than did Working Adults. However, computer coding was not generally stressed during the course so the more relevant computer experience for the Working Adults was that most had previously used computer drawing software and complex computer mapping software and Autocad or other Autodesk suite applications. This, along with their experience with Land Surveying, should have given the Working Adults an advantage to learning and mastering use of the Bentley software applications. In particular, most of the Working Adults likely understood the functionality and utility in Land Surveying tasks of Bentley software more readily than either the College students or Middle School/High School students in the class and so could concentrate on learning the terminology differences between Bentley and comparable Autodesk products and what keystrokes and tools did.

5.10 One of the goals of the ELAC NSF grant project is to increase the skills and professionalization of workers currently in the Land Surveying workforce, which many of the Working Adults are. This is also consistent with the NSF national ATE program of having more skilled workers in technology professions such as Land Surveying. It is therefore relevant to explore the professional goals or activities that the Working Adult students before the GE 385 class started. The Working Adults were asked their level of agreement with the same questions asked of Middle School/High School students and college students, but with the addition of a "not applicable" choice on the assumption that some had already achieved a specified professional status or were already engaged in an action rather than just intending to do it. The resulting responses are show in the Table 23 below. Three or four Working Adults used the "not applicable" option and one person did not answer these questions, so the total respondents to this series of questions is only 11 or 12, instead of 16, which affects the percentages.

5.11. While the most common response (42%) is the neutral "neither agree nor disagree," it is a potential positive for ELAC project goals that half of the Working Adults "strongly agree" or "agree" that they intend to obtain a Land Surveyor license. Even more (59%) "strongly agree" or "agree" that they intend to become a professional Land Surveyor.[5] However, unlike Middle School/High School students and College students, only 18% of the Working Adults "strongly agree" or "agree" that they intend to become licensed Civil Engineers. In addition, almost 40% did intend designing construction projects, which is one of many Land Surveying related activities. Also, 18% of the Working Adults "Strongly Agree" and over one-third (36%) "Agree" that they had other career plans in which Land Surveying can be a useful skill The logical conclusion is that class outreach has clearly tapped into a pool of Working Adults who are committed specifically to Land Surveying as a profession (instead of Civil Engineering or other careers), more so than it did with Middle School/High School students or College students.

[5] One of the respondents may not yet realize that to use the profession "Land Surveyor" title legally in California one has first to obtain a Land Surveyor license.

Table 23. Pre-test Survey, Working Adults Career Goals

BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements?	Strongly Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree		TOTAL	Not Applicable
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	N
One of my long-term goals is to obtain a Land Surveyor License.	2	17%	4	33%	5	42%	1	8%			12	3
I intend to become a professional Land Surveyor	2	17%	5	42%	3	25%	1	8%	1	8%	12	3
I intend to become a licensed Civil Engineer	2	18%			5	45%	3	27%	1	9%	11	4
I intend to design construction projects.	2	17%	3	25%	5	42%	1	8%	1	8%	12	3
I have other career plans in which Land Surveying can be a useful skill	2	18%	4	36%	4	36%	1	9%			11	4

5.12. Another objective of the ELAC NSF ATE grant is to provide education toward obtaining certificates, community college or baccalaureate degrees in Land Surveying or related disciplines for which Land Surveying would be a useful skill and a Land Surveying license desirable. The Working Adults as a sub-group had a much more diverse educational background than Middle School/High School students or the College students in the class. This is shown by the following statistics (the categories are not exclusive):

- 94% had a high school diploma or GED (compare 83% of the college students);
- A lower proportion of Working Adults than College students in the class had an Associate degree in a STEM field (6% compared to half) or a non-STEM field (19% compared to one-third);
- However, 31% already had earned a Bachelor's degree in a STEM field, 13% (two people) in a non-Stem field, and one had earned a more advanced degree.

These educational accomplishments could affect Working Adult student interest in seeking additional college degrees, especially since these are older adults with established career directions that might not require earning additional college degrees.

5.13. While it would be possible to crosstabulate prior educational accomplishments with future educational intentions,

the number of Working Adults in the class is too small to make more than anecdotal comments about the implications for future ELAC NSF ATE grant actions related to Working Adults. However, it is relevant to the grant to consider the future course taking and educational intentions of the Working Adults at the beginning and end of the class. The academic intentions of the Working Adults at the beginning of the class are shown in Table 24 below. Of special interest to project planning is that even when just starting the class almost half (47%) of the students were interested in additional courses in Land Surveying and about another quarter (27%) were unsure. This indicates an opportunity for offering additional appropriate ELAC courses designed to continue and strengthening the education and skills of Working Adults already in or considering the Land Survey field. None were interested in a Land Survey Internship (perhaps because they already were employed full-time or part-time) although the six (40%) who were not sure might consider that (perhaps if consistent with other career plans?). While only three (19%) were interested in a college certificate in Land Surveying, over twice as many (7 or 44%) were not sure. There is therefore a small existing market and a larger potential market for ELAC to provide continuing education courses and certificates in Land Surveying for working adults.

Table 24. Pre-test Survey, Working Adult Interest in Land Survey Courses, Certificates or Degrees

	Yes		Not Sure		No		TOTAL		No Ans.
At this time are you interested in seeking:	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Additional Courses in Land Surveying	7	47%	4	27%	4	27%	15	100%	1
An Internship (paid or unpaid) in Land Surveying			6	40%	9	60%	15	100%	1
A multi-course college certificate in Land Surveying	3	19%	7	44%	6	38%	16	100%	1
An Associate Degree in Land Surveying	2	13%	5	33%	8	53%	15	100%	1
A Bachelor's degree in a field related to Land Surveying			8	53%	7	47%	15	100%	1
A Master's degree in a field related to Land Surveying			6	40%	9	60%	15	100%	1

5.14. The Working Adults were mostly not interested in degrees in Land Surveying and the more advanced the degree, the less interest there was in seeking it. Only two Working Adults in the survey were interested in earning an Associate degree in Land Surveying and the majority (53%) were not interested. No Working Adult definitely wanted to seek a Bachelor's degree in a field related to Land Surveying although a slim majority (53%) were not sure about the prospect. At the Master's level, no one wanted to seek a degree in a field related to Land Surveying and six out of ten were not interested.

5.15. In relation to the grant project goals and national goals of the federal NSF ATE program a summary is that these Working Adults were interested in improving their Land Survey skills and willing to take community college courses to do so. However, if the Working Adults taking this course are typical, under 20% of them would be interested in a community college certificate or degree in Land Surveying, which is a focus of the national ATE program. However, the national relevance is in increasing the number of individuals skilled in Land Surveying, and to increase the overall number of professional Land Surveyors. However, since there are very few women already in the workforce doing Land Surveying, and LatinX people working in the field are in the minority, the ELAC project will likely not add many women and LatinX people skilled in Land Surveying to the workforce by marketing to existing older Working Adults, providing Land Survey courses and encouraging them to seek community college certificates or Associate degrees in Land Surveying.

Post Test (End of Class) Survey Results

Overview of the End of Class Survey and Evaluation Analysis

6.1. The first end-of-class (Post-test) survey request was e-mailed to 61 students in the class on November 24, 2020 and the first five responses came back that day. The last of four reminder messages to non-respondents (sent about three days apart) went out on December 7, 2020 and the last 14 responses came in before on December 8, 2020, the last day of class, before the survey closed at 11:59 p.m. The evaluator chatted with multiple respondents during the last class, double-checking their e-mail addresses and noting no response from them yet. The result after cleaning the data to remove some duplicate responses was 46 total usable survey responses, for a nominal response rate of around 75%. The exact response rate for the enrolled class was not determinable since there were multiple administrative and schools related difficulties in enrolling Middle School/High School age students in the community college course. That process was not completed by the end of the class sessions. One Latino (male) Middle School student only responded to the demographic questions and another Latino (male) High School student did not respond to the Middle School/High School specific questions. For these reasons, the total responses are 46 for demographic questions, 45 for other questions asked of everyone, and 44 total responses to the student type specific questions.

6.2. For the fairest evaluation of results, the pre-test (beginning of class) and post-test (end of class) survey datasets were combined using a first and last names records match in SPSS after names were associated with IP and e-mail addresses in both databases to the extent possible. Because some of the respondents only answered one of the surveys, and some names were missing in the pre-test survey due to use on the last day of that survey of a data collector that did not collect student names, it was only possible to include 39 students in the merged file who had answered most of the questions in both surveys. From an evaluation perspective the merged file potentially provides the best data to use when comparing responses from the pre-test and post-test survey results since it concerns matched responses from the same group of individual class members. However, the numbers are too small for most valid and reliable statistical analyses of differences. In addition, one student had identified as a "Working Adult" in the pre-test survey but as a "College student" in the post-test survey in the merged file, with such an individual identity shift understandable if the person had lost a job during the fall as part of the pandemic health or economic impact. The other 38 people in the merged file specified the same student type in the pre-test and post-test files. Therefore, in the end Dr. Maack decided to use the somewhat large Post-test survey dataset for the report analysis below, with some referral to the merged dataset if the analysis needed clarification.

6.3. The Post-test survey analysis starts with a review of demographics for Post-test survey respondents. Then, because of the relevance of student type (Middle School/High School, College students, and Working Adults) verified in the analysis of the pre-test survey the analysis will turn to considering results by student type, based on questions in the Post-test survey. When appropriate, there will be consideration of whether the merged file of 39 students who completed both surveys tells the same general story about the impact of the class as the analysis of the 46 end of class survey respondents, some of whom did not complete the pre-test survey. The results for the College students should be viewed as representative only of those specific individuals, since there were only four who answered the post-test survey, six who answered the pre-test survey. Note the comment above about one person switching student type from "Working Adult" in the pre-test survey (and answered the Working Adult specific questions in that survey) to "College student" type in the post-test survey (and answered the different set of "College student" questions in that survey).

Demographic Post-test Survey Results.

7.1. Allowing for the differences in number of respondents, that the sub-groups of the class are different, and looking at the percentages in the Table 25 it appears that attrition from the beginning to the end of the class affected the Middle School/High School, College Student and Working Adults mostly in the same ways. This is not a definitive conclusion since people may have had different reasons to respond or not respond to the two surveys. So reasons for dropping the class by the end of it may have cancelled out or compensated for survey response variance among the student types. Table 26 shows results from the merged dataset reminds us that one student changed status from "Working Adult" to "College Student" between the beginning and end of the class and shows the impact on the small number of the 39 cases in that sub-group. Class students in grades 8 to 12 remained in that range of grades throughout the term.

Table 25. Pre-test and Post-test Survey Respondents by Student Type

	Grades 8 to 12	College Students	Working Adults	Class Total
Pre-Test Survey Dataset Only	32 59%	6 11%	16 30%	54 100%
Post-Test Survey Dataset Only	29 63%	4 9%	13 28%	46 100%

Table 26. Matched Respondents, Merged File Pre-test and Post-test Survey Respondents by Student Type

Merged Pre-Test/Post-Test Surveys Matched Dataset	Grades 8 to 12	College Students	Working Adults	Class Total
Total Respondents in Pre-test survey	23 59%	3 8%	13 33%	39 100%
Total Respondents in Post-test survey	23 59%	4 10%	12 31%	39 100%

7.2. Table 27 on the next page underlines the current lack of women in Land Surveying at the college or workforce levels. The class population is relatively small in a statistical sense and the sub-groups of females and males even smaller as well as unevenly distributed across student types. The percentage shifts are also relatively small, and the small counts mean that a shift in response of one person can have an oversized impact on the percentages and so may simply represent idiosyncratic reasons rather than a sub-group phenomenon. Without more data and analysis it is simply not possible to tell why the number and proportion of females fell among Pre-test and Post-test survey respondents, whether it is an actual indicator of attrition of females from the class during the term, or if that occurred, whether differential attrition had anything to do with gender, the class itself, or how it was conducted.[6]

[6] Because of time and evaluation budget no further inquiries were made but some analysis was done. The gender balance among those who answered both surveys remained the same and no one in the matched file had switched genders in the two surveys. The person who identified as a Working Adult in the first survey and a College Student in the second was a male. We know some people responded to the first survey but not the second (and vice versa) but not why. There are many reasons for survey non-response that might have nothing to do with the class itself, how it was taught, or demographics.

Table 27. Shifts in Gender Distribution Between Pre-test and Post-test Survey Respondents

Student Type/ Student Gender	Grades 8 to 12	College Students	Working Adults	Class Total
Females in Pre-test Survey	16	2	1	19
	50%	33%	6%	35%
Males in Pre-test Survey	16	4	15	35
	50%	67%	94%	65%
Females in Post-test Survey	14	1	0	15
	48%	25%		33%
Males in Post-test Survey	15	3	13	31
	52%	75%	100%	67%

7.3. One of the grant goals is to attract more Hispanics (LatinX) people into Land Surveying and the class did well in that regard at all student levels. The ethnic/"race" distribution of students in the Pre-test, Post-test surveys and the matched by names merged dataset is shown in Table 28. Interpreting the table is confusing because of three factors. First, one student switched his stated identification from "Working Adult" in the Pre-test Survey to "College Student" in the Post-test survey. As a result, in the merged survey cross-tabulating the ethnicity/race variable by student type results in different counts for "Working Adults" and "College Students" depending on whether one subsets the file by the Pre-test survey or the Post-test survey variable. Second, the survey allowed for multiple "ethnicity/race" identifications. It was always LatinX people who chose multiple identity categories. However, one student in the merged file identified himself only as a "Latino" in the Pre-test survey and both "Latino and White" in the Post-test survey. Finally, a Black Latina 8th to 12th grade student responded to the second survey but not the first (so is not in the merged dataset).

7.4. The first takeaway from Table 28 is that in the post-test survey as well as the merged dataset LatinX individuals are the most frequently encountered student type in grades 8 to 12, no matter how the crosstabulation is determined. The second takeaway is that by the end of class, as at the beginning, White students were the second most numerous ethnic category, primarily because of the Working Adults. Since we saw in the Pre-test results that the Working Adults include many people already in the Land Survey field this simply underlines the importance of the ELAC project in trying to increase the number of LatinX people among skilled Land Surveyors. However the grant is not trying to do this primarily by graduating college students so much as by creating a pipeline of 8th to 12th grade students to become interested in Land Surveying through courses such as this one. Finally, Asian/Asian Americans attended the course mostly as College students and Working adult, at the end of the class as at the beginning.

Table 28. Pre-Test, Post-test Surveys and Merged Data, Ethnicity Distribution by Student Type

	Grade 8 to 12	Row Pct.	Col-lege	Row Pct.	Work-ing Adults	Row Pct.	Responses Total
White Pre-test	1	11%			8	89%	9
White Post-test	**1**	**11%**			**8**	**89%**	**9**
Merged files - pre-test student type					7	100%	7
Merged files – post-test student type	1				7	88%	8
Black Pre-test							
Black Post-test	**1**	**100%**					**1**
Merged files - pre-test student type							
Merged files – post-test student type							
LatinX Pre-test	29	78%	4	11%	4	11%	37
LatinX Post-test	**29**	**83%**	**3**	**9%**	**3**	**9%**	**35**
Merged files - pre-test student type	23	79%	2	7%	4	14%	29
Merged files – post-test student type	23	82%	2	7%	3	11%	28
Asian or Asian Amer. Pre-test	1	13%	2	25%	5	63%	8
Asian or Asian Amer. Post-test			**2**	**50%**	**2**	**50%**	**4**
Merged files - pre-test student type			2	67%	1	33%	3
Merged files – post-test student type			2	50%	2	50%	4
American Indian Pre-test	2	100%					2
American Indian Post-test	**1**	**100%**					**1**
Merged files - pre-test student type	1	100%					1
Merged files – post-test student type	1	100%					1
Total Pre-test Categories Checked	33	59%	6	11%	17	30%	56
Total Post-test Categories Checked	32	67%	4	8%	12	25%	48
Merged files - pre-test student type	24	60%	4	10%	12	30%	40
Merged files – post-test student type	25	61%	4	10%	12	29%	41

7.5. As with gender, because of the small sample sizes and data anomalies discussed in 7.3. we cannot determine for certain why more (and larger percentages of) LatinX Middle School and High School students may have stopped attending class by the end or simply did not responded to the final survey. The reasons might include the lack of familiarity of this student sub-group with Land Surveying and the difficulty of learning the Bentley software and mastering the many kinds of tools being demonstrated. However, it is a credit to the trainers and the LatinX students that the Middle and High School students

remained high at the end of the class as measured by the Post-test survey and in the merged file. This is a potentially positive accomplishment for the ELAC ATE project in its efforts to build a pipeline of LatinX students from 8th grade on until reaching College and the Workforce.

7.6. The teaching led to both older and younger students staying in the class. Because the comparison below is of two different sub-groups of the class and because we do not know the ages of those not answering the surveys or why they did not answer we cannot be certain of that. However the fact that the percentages of each sub-group of survey respondents by age are so similar suggests that the class educational process did not result in a notably negative or positive impact linked to student age.

Table 29. Pre-test and Post-test Survey Respondents by Student Type by Age Group

Survey Respondents by Student Type and Age Group	Grades 8 to 12		College		Working Adults		Respondents Total	
Age Group	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Under 15	16 52%	15 52%					16 30%	15 33%
15 to 19	15 48%	14 48%					15 28%	14 30%
20 to 24			2 33%	1 25%			2 4%	1 2%
25 to 29			4 67%	2 50%	4 25%	4 31%	8 15%	6 13%
30 to 34						1 8%		1 2%
35 to 39					4 25%	2 15%	4 8%	2 4%
40 to 54				1 25%	3 19%	2 15%	3 6%	2 4%
55 or older					5 31%	4 31%	5 31%	4 9%
TOTAL	31	29	6	4	16	13	53	45

GE 385 Online Class Learning Student Context

8.1. In this section a comparison is made of the online class contexts in which the students took the class. The circumstances in which one takes an online class may affect what is learned or the reaction to the content. How did the learning context for Middle School/High School, College and Working Adult students differ for this online only class? We explore several relevant factors to address this question.

8.2. Taking an online course requires technology and internet access just to view the software demonstrations. One can access the internet from multiple kinds of devices and use different devices to access at different times. Therefore, the survey question providing data for the first part of Table 30 allowed multiple responses on device type. As shown in Table 30, by far the greatest access to the class was through use of a laptop or desktop computers. For 8th to 12th Graders and College Students laptops were favored over desktops. However, five 8th to 12th graders, one College level and seven Working Adult students used a desktop computer at least part of the time. No one used a tablet to access the class but three 8th to 12th grade students and one of the Working Adults used cell phones at least part of the time. Trying out the software and completing the homework required having Bentley software downloaded and installed on a laptop or desktop computer and having access to that device. The Middle School/High School students were the most likely to have a laptop or desktop computer with Bentley software on it available to use only part of the time, and seven (one-quarter of the sub-group) never had such a computer available during the class. That means the one-quarter of the 8th to 12th graders could only look at the live class demonstrations and recordings of those, and almost 40% could only try out the software part of the time.

Table 30. Technology Used and Laptop/Desktop Availability During GE 385 Class Instruction

Technology Used for Online Access	8th to 12th Grades	College	Working Adults	Total
Cell Phone	3 11%		1 8%	4 9%
Laptop Computer	25 89%	4 100%	6 46%	35 78%
Desktop Computer	5 18%	1 25%	7 54%	13 29%
Laptop or Desktop Computer with Bentley Software Installed				
Available All of the Time	10 36%	3 75%	11 85%	24 53%
Available Part of the Time	11 39%	1 25%	1 8%	13 29%
Available None of the time	7 7%		1 8%	8 18%
TOTAL N	28	4	13	45

8.3. During the Covid-19 pandemic availability of laptops or desktops to access the internet has been a known problem for K-12 education. Aware of the issue, the grant Principal Investigator arranged for loans of ELAC laptops (some purchased with the NSF grant funds) to the Middle School and High School students in the class who needed them and either pre-loaded Bentley software on the laptops or helped students with downloading it. However, there were delays and problems with the laptop distribution and the result was apparently that almost half (46%) of the Middle School/High School students were left without computers some or all of the class. Therefore, over half were unable to try out Bentley software or use it to do homework assignments some or all of the time. In contrast, one-quarter of the College students (one of four) and 15% of the Working Adults (two of 13) lacked laptop/desktop access to the class some or all of

the time. Simply because of these technology issues the Middle School/High School students were most likely to be unable to take full advantage of learning resources and learning modes available during GE 385.

8.4. Another issue for any online class is having a quiet place to view the Zoom class sessions live and/or in recorded format and to do homework. This has been a special concern during the Covid-19 pandemic because of periodic lockdown or "stay at home" orders that leave entire families "sheltering in place," sometimes with young children disrupting Zoom sessions or concentration. As shown in Table 31, the Middle School/High School students were most likely to encounter such issues but the College students and Working Adults sometimes also did.

Table 31. **Availability of a Quiet Place to Watch Classes Live, Review Class Videos and Do Homework by Student Type**

Availability of a quiet place	Student Type	Always	Mostly	Seldom	Never	TOTAL
to watch the software demonstrations live	8th to 12th Grades	14 50%	11 39%	3 11%		28 100%
	College	1 25%	3 75%			4 100%
	Working Adults	5 38%	7 54%	1 8%		13 100%
	Total	20 44%	21 47%	4 9%		45 100%
to view the recordings of the software demonstrations	8th to 12th Grades	15 54%	9 32%	3 11%	1 4%	28 100%
	College	1 25%	3 75%			4 100%
	Working Adults	6 46%	5 38%	1 8%	1 8%	13 100%
	Total	22 49%	17 38%	4 9%	2 4%	45 100%
to do homework	8th to 12th Grades	12 43%	11 39%	4 14%	1 4%	28 100%
	College	1 25%	3 75%			4 100%
	Working Adults	6 46%	5 38%	1 8%	1 8%	13 100%
	Total	19 42%	19 42%	5 11%	2 4%	45 100%

8.5. Another issue with online courses concerns whether a student actually attends Zoom sessions when offered live (as this class was) or reviews it later. If a person does not attend a particular session then learning may

be less because the student cannot ask questions in real time, and as a result the student must learn the material more on his or her own. If a student doesn't view a live or recorded class about a particular type of Bentley software, then he or she misses an opportunity to learn about that software from this class. However, some of the College students and Working Adults had prior experience with some of the Bentley software or similar Autodesk suite software so might have skipped certain classes as not worth their time to watch. To get an overview of exposure to the class we asked respondents to the end of class survey to self-report class sessions that they had attended either live or by viewing the recording or both. The responses are shown in Table 21. Almost all the Working Adults and all or three of the four College students attended almost all of the sessions. The Middle School/High School student class viewing was spottier with only 71% to 89% of those students attending any specific session. On the sessions that the evaluator attended live he noted that some of the 8th to 12th grade students also would show up at class late or leave early. The least well-attended sessions concerned the Context Capture and LumenRT sessions.

Table 32. GE 385 Class Content Sessions Viewed by Student Type

Viewed the class session/demonstrations live or recorded or both ways	8th to 12th Grades	College	Working Adults	Total
Course Overview	25	3	13	41
	89%	75%	100%	91%
Microstation CAD	24	4	13	41
	86%	100%	100%	91%
LumenRT	22	3	12	37
	79%	75%	92%	82%
Context Capture	20	4	13	37
	71%	100%	100%	82%
Concept Station	23	4	13	40
	82%	100%	100%	89%
Open Roads	22	3	13	38
	79%	75%	100%	84%
Total Students	**28**	**4**	**13**	**45**

Course Reactions and Ratings Overview

9.1. Since analysis of the Pre-test (beginning of the class) survey results showed that the different types of students had rather different reasons for attending the class the reactions to and ratings of the class is organized by type of student. Because of the small number of responses in each group the analysis is not done using statistical tests of change, but quantitatively based on counts and percentages, qualitatively and logically, with reflections on the Pre-test and Post-test responses. At the end of each discussion by student type there is a review or responses to questions specifically related to the ELAC NSF ATE grant outcome and output goals.

Middle School/High School Students Course Reactions and Ratings

10.1. Because the Middle School/High School sub-group was nearly evenly split between boys and girls and because of the grant project goal of getting more females into Land Surveying this section presents break-

outs of survey question responses by gender

Table 33. 8th to 12th Grade Student Reactions to GE 385 in Relation to Starting Expectations by Gender

Did this course meet your expectations for it? Why or why not?	
Responses by 14 Girls in 8th to 12th grades	**Responses by 13 Boys in 8th to 12th grades**
Yes, it met my expectations because I learned about Microstation and Bentley software.	This course did meet my expectations because it gave me lots of information about the programs that we have available and can be used for our future.
Yes, this course helped me explore my options for my career. It was very interesting.	Yes, in general this course met my expectations because it was very helpful as the instructors showed different programs and their functions, and even showed some examples of how some designs are done.
Yes because I learned a lot of new things that I din't know were that important for engineering.	Yes this course met the expectations I had for it because it was a class were /sic/ I was greatly introduced into engineering and different programs they use for land surveying and such things.
Yes it did. I had taken a lot of previous college class but this one seemed more advanced and it was very interesting.	yes it met all my expectations. I learned new things I didn't know before.
The course did meet my expectations, it went beyond it too.	Yes. It was fun and I learned a lot about land surveying and the things that they do and use.
Yes it did meet my expectations this is more than I expected.	Yes his course met my expectations because I signed up for this class to challenge myself to learn new material.
It did meet my expectations. I learned above from what I initially thought I was going to.	Yes it met my expectations for it because I was able to learn a lot from the zoom sessions and the homework was fun.
Yes because it teached /sic/ me a lot of new things.	Yeah, it was a fun and good time.
Yes because there was /sic/ many things that I learned from this class.	Yes it was fun. I enjoyed most of the classes.
Yes this course met my expectations. I founded /sic/ this class very interesting.	Yes because I thought the class was going to be fun and interesting and it was.
Yes because I really enjoyed it.	It did meet my expectations, but I wished it fit my school schedule.
No but it seemed fun and really cool today.	
The course did not meet my expectation. I thought the class size was going to be smaller. I also thought we would of done more physical and hands on work with the program.	
I really don know. I have been having hard times with understanding the work and the rules for the work and am too shy to talk because I don't know any one from there.	

The overall response of the Middle School/High School student response about the course was favorable, based on replies of 14 (of 14) girls and 13 (of 15) boys who answered the open-ended question "Did this course meet your expectations for it? Why or why not?" The few negative responses are highlighted in Table 33. Many of these students commented about learning many new things about the Bentley software (which few were familiar with previously) but also about Engineering and Land Surveying. A few volunteered that the course exceeded their expectations, some explaining how or why. Other students commented that they found the course fun or interesting (or both), including one girl whose expectation were not met (without clarification). There were only two truly negative responses, both from girls. One girl found the class size too large and felt there was not enough hands-on work with the computer applications. The other girl had trouble understanding the content and noted that she was too shy to ask because and did not know anyone in the class.[7]

10.2. The Post-test survey included two questions that asked first students to rate their levels of understanding the functionality of the five Bentley software applications covered in the course, then to rate their ability to use that software.

Table 34. 8th to 12th Grade Student Understanding of Bentley Software Functionality by Application

How would you rate your UNDERSTANDING of the functionality of the following software:	Excellent		Good		Fair		Poor		Very Poor		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Microstation CAD	4	15%	8	30%	13	48%	2	7%			27
Females	2	15%	5	38%	5	38%	1	8%			13
Males	2	14%	3	21%	8	57%	1	7%			14
LumenRT	3	11%	7	25%	11	39%	7	25%			28
Females	2	14%	5	36%	5	36%	2	14%			14
Males	1	7%	2	14%	6	43%	5	36%			14
Context Capture	4	14%	9	32%	13	46%	2	7%			28
Females	2	14%	5	36%	6	43%	1	7%			14
Males	2	14%	4	29%	7	50%	1	7%			14
Concept Station	3	11%	8	29%	13	46%	4	14%			28
Females	2	14%	4	29%	7	50%	1	7%			14
Males	1	7%	4	29%	6	43%	3	21%			14
Open Roads	4	14%	9	32%	12	43%	3	11%			28
Females	2	14%	7	50%	4	29%	1	7%			14
Males	2	14%	2	14%	8	57%	2	14%			14

According to Pre-test survey results, most of the 8th to 12th grade students came into the class knowing little to nothing about Bentley software or Land Surveying. Among those who answered the end of the class

[7] In surveys of the 2019 "boot camp" about land surveying that over 100 teenagers from several schools attended at ELAC some students also mentioned not knowing anyone and/or getting to know others during class small group exercises, with girls mentioning relationship issues more often than boys. There did not seem to be much informal public Chat interaction among students during most Zoom classes that the evaluator attended. I don't know how much private chatting took place.

surveying the most common rating of understanding about the functionality of Bentley software applications was "Fair," with no one indicating a "Very Poor" knowledge and few indicating a "Poor" knowledge of functionality except in regard to LumenRT. More girls than boys gave an "Excellent" or "Good" rating of their understanding for every application, especially MicroStation CAD, LumenRT, and Open Roads. It is positive from the perspective of grant goals that larger proportions of girls claimed greater levels of understanding of Bentley software than did the boys. The overall ranking of "Excellent" plus "Good" ratings of understanding about the functionality the various applications was: Context Capture 46%, Open Roads 46%, Microstation CAD 45%, Concept Station 40% and LumenRT 36%.

10.3. The Middle School/High School students as a group generally rated themselves less able to use the Bentley software than to understand the functionality of the applications. To some extent this distribution is to be expected because of the problems encountered in providing laptops with Bentley software installed (see section 8.2). Without access to computers with Bentley software on it some 8th to 12th grade students could always or not ever practice keystrokes and keystroke sequences need to use these complex applications effectively and efficiently. The most common rating of ability to use the Bentley applications was "Fair" (43% to 54% of overall responses) but only one or two rated their ability to use some of the software (i.e., Microstation CAD, Context Capture or Concept Station) as "excellent." For each of the software applications one male rated his usage ability as "Very Poor." In addition, the "Poor" ratings equaled or within one or two people of the "Good" ratings for each type of software. The overall combined "Excellent" plus "Good" ratings of ability to use for this sub-group were: Microstation CAD 29%, LumenRT 29%, Concept Station 28%. Context Capture 25%, Open Roads 25%, These are at best mediocre usage learning outcomes for this sub-group of students.

Table 35. 8th to 12th Grade Student Ratings of Ability to Use Bentley Software by Application

How would you rate your ABILITY TO USE the following software:	Excellent		Good		Fair		Poor		Very Poor		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Microstation CAD	1	4%	7	25%	13	46%	6	21%	1	4%	28
Females	1	7%	3	21%	6	43%	4	29%			14
Males			4	29%	7	50%	2	14%	1	7%	14
LumenRT			8	29%	12	43%	7	25%	1	4%	28
Females			3	21%	7	50%	4	29%			14
Males			5	36%	5	36%	3	21%	1	7%	14
Context Capture	2	7%	5	18%	15	54%	5	18%	1	4%	28
Females	2	14%	1	7%	8	57%	3	21%			14
Males			4	29%	7	50%	2	14%	1	7%	14
Concept Station	2	7%	6	21%	14	50%	5	18%	1	4%	28
Females	2	14%	1	7%	8	57%	3	21%			14
Males			5	36%	6	43%	2	14%	1	7%	14
Open Roads			7	25%	15	54%	5	18%	1	4%	28
Females			3	21%	7	50%	4	29%			14
Males			4	29%	8	57%	1	7%	1	7%	14

10.4. On the positive side of learning, and good for the overall grant project goals, the majority (girls and boys

both) of the 8th to 12th grade students who responded to the end of class survey now understand the steps needed to earn a Land Surveyor license. The plurality of the total sub-group and of girls also understand the steps needed to obtain a Civil Engineering license, although the plurality of boys are not sure. Also the majority overall and of each gender are still unsure that one person could hold both licenses simultaneously. These were topics that most Middle School/High School Students were unsure about at the beginning of the class (see Section 3.11.).

Table 36. Post-test Survey, 8th to 12th Grade Student Knowledge of Land Survey & Civil Engineering Licensure

At this time (last two weeks of the class) do you understand the steps needed to:	Yes		Not Sure		No		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N
Obtain a Land Surveyor license	14	56%	8	32%	3	12%	25
Females	7	58%	4	33%	1	8%	12
Males	7	54%	4	31%	2	15%	13
Obtain a Civil Engineering license	12	46%	11	42%	3	12%	26
Females	7	54%	5	38%	1	8%	13
Males	5	39%	6	46%	2	15%	13
Can one be both a licensed Land Surveyor AND a licensed Civil Engineer?	10	38%	15	58%	1	4%	26
Females	4	31%	8	62%	1	8%	13
Males	6	46%	7	54%			13

10.5. Unfortunately for grant goals, as shown in Table 37, taking this Land Surveying software oriented course did not move many Middle School/High School students toward greater interest in Land Surveying according to most indicators. For the most part, as was also found at the beginning of the term (section 3.8), most students remain neutral – neither agreeing nor disagreeing with each expect for one of the indicators. However, depending on the indicator, by the end of the course 8% to 20% of all Middle School/High School students and 15% to 38% of the boys strongly disagreed with any of the indicator statements. In fact, the most common reaction of the boys (38%) was to "Strongly disagree" that they had a long-term goal of obtaining a Land Surveyor license or becoming a professional Land Surveyor. While that works against getting more LatinX boys into Land Surveying, at last none of the girls strongly disagreed with those statements. However, those negative percentages are higher than among the group that answered the Pre-test survey. Furthermore, after taking GE 385 no students strongly agreed with any indicator statements except for one. From the grant perspective, the major career ratings for the GE 385 course are that 36% of this sub-group of students (including over half of the boys and 17% of the girls) "Agree" that they "have other career plans in which Land Surveying can be a useful skill" and one girl "Strongly Agrees" with that statement. However, those results are no better than found among the sub-group who answered the same questions during the Pre-test. In the Pre-test responses (see Table 10), 37% "Strongly Agreed" or "Agreed" that they wanted to design construction projects and over half (54%) that they had "Other career plans in which Land Surveying can be a useful skill" and 3 boys "Strongly Agreed" with that statement. The utility of Land Surveying for multiple careers might be used as a talking point for recruiting and getting more students at this level interested in Land Surveying courses and more skilled in Land Surveying in the future. That would be consistent with the national NSF ATE program in getting more people skilled in Land Surveying into the workforce. However, the net impact of trying to learn Bentley software applications among 8th to 12th grade students with almost no education or experience in Land Surveying, who are trying to find out about careers, might be to turn more away from Land Surveying as a

career than to encourage them towards it. To determine why would need further qualitative investigation.

Table 37. Post-test Survey, 8th to 12th Grade Student Career Goals

To what extent would you agree or disagree with the following statements?	Strongly Agree		Agree		Neither Agree nor Disagree		Disagree		Strongly Disagree		Total
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
One of my long-term goals is to obtain a Land Surveyor License.			3	12%	11	44%	6	24%	5	20%	25
Females					9	75%	3	25%			12
Males			3	23%	2	15%	3	23%	5	38%	13
I intend to become a professional Land Surveyor			1	4%	11	44%	8	32.%	5	20%	25
Females					7	58%	5	42%			12
Males			1	8%	4	31%	3	23%	5	38%	13
I intend to become a licensed Civil Engineer			2	8%	12	48%	8	32%	3	12%	25
Females			1	8%	7	58%	4	33%			12
Males			1	8%	5	38%	4	31%	3	23%	13
I intend to design construction projects.			3	12%	17	68%	3	12%	2	8%	25
Females			1	8%	8	67%	3	25%			12
Males			2	15%	9	69%			2	15%	13
I have other career plans in which Land Surveying can be a useful skill	1	4%	9	36%	12	48%			3	12%	25
Females	1	8%	2	17%	9	75%					12
Males			7	54%	3	23%			3	23%	13

10.6 Finally, did the course increase Middle School/High School educational or academic certificate or degree interest in Land Surveying? Unfortunately for the grant goals GE 385 did not increase educational interest among the plurality or majority of these students, depending on the indicator, as shown in Table 38. The plurality or majority of respondents, both boys and girls, responded "not sure" on most of the indicators, as was also the case among the Pre-test group (see section 3.10 and Table 11). In fact, 23% to 42% of the entire group of teenagers flatly rejected every one of the possibilities by responding "No." Especially notable is that 62% of the boys replied "No" to taking more Land Surveying courses while in High School and 46% replied "No" to taking Land Survey courses after leaving High School or seeking either and Associate degree in Land Survey or a bachelor's degree in a field related to it. Although generally less negative than the boys, 38% of the girls replied "No" to an Associate degree and almost one-third to a College Certificate in Land Surveying. At the end of the course only one to four students (including zero to two girls) answered "Yes" on any of the additional education or academic achievement possibilities in the table below. Comparing Tables 11 and 38 with the understanding that these are different sub-groups of the

class, the direction of change on every additional indicator was from "Yes" responses toward greater percentages of "Not Sure" of "No" responses. Without further qualitative inquiry it is not clear if mote students were turned off by the course or simply gave up and dropped out or decided not to answer the final survey at all. In any case, among those who did answer the final survey toward the end of the class, 2020 GE 385 course simply did not spur much interest at all in further Land Surveying course, certificates or degrees and turned more of these students (both girls and boys) against the options listed than toward them.

Table 38. Post-test Survey, 8th to 12th Grade Student Interest in Land Survey Courses, Certificates or Degrees
"

At this time (last two weeks of GE 385) are you interested in the following:	Yes		Not Sure		No		Total
	N	Pct.	N	Pct.	N	Pct.	N
One-on-One instruction in using software tools like those taught this fall.	2	8%	18	69%	6	23%	26
Females			10	77%	3	23%	13
Males	2	15%	8	62%	3	23%	13
Additional Courses in Land Surveying before leaving high school	4	15%	12	46%	10	38%	26
Females	2	15%	9	69%	2	15%	13
Males	2	15%	3	23%	8	62%	13
Courses in Land Surveying after leaving high school	1	4%	18	69%	7	27%	26
Females			12	92%	1	8%	13
Males	1	8%	6	46%	6	46%	13
An Internship (paid or unpaid) in Land Surveying	4	15%	14	54%	8	31%	26
Females	1	8%	8	62%	4	31%	13
Males	3	23%	6	46%	4	31%	13
A college certificate in Land Surveying	4	16%	12	48%	9	36%	25
Females	1	8%	7	58%	4	33%	12
Males	3	23%	5	38%	5	38%	13
An Associate Degree in Land Surveying			15	58%	11	42%	26
Females			8	62%	5	38%	13
Males			7	54%	6	46%	13
A Bachelor's degree in a field related to Land Surveying	1	4%	15	58%	10	38%	26
Females			9	69%	4	31%	13
Males	1	8%	6	46%	6	46%	13

College Students Course Reactions and Ratings

11.1. Only four students who responded to the end of course survey identified themselves as College students and responded to the questions specific to such students. Because of the small numbers involved response distributions are idiosyncratic, presentation of percentage statistics has little informative value with one person representing 25% of sub-group responses, and statistical analyses would not meet validity and reliability criteria as representing a presumed larger population. In addition, one of the self-identified

College students in the end of class survey had identified himself as a "Working Adult" and responded to questions specific to that sub-group rather than those specific to College students in the beginning of the course survey. Comparison of pre-test and post-test survey results for this sub-group would only concern three students without a great deal of data manipulation not worth the time and effort. For these reasons, the tables in this section will not include percentages and the analysis will be limited and general.

11.2. For the record, there was one woman among the four College respondents to the post-test survey and to protect her identity and confidentiality of her responses there will be no reporting or comment in this section about differences in responses by gender. Two of the six College respondents to the Pre-test survey were women but one apparently either dropped the class or simply did not respond to the Post-test survey.[8] Two of the College students as LatinX and two as Asian or Asian-American, and none used both or categories or any other ethnicity/race categories. Again, to protect identities and response confidentiality no specific analyses of the LatinX responses will be made. The age ranges were as expected for College students from the Pre-test survey, with the addition of one slightly older student who had previously identified as a Working Adult.

11.3. Three of the four College students were working part-time and the fourth was working full-time while taking the course. None were interns or employees in Land Surveying or a related field. One of these students indicated that he or she was only a community college student, part-time but taking more than one course, with GE 385 as the only online course[9]. The other three College students were attending four-year colleges or universities as full-time students taking multiple courses, and for two of these three GE 385 was not their only online course. Data presented above in the tables in Section 8 of this report indicate that the online learning context for the College students was generally quite good and that the majority (three or four) of the students attended each class session. These appear to be primarily serious students concerned about gaining skills for their futures as in the workforce and they appear to have taken the course seriously as an opportunity to learn useful skills.

11.4. As shown by the open-ended comments in the Table 39, three-quarters of the College students felt that they had in fact learned useful information during the class. All but one suggested that the course had lived up to or exceeded its advance billing as to what a College student could learn. One College Student commented that availability of recorded Zoom class sessions for viewing later was viewed as a plus for review of the class content. One student criticized the GE 385 in that the class for including more than just College students. This student also had expected to learn and practice the keystrokes for the Bentley software applications through hands-on homework ("actually get a feel for the software") rather than simply observe

[8] The post-test survey data was cleaned through manual IP address matching in order to add missing names to the survey before doing a match with the Pre-test survey by first and last name, and the reverse process was used with Pre-test survey data. Every individual who responded to the Post-Test survey was identified by name using the IP address cross-check except for four whose e-mail addresses were known but whose nae couple not be determine. Using e-mail addresses and name matches that Dr. Maack had done from Zoom session names compared to e-mail addresses,,Dr. Gallegos was able to identify two as Middle School/High School students and two as Working Adults, one of whom had responded to the post-test survey twice and had one response removed as a result. This meant that all four College students in the Post-test survey were identified by name and name matches made with Pre-test survey results. Of the six people without name identification left in the Pre-test survey without names after cleaning that dataset, one was a College student, but he identified himself as a male Latino, so provided no additional information clarifying why on female College student did not respond to the Post-test survey.

[9] ELAC and all other Los Angeles Community College District community colleges only offered online courses in Fall 2020 but other nearby community colleges such as Pasadena City College or Rio Hondo College might have been offering some in-person classs.

demonstrations of the software capabilities and get an overview of the functionality of what each application could do.

Table 39. Open-ended College Student Reactions to GE 385 in Relation to Starting Expectations

In general did this course meet your expectations for it? Why or why not? (College Students)
Yes it did. I learned how to be more proficient in various software programs that involve engineering related work. The quality of work from the presenters exceeded my expectations for the course. To be able to go back and rewatch the lectures is a valuable tool for my future success.
The course id meet expectations. It gave students quick overviews of all the software covered.
yes. I learned a lot of things I wanted to learn.
No. I thought this was going to be a class of only college students where we would be assigned weekly labs to actually get a feel for the software.

11.5. The pre-class survey results for these four College students indicated that all had a little to a lot of experience doing Land Surveying. All had used Autocad software at least a little and two had used other Autodesk suite software at least a little. However, only two had used Microstation CAD and one Open Roads previously (a moderate amount). Furthermore, only one had previously used and two had not even heard of /Concept Station or Context Capture and only one had used other Bentley software. The College students had an important learning advantage over the 8th to 12th grade students through their knowledge of Land Surveying and competitor land surveying software, but only a slight advantage in knowing about or using any Bentley applications in particular.

11.6 There are too few College students in the class (four) to do more than show their distribution across the five point Likert scales measuring their responses to the specific Bentley application teaching and learning and making some general comments. Similarly, detailed comments or quantitative measurement of Pre-test familiarity/use and Post-test ratings be more than anecdotally informative. Therefore we only present the count distributions in the two tables on the next page and make general observations in 11.7 below.

11.7. By the end of the class the College students as a group rated their understanding of the functionality of each of the Bentley applications better than their rating of their ability to use the applications. The ratings of understanding of functionality were always in the "Fair" to "Excellent" range with one person rating understanding of functionality of Context Capture "Poor" and two rating understanding of the functionality of LumenRT "Poor." At least one person gave an "Excellent" rating to his or her understanding of functionality of each of the applications, and two did so for Microstation CAD and Open Roads. In contrast the ratings of ability to use the Bentley applications were generally in the "Good" to "Poor" range with three of the four College students rating their ability to use LumenRT "Poor" and two providing that rating for their ability to sue Context Capture and Concept Station. Only ability to use Microstation CAD escaped "Poor" ratings and three people rated their ability to use it as "Good." That is not too surprising because all four College students had at least some experience with the similar functionality of Autocad, its direct competitor in functionality, so mostly would have to learn terminology and keystroke differences and nuances of Microstation CAD capabilities. The only two Bentley applications that had any "Excellent" ratings in College student ability to use them at the end of the course were for Concept Station and Open Roads (one such rating each).

Table 40. College Student Understanding of Bentley Software Functionality by Application

How would you rate your UNDERSTANDING of the functionality of the following software?	Excellent	Good	Fair	Poor	Very Poor	TOTAL
	N	N	N	N	N	N
Microstation CAD	2	1	1			4
LumenRT	1		1	2		4
Context Capture	1	1	1	1		4
Concept Station	1	1	2			4
Open Road	2	1	1			4

Table 41. College Student Ratings of Ability to Use Bentley Software by Application

How would you rate your ABILITY TO USE the following software?	Excellent	Good	Fair	Poor	Very Poor	TOTAL
	N	N	N	N	N	N
Microstation CAD		3	1			4
LumenRT		1		3		4
Context Capture		1	1	2		4
Concept Station	1	1		2		4
Open Roads	1	1	1	1		4

11.8 GE 385 was not successful in motivating most of these College students by the end of the class to obtain a Land Surveyor license or to become professional Land Surveyors, as shown in Tables 42 and 43 on the next. Toward the end of the course only one College student both intended to obtain a Land Survey license and become a professional Land Surveyor and had no other career plans in which Land Surveying would be a useful skill. Three of the four College students disagreed or strongly disagreed that they intended to obtain a Land Survey license and become professional Land Surveyors. Those students intended to become licensed Civil Engineers and all three either strongly agreed or agreed that they had "other career plans in which Land Surveying can be a useful skill." All four understood that one could be both a licensed Civil Engineer and a licensed Land Surveyor. All four of the College students strongly agree that they intend to design construction projects. The three potential future Civil Engineers reported that they knew the steps needed to obtain both kinds of licenses so may have decided it was not worth their time and effort to be dual licensed. The potential Land Surveyor, though, that he or she did not know the steps needed to obtain either license. REAP Change is not sure whether, when or how much the steps needed to obtain a Land Surveying license was covered in GE 385. These findings are remarkably similar to what one found for a different Sub-group of College students in the Pre-test survey. While the course did provide College students with survey related computer application knowledge it is questionable whether it changed anyone's minds in relation to the ELAC NSF ATE grant goals.

Table 42. Post-test Survey, College Student Career Goals

At this time (toward the end of the course) to what extent would you agree or disagree with the following statements?	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	TOTAL
	N	N	N	N	N	N
One of my long-term goals is to obtain a Land Surveyor License.	1			2	1	4
I intend to become a professional Land Surveyor	1			2	1	4
I intend to become a licensed Civil Engineer	3			1		4
I intend to design construction projects.	4					4
I have other career plans in which Land Surveying can be a useful skill	2	1			1	4

Table 43. Post-test Survey, College Student Knowledge of Land Survey & Civil Engineering Licensure

At this time do you understand the steps needed to:	Yes	Not Sure	No	TOTAL
	N	N	N	N
Obtain a Land Surveyor license	3		1	4
Obtain a Civil Engineering license	3		1	4
Can one be both a licensed Land Surveyor AND a licensed Civil Engineer?	4			4

Table 44. Post-test Survey, College Student Interest in Land Survey Courses, Certificates or Degrees

At this time (end of the course) are you interested in seeking:	Yes	Not Sure	No
	N	N	N
A college certificate in Land Surveying	1	2	1
An Internship (paid or unpaid) in Land Surveying	1	2	1
An Associate Degree in Land Surveying		3	1
A Bachelor's degree in a field related to Land Surveying	2		2
A Master's Degree in a field related to Land Surveying	1	1	2
A PhD in a field related to Land Surveying	1	1	2

11.9. Analysis of the Pre-test survey data showed that all College Students had graduated from high school and none had yet earned a Bachelors. It is therefore perhaps not surprising that the GE 385 class did little to encourage the College students to seek community college degrees or certificates in Land Surveying, as

shown in Table 44. Only one of the students (a potential future Civil Engineer) was interested in a college certificate and all four of the College students were either unsure about or did not want an Associate degree in Land Surveying. The person who indicated an intent to become a professional Land Surveyor and obtain a Land Surveying license was not sure about obtaining a college certificate or Associate degree in the field and was not interested in seeking any higher degree listed.[10] The two College students interested in seeking "a Bachelor's degree in a field related to Land Surveying" intended to become Civil Engineers. The question might have been poorly worded since they might have been thinking about "Civil Engineering" as "a field related to Land Surveying" such as a B.S. in Civil Engineering, Geospatial Engineering specialty offered at Cal Poly rather than a rather than a Bachelors in Land Surveying. Only one of the College students interested in becoming a Civil Engineer was interested in any of the higher academic level degrees in "a field related to Land Surveying."

11.10 This NSF ATE grant project in Geospatial Engineering and Technology (GSET) includes not only the academic program (courses, certificates, and Associate degree) in Land Surveying at East Los Angeles College, but also several other related academic programs at four-year universities, the most closely affiliated of which is Cal Poly. The project co-PI, Dr. Mora, heads the Civil Engineering, Geospatial Engineering specialty degree program at Cal Poly and is arranging articulation agreements with his university and several others so that ELAC community college students can transfer Land Survey credits to other universities with related baccalaureate (or higher) degree programs.

11.11 None of the students in GE 385 who responded to the survey identified themselves as ELAC students in the Pre-test survey. The Post-test survey asked the College students (as well as the Working Adults) in the class to indicate if they were potentially interested in taking additional continuing education (non-degree) courses at ELAC, four-year universities affiliated with the NSF ATE project or any other university. The survey allowed multiple responses and the distribution of responses is shown in Table 45. There was more interest expressed by these four College students in additional online courses in fields related to Land Surveying at ELAC or any of the four-year universities than in in-person classes (specified in the survey as "after the pandemic"). The only interest in in person classes was for those held at ELAC or at Cal Poly, Pomona. Due to the small number of College students not much should be concluded from this distribution.

Table 45. College Student Interest in Continuing Education (Non-degree) Land Survey Related Courses

Would you be interested in taking additional continuing education (non-degree) courses in fields related to Land Surveying at (check all that apply)	In person	Online	Not Sure	No
East Los Angeles College	2	3		1
California State Polytechnic University, Pomona	2	2		1
California State University, Fresno		1		1
Oregon Institute of Technology		1		1
Another university		2		1

[10] In order to be licensed in Land Surveying or become a professional Land Surveyor the steps needed include obtaining knowledge in the field through academic courses or practical experience doing it, but not a certificate or degree of any sort in Land Surveying or a closely related degree.

Working Adults Course Reactions and Ratings

12.1 Thirteen students identified themselves as Working Adults in the Post-test survey. There had been 16 Working Adults who responded to the Pre-test survey, of whom one classified himself as a "College Student" in the Pre-test survey and 12 responded to both surveys as Working Adults. There is no further information available as to whether two Working Adults dropped out by the end of the class or simply did not respond to the Post-test survey, or why one Working Adult responded to the Post-test but not the Pre-test survey.

12.2. This section of the report only considers the responses of the 13 Working Adults in the Post-test survey, rather than the 12 who answered both surveys. As shown in the tables in sections 7.2. and 7.4. above, all 13 of the Working Adults are males. The lone female Working Adult who answered the Pre-test survey did not answer the Post-test survey. The 13 include eight Whites (62%), three LatinX (23%) and two Asian/Asian Americans (15%). The numbers are too small for analysis of breakout results for LatinX respondents to be very informative. The age distribution of the Working Adults who answered the Post-test resembled that of the Pre-test respondents.

12.3. The end of the course survey provided additional context regarding the work and experience of the 13 Working Adults. All but one worked full-time while attending the class, and one was working part-time. Seven or over half (52%) had any current or prior part-time or full-time paid experience as an employee or as an intern (paid or unpaid) working in Land Surveying or a related field. Their current job titles were:

Table 46. Job Titles of Working Adults by Current or Prior Land Surveying Related Experience

	Current or Prior Land Surveying Related Experience?	
Title	Yes	No
Design Technology Manager	1	
Project Manager	1	
Survey Project Manager	1	
Survey Party Chief II. Professional Land Surveyor	1	
Survey Party Chief	2	
Surveyor	1	
Department supervisor		1
Project Designer		1
Design Engineer		1
QC		1
Technician		1
Viticulture technician		1

12.4. All the Working Adults commented that GE 385 met their expectations. One thought it was "excellent," and another that it provided "a solid introductory demonstration" and another noted that it was a "general overview." Three mentioned Microstation CAD and/or other Bentley products. One was equivocal, appreciating the introduction to the software but had expected more hand-on work with it. The other expected a "more detailed" course and felt it was too basic, geared too much toward future Civil Engineering or Land Survey students rather than working professionals.

Table 47. Open-ended Working Adults Reactions to GE 385 in Relation to Starting Expectations

In general did this course meet your expectations for it? Why or why not? (Working Adults)
This course was excellent, it surpassed my expectations as I was able to learn about programs that related to my career interest.
Yes. I expected to learn about new software that could potentially be useful in my career, and I did.
Yes. It was a great general overview of multiple geospatial programs.
Yes, the class served as a solid introductory demonstration of the desired software.
Gave me exposure to different software..
Yes because it taught me some of the basics of Microstation and other Bentley products
Yes. I did learn the Microstation and learn those new software too
Yes, intro to micro station and open roads and context capture
Yes
Yes
yes and no Being introduced to the software was great but I had some more hands-on user expectations
Yes, but it could have been more detailed. I did not realize that the content of the class would be so basic and catered toward future CE or LS students. As a working professional I enrolled for more vocational-type training to improve my skills using specific software

12.5 As was also true of the other sub-groups of students, by the end of the class the Working Adults rated their understanding of the specific Bentley software applications higher than their ability to use them. Likely because of their professional backgrounds, working experience and interest in career advancement the Working Adults had by far the highest self-ratings of understanding of the software of all the sub-groups. The numbers were too small and the ratings too skewed to provide statistically valid or reliable measurement of differences based on prior experience doing Land Surveying even after collapsing ratings from five to three categories. The rating range for understanding was always "Fair" to "Excellent" except that none rated themselves as "Excellent" in understanding LumenRT and one person rated himself "Poor." The most common rating about understanding was "Good" (77% to 92% (except 62% for LumenRT). All the Working Adults used the top two ratings for their understanding of Microstation CAD and for Open Roads and 93% did so for Concept Capture and Concept Station. These are remarkably high teaching and learning ratings for understanding functionality.

Table 48. Working Adults Understanding of Bentley Software Functionality by Application

How would you (Working Adults) rate your UNDERSTANDING of the functionality of the following software presented in the course:	Excellent		Good		Fair		Poor		Very Poor		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Microstation CAD	3	23%	10	77%							13
LumenRT			8	62%	4	31%	1	8%			13
Context Capture	1	8%	11	85%	1	8%					13
Concept Station	1	8%	11	85%	1	8%					13
Open Roads	1	8%	12	92%							13

12.6. However, Working Adults, as other sub-groups did, rated their abilities to use the various Bentley software applications lower than their ability to understand functionality. All these students had laptops or desktops to use and the Bentley software was made available for free to all students in the class for download and use so that does not explain the lower ratings. There were no interviews or focus groups with the students to provide qualitative insights but the mention of lack of hand-on instruction during the class or the nature of the homework or simply lack of time to practice the keystrokes needed to use the tools effectively and efficiently might be reasons. The numbers were too small and the ratings too skewed to provide statistically valid or reliable measurement of differences based on prior experience doing Land Surveying even after collapsing ratings from five to three categories. The most used rating was "Good" ability to use specific software applications (46% to 62%) and the second most frequent response was "Fair" (31% to 38%). While 23% rated their ability to use Microstation CAD as "Excellent," 15% did so for Context Capture and 8% did so for Concept Station, no one used that rating for Open Roads or LumenRT (and 15% rated themselves "Poor" in using LumenRT). The combined "Excellent" and "Good" ability to use ratings for the five software applications are Microstation CAD 69%, Concept Station 70%, Open Roads 69%, Context Capture 61%, and LumenRT 46%.

Table 49. Working Adults Ratings of Ability to Use Bentley Software by Application

How would you (Working Adults) rate your ABILITY TO USE the following software:	Excellent		Good		Fair		Poor		Very Poor		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
Microstation CAD	3	23%	6	46%	4	31%					13
LumenRT			6	46%	5	38%	2	15%			13
Context Capture	2	15%	6	46%	5	38%					13
Concept Station	1	8%	8	62%	4	31%					13
Open Roads			9	69%	4	31%					13

12.7. Of all the sub-groups this was the one most likely to have their current career directions confirmed by GE 385 or be encouraged to seek licensure in Land Surveying or becoming a Professional Land Surveyor. As discussed in section 12.3., seven of the Working Adults had current or prior experience in Land Surveying and their current job titles support that, but the job title of only one of those seven one indicated that he had already achieved professional Land Surveyor status (and the other Survey Party Chief highly likely had a

Land Survey license but had not completed some other requirements that would let him legally use the Land Surveyor title. These observations, along with the information that the Working Adults were taking the class for career or job advancement, or to meet a job requirement, or personal professional development or continuing education provide context for the following table. Note that three of the 13 Working Adults intend to become licensed Civil Engineers, compared to six intending to obtain Land Surveyor licenses and become professional Land Surveyors. The numbers were too small and the ratings too skewed to provide statistically valid or reliable measurement of differences based on prior experience doing Land Surveying even after collapsing ratings from five to three categories.

Table 50. Post-test Survey, Working Adults Career Goals

to what extent would you (Working Adults) agree or disagree with the following statements?	Strongly Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N	Pct.	N
One of my long-term goals is to obtain a Land Surveyor License.	6	46%			5	38%	1	8%	1	8%	13
I intend to become a professional Land Surveyor	6	46%			5	38%	1	8%	1	8%	13
I intend to become a licensed Civil Engineer	1	9%	2	18%	4	36%	3	27%	1	9%	11

12.8. As shown in Table 51 below, toward the end of the GE 385 were not particularly a good market for future ELAC certificates or Associates degrees in Land surveying or higher formal degrees in fields related to Land Surveying. However, two were interested in seeking a doctoral degree in a related field compared to one for lower level academic degrees. While over half (56%) replied "No" regarding lower academic level certificates or degrees in Land Surveying, nearly half were "Not Sure" (so might potentially be convinced?).

Table 51. Post-test Survey, Working Adults Interest in Land Survey Courses, Certificates or Degrees

At this time (toward the end of the class) are you (Working Adults) interested in seeking:	Yes		Not Sure		No		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N
A college certificate in Land Surveying	1	8%	5	38%	7	54%	13
An Associate Degree in Land Surveying	1	8%	5	38%	7	54%	13
A Bachelor's degree in a field related to Land Surveying	1	8%	5	38%	7	54%	13
A Master's degree in a field related to Land Surveying	2	15%	5	38%	6	46%	13

12.9. We turn to the matter of coursework in Land Surveying that does not lead to a certificate or degree. The question response choices for the Working Adults were more general than those asked of College students, as shown in the table below, but cover the same selection of colleges and universities. There is interest in further from the Working Adults in continuing education courses related to Land Surveying at the ATE grant partners ELAC and Cal Poly, Pomona although further inquiry would be needed to determine whether online or in-person courses might attract more Working Adult students. There is also interest in online continuing education courses related to Land Surveying at other universities including those that are grant partners and even more interest about online courses in Land Surveying offered at other universities. The

latter might be universities widely known in the Land Surveying community, perhaps as far away as New York or Pennsylvania, or indeed anywhere in the world.

Table 52. Working Adults Interest in Continuing Education (Non-degree) Land Survey Related Courses

Would you be interested in taking additional continuing education courses in fields related to Land Surveying at (check all that apply)	Yes (Checked)	Pct. of 13
East Los Angeles College (online or in person)	10	77%
California State University, Pomona (online or in person)	8	62%
California State Polytechnic University, Fresno (online or in person)	5	38%
Oregon Institute of Technology (online)	4	31%
Another university (online)	7	54%

12.10. The final three questions asked of the Working Adults concerned personal and employer factors that are relevant to consideration of future classes in Bentley software applications. The questions and responses are shown below in Table 53. The most important points are that nine out of ten Working Adult respondents are interested in more training in Bentley software and over three-quarters see themselves using the software in the future. These findings suggest a potentially strong market among Working Adults for further courses in Bentley Land Survey application software.

Table 53. Working Adults Personal and Employer Factors Related to Future Classes in Bentley Software

	Yes		Don't Know		No		TOTAL
	N	Pct.	N	Pct.	N	Pct.	N
Does your company use Bentley software?	9	69%			4	31%	13
Do you see yourself ever using Bentley software in the future?	10	77%	3	23%			13
Would you be interested in more training in Bentley software?	11	92%	1	8%			12

Evaluator Conclusions and Recommendations

13.1. The GE 385 course was developed as an innovative, experimental response to the impact of the COVID-19 pandemic that seriously disrupted the ELAC NSF ATE grant project. In some respects the course worked online, thanks to the experience and skills of the teaching team. However, the experiment simply did not work in relation to the ELAC NSF ATE grant project goals or the national NSF ATE program focus on counting more certificates and degrees in Land Survey and skilled Land Surveyors in the workforce. While a course offering technical training in Bentley software use might have a place in the ELAC GSET academic offerings, if a new course is designed and approved by the ELAC administration for inclusion in the catalog more, for a better teaching/learning context, careful consideration should be given to appropriate prerequisites, backgrounds of students allowed to take the course and the appropriate place in the curricular course sequence.

13.2. Considering the entire set of evaluation findings, REAP Change recommends AGAINST offering this online course again to such a mixed educational level group of students in one class. It should not be offered again to Middle School/High School students online using NSF ATE grant funds. The teaching format and approach has little cost-benefit in relation to grant goals besides serving more LatinX students and females. The Middle School/High School students were least able of any of the class sub-groups in terms of understanding the functionality of the specialized Bentley Land Surveying software applications.

13.3. If a course with similar content and focus is offered again to K-12 students using non-grant funds it might be more effective as an in-person course with technical help available for managing the software, understanding functions of the many tools, and using keystrokes efficiently and effectively. Bentley provides complicated professional Land Surveying software designed to perform complicated or complex Land surveying tasks efficiently and effectively through automation. The functionality of the software and its many tools are easiest understood by someone who has some knowledge of Land Surveying, its tasks, workflows, and technical concerns. The software also performs complex mathematical calculations and spatial drawing automatically. While many were familiar with computers in general and computer drawing programs, some of the K=12 students who took GE 385 lacked even knowledge of geometry and almost all did not know about Land Surveying as a discipline and profession. That probably put them at a learning disadvantage from the start. If offered again to Middle School/High School students, consideration might be given to limiting the course to those who had prior learning or experience with at least geometry (and possibly trigonometry) and some knowledge or experience with Land Surveying field work or activities. Because of age, maturity, biological development changes and other differences, K-12 students (and teachers) typically view Middle School and High School as two separate social realms requiring different teaching approaches. For that reason (and without specific evaluation evidence) REAP Change recommends not mixing Middle School and High School students in the same class. Finally, judging from variations in self-ratings of understanding and usage gains for the different software applications, it might be appropriate to cover fewer Bentley software modules in one semester for students this young. LumenRT might be dropped?

13.4 1based on the evaluation results, REAP Change recommends that the co-PIs consider using ELAC or other funds to offer a technical course in Bentley software online again to a combined class of College students and Working Adults. However, the cost-benefit in relation to NSF ATE national and local grant goals is not there to justify using NSF ATE grant funds again to offer this kind of course to College students or Working Adults. If offered again, the course might include more hand-on training and Bentley application use, with more complex and sophisticated homework problems. Fewer Bentley software applications might be taught in one term, with LumenRT being the most likely candidate to drop. Course output and outcome goals might relate more to skills development in Bentley software rather than a larger number of people seeking more certificates or degrees in Land Surveying. If offered online again, the grant co-PIs also might consider marketing the course more strongly not only to local students seeking Land Surveying, Civil Engineering, Architecture, construction design or GIS degrees but also to Working Adults, regionally, statewide, nationally (or worldwide?) as well as locally. Course marketing might stress the utility of Land Surveying knowledge and skills development in a variety of professions and jobs (and the developing shortage of people with skills in Land Surveying as the workforce ages into retirement years).

ELAC GE 385 Beginning of Course Survey 2020

Introduction

Thank you for taking the GE 385 course this fall.

The course was partially funded by a National Science Foundation (NSF) grant awarded to ELAC in order to increase the number of licensed professional land surveyors. The grant is being evaluated and this survey is part of that evaluation. Your participation in this survey is voluntary but needed to do a good evaluation. The evaluation will include this survey at the beginning of the course and a follow-up survey at the end of the course. If you have questions or concerns about the survey or its uses please contact Stephen Maack, Owner and Lead Consultant, REAP Change Consultants as consultant@reapchange.com. Thank you for your help.

ELAC GE 385 Beginning of Course Survey 2020

Permission Request

You may refuse to take the survey at all, stop taking it part way through, or not answer specific questions. Your individual responses will not be shared with the instructors. They will only receive a summary report and analysis of aggregated class responses. All that we ask is that you respond in the survey as honestly, frankly, and completely as possible.

* 1. I have read the Introduction, permission request, and survey taking options and voluntarily agree to take this survey

- Yes (Selecting this response will take you to the rest of the survey)
- No (Selecting this response will take you to the end of the survey)

ELAC GE 385 Beginning of Course Survey 2020

Demographics for Analysis

* 2. What is your gender?

- Female
- Male
- Other
- Prefer not to answer

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

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

* 4. How old are you today (please select your age range from the pull-down menu)

5. Have you already completed (please respond to each row. "STEM" stands for Science, Technology, Engineering, or Mathematics):

	Yes	No
A high school diploma or GED	○	○
An Associate degree in a STEM field	○	○
An Associate degree in a non-STEM field	○	○
A bachelor's degree in a STEM field	○	○
A bachelor's degree in a non-STEM field	○	○
A degree higher than a bachelor's degree	○	○

ELAC GE 385 Beginning of Course Survey 2020

Pre-Course Questions

6. Why are you taking this course at this time?

7. BEFORE starting this course in September, 2020, how familiar were you with the following:

	Not at all familiar	Heard of it, haven't used it or done it	Used or did it a little	Used or did it a moderate amount	Used or did it a great deal	Expert in it
land surveying	○	○	○	○	○	○
Microstation	○	○	○	○	○	○
Open Roads	○	○	○	○	○	○
Concept Station	○	○	○	○	○	○
Context Capture	○	○	○	○	○	○
Other Bentley software	○	○	○	○	○	○
Autocad	○	○	○	○	○	○
Other Autodesk software	○	○	○	○	○	○

Other (please specify)

ELAC GE 385 Beginning of Course Survey 2020

Routing Question Page

Your answer on this page will route you to questions appropriate to your status and skip you over inappropriate or irrelevant questions for your situation.

* 8. By taking this course everyone is an East Los Angeles College student, but that may not be how you primarily view yourself at this time. Which of the following choices BEST describes how your view your current status? (Choose one.)

- ○ A middle school or high school student taking a community college course
- ○ A full-time or part-time ELAC student
- ○ A full-time or part-time student at another higher education institute taking an ELAC course
- ○ A working adult (even if currently unemployed or only working part-time) taking a community college course

ELAC GE 385 Beginning of Course Survey 2020

Middle School and High School Student Questions

The following questions ONLY apply to Middle School or High School students. If that is not the BEST description of your current status, scroll down to the bottom of this page without answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

* 9. What grade are you in this fall?

- 6th grade
- 7th grade
- 8th grade
- 9th grade
- 10th grade
- 11th grade
- 12th grade

10. What mathematics courses have you successfully passed to date? (Please respond to each row)

	Yes	No	Not Available
Arithmetic (add, subtract, multiple, divide)			
Pre-Algebra			
Algebra			
Geometry			
Trigonometry			
Calculus			

11. BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
One of my long-term goals is to obtain a Land Surveyor license					
I intend to become a professional Land Surveyor					
I intend to become a licensed Civil Engineer					
I intend to design construction projects					
I have other career plans in which Land Surveying can be a useful skill					

12. At this time are you interested in seeking

	Yes	Not Sure	No
Additional courses in Land Surveying	○	○	○
An internship (paid or unpaid) in Land Surveying?	○	○	○
A multi-course college certificate in Land Surveying	○	○	○
An Associate degree in land surveying	○	○	○
A Bachelor's degree in a field related to Land Surveying	○	○	○
A Master's degree in a field related to Land Surveying	○	○	○

13. At this time do you understand the steps needed to:

	Yes	Not Sure	No
Obtain a Land Surveyor license	○	○	○
Obtain a Civil Engineering license	○	○	○

14. Can one be both a licensed Land Surveyor AND

	Yes	Not Sure	No
a licensed Civil Engineer	○	○	○

15. Do you have any prior experience with the following:

	Not at all	A little	A moderate amount	A lot	Not sure
	○	○	○	○	○
using computer drawing programs	○	○	○	○	○
using complex computer mapping (GIS) programs like ArcMAP or QGIS		○	○	○	○

ELAC and Other College Students

This page should only be completed by people who identified themselves as a full-time or part-time community college or other college/university student, whether or not they are also working. If that is not the BEST description of your current status, scroll down to the bottom of this page without answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

16. What mathematics courses have you successfully passed to date? (Please respond to each row)

	Yes	No	Not Available
Pre-Algebra	○	○	○
Algebra	○	○	○
Geometry	○	○	○
Trigonometry	○	○	○
Calculus	○	○	○

17. Are you currently working for pay in any job while going to college?

- ○ Yes, part-time
- ○ Yes, full-time
- ○ No

18. Do you have any current or prior part-time or full-time experience as an intern (paid or unpaid) or an employee working for pay in Land Surveying or a related field?

- ○ Yes
- ○ No

19. BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
One of my long-term goals is to obtain a Land Surveyor license					
I intend to become a professional Land Surveyor					
I intend to become a licensed Civil Engineer					
I intend to design construction projects					
I have other career plans in which Land Surveying can be a useful skill					

20. At this time are you interested in seeking

	Yes	Not Sure	No
Additional courses in Land Surveying			
A multi-course college certificate in Land Surveying			
An internship (paid or unpaid) in Land Surveying?			
An Associate degree in land surveying			
A Bachelor's degree in a field related to Land Surveying			
A Master's degree in a field related to Land Surveying			

21. At this time do you understand the steps needed to:

	Yes	Not Sure	No
Obtain a Land Surveyor license			
Obtain a Civil Engineering license			

22. Can one be both a licensed Land Surveyor AND

	Yes	Not Sure	No
a licensed Civil Engineer	○	○	○

23. Do you have any prior experience with the following:

	Not at all	A little	A moderate amount	A lot	Not sure
doing computer coding	○	○	○	○	○
using computer drawing programs	○	○	○	○	○
using complex computer mapping (GIS) programs like ArcMAP or QGIS	○	○	○	○	○

ELAC GE 385 Beginning of Course Survey 2020

Working or Unemployed Adults

The questions on this page are intended for people who primarily consider themselves to be working adults (even if currently only working part-time or unemployed), rather than as students. If that is not the BEST description of your current status, scroll down to the bottom of this page without answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

24. Do you have any current or prior part-time or full-time experience as an employee working for pay or as an intern (paid or unpaid) in Land Surveying or a related field?

- ○ Yes
- ○ No

25. Are you currently working for pay in any job?

- ○ Yes, part-time
- ○ Yes, full-time
- ○ No

26. Are you currently licensed in California as

	Yes	No
a Land Surveyor	○	○
a Civil Engineer	○	○
an Architect	○	○
a Construction Engineer	○	○

27. Have you learned the following kinds of mathematics through courses, workshops, self-study, or in other ways before starting GE 385? (Please respond to each row)

	Yes	No
Algebra	○	○
Geometry	○	○
Trigonometry	○	○
Calculus	○	○

28. BEFORE starting this course in September 2020, to what extent would you agree or disagree with the following statements? If you are already licensed or have already achieved the designated status please check "Not Applicable".

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Not Applicable
One of my long-term goals is to obtain a Land Surveyor license	○	○	○	○	○	○
I intend to become a professional Land Surveyor	○	○	○	○	○	○
I intend to become a licensed Civil Engineer	○	○	○	○	○	○
I intend to design construction projects	○	○	○	○	○	○
I have other career plans in which Land Surveying can be a useful skill	○	○	○	○	○	○

29. Are you taking this course for any of the following reasons (check all that apply)

- ☐ continuing personal/professional improvement
- ☐ curiosity to learn how to use the Bentley tools
- ☐ to be able to get out of the field and work more in the office
- ☐ job requirement to have skills in using the Bentley tools
- ☐ to get more pay
- ☐ for a lateral career change
- ☐ for vertical career advancement
- ☐ to get licensed as a Land Surveyor
- ☐ to enter a different field
- ☐ Other (please specify)

30. At this time are you interested in seeking

	Yes	Not Sure	No
Additional courses in Land Surveying			
An internship (paid or unpaid) in Land Surveying?			
A multi-course college certificate in Land Surveying			
An Associate degree in land surveying			
A Bachelor's degree in a field related to Land Surveying			
A Master's degree in a field related to Land Surveying			

31. Do you have any prior experience with the following:

	Not at all	A little	A moderate amount	A lot	Not sure
doing computer coding					
using computer drawing programs					
using complex computer mapping (GIS) programs like ArcMAP or QGIS					

ELAC GE 385 Beginning of Course Survey 2020

End of Survey

Thank you for your responses!! Click "Done" to exit this page.

ELAC GE 385 End of Course Survey 2020

Introduction

Thank you for taking the GE 385 course this fall.

The course was partially funded by a National Science Foundation (NSF) grant awarded to East Los Angeles College (ELAC) in order to increase the number of licensed professional land surveyors. The grant is being evaluated and this survey is part of that evaluation. Your participation in this survey is voluntary but needed to do a good evaluation. The evaluation will include analysis of this student survey taken at the end of the course. If you have questions or concerns about the survey or its uses please contact Stephen Maack, Owner and Lead Consultant, REAP Change Consultants as consultant@reapchange.com.

You may refuse to take the survey at all, stop taking it part way through, or not answer specific questions. Your individual responses will not be shared with the instructors. They will only receive a summary report and analysis of aggregated class responses. All that we ask is that you respond in the survey as honestly, frankly, and completely as possible. Thank you for your help.

* 1. I have read the Introduction and survey taking options and voluntarily agree to take this survey

- ◯ Yes (Selecting this response will take you to the rest of the survey)
- ◯ No (Selecting this response will take you to the end of the survey)

ELAC GE 385 End of Course Survey 2020

Demographics for Analysis

* 2. What is your gender?

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

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

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

* 4. How old are you today (please select your age range from the pull-down menu)

ELAC GE 385 End of Course Survey 2020

End of Course General Questions

5. In general did this course meet your expectations for it? Why or why not?

6. How would you rate your UNDERSTANDING of the functionality of the following software presented in this course?

	Excellent	Good	Fair	Poor	Very Poor
Microstation CAD	○	○	○	○	○
LumenRT	○	○	○	○	○
Context Capture	○	○	○	○	○
Concept Station	○	○	○	○	○
Open Roads	○	○	○	○	○

7. How would you rate your ABILITY TO USE the following software at this time?

	Excellent	Good	Fair	Poor	Very Poor
Microstation (sketch to CAD)	○	○	○	○	○
LumenRT (sketch to 3D to LumenRT)	○	○	○	○	○
Context Capture (surveying and control points)	○	○	○	○	○
Concept Station (freeways and moving cars)	○	○	○	○	○
Open Roads	○	○	○	○	○

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Course Taking Context

8. What technology did you use to take this online course (check all that apply)

- ☐ Cell phone
- ☐ Tablet
- ☐ Laptop computer
- ☐ Desktop computer

9. While taking this course how often did you have a quiet place

	Always	Mostly	Seldom	Never
to watch the software demonstrations live	○	○	○	○
to view the recordings of the software demonstrations	○	○	○	○
to do your homework	○	○	○	○

10. During this course did you have access to a laptop or other computer with Bentley software installed on it?

- ○ Yes, all of the time
- ○ Yes, part of the time
- ○ No, none of the time

11. Did you view the course sessions/demonstrations (live or recorded or both ways, check all that apply)

- [ ] Course Overview (Humberto Gallegos and Tom Lazear)
- [ ] Microstation CAD (MIke Lazear)
- [ ] LumenRT (MIke Lazear)
- [ ] Context Capture (Josh Lazear)
- [ ] Concept Station (Danny Lazear)
- [ ] Open Roads (Danny Lazear)

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Routing Question Page

Your answer on this page will route you to questions appropriate to your status and skip you over inappropriate or irrelevant questions for your situation.

* 12. By taking this course everyone is an East Los Angeles College student, but that may not be how you primarily view yourself at this time. Which of the following choices BEST describes how you view your current status? (Choose one.)

- ◯ A middle school or high school student taking a community college course
- ◯ A full-time or part-time community college, college or university student
- ◯ A working adult (even if currently unemployed or only working part-time) taking a community college course

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Middle School and High School Student Questions

The following questions ONLY apply to Middle School or High School students. If that is not the BEST description of your current status, scroll down to the bottom of this page without answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

* 13. What grade are you in this fall?

- ◯ 6th grade
- ◯ 7th grade
- ◯ 8th grade
- ◯ 9th grade
- ◯ 10th grade
- ◯ 11th grade
- ◯ 12th grade

14. What mathematics courses have you successfully passed to date? (check each course passed)

- ☐ Algebra
- ☐ Geometry

15. At this time. to what extent would you agree or disagree with the following statements?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
One of my long-term goals is to obtain a Land Surveyor license	◯	◯	◯	◯	◯
I intend to become a professional Land Surveyor	◯	◯	◯	◯	◯
I intend to become a licensed Civil Engineer	◯	◯	◯	◯	◯
I intend to design construction projects	◯	◯	◯	◯	◯
I have other career plans in which Land Surveying can be a useful skill	◯	◯	◯	◯	◯

16. At this time are you interested in the following:

	Yes	Not Sure	No
One-on-One instruction in using software tools like those taught this fall			
Additional courses in Land Surveying taken before leaving high school			
Course in Land Surveying taken after leaving high school			
An internship (paid or unpaid) in Land Surveying?			
A college certificate in Land Surveying			
An Associate degree in land surveying			
A Bachelor's degree in a field related to Land Surveying			

17. At this time do you understand the steps needed to:

	Yes	Not Sure	No
Obtain a Land Surveyor license			
Obtain a Civil Engineering license			

18. Can one be both

	Yes	Not Sure	No
a licensed Land Surveyor AND a licensed Civil Engineer			

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ELAC and Other College Students

This page should only be completed by people who identified themselves as a full-time or part-time community college or other college/university student, whether or not they are also working. If that is not the BEST description of your current status, scroll down to the bottom of this page without

answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

19. What was your status while taking this course?

	Yes	No
I was only a community college student	○	○
I was a 4-year college student taking this ELAC course	○	○
I was only taking this online course this term	○	○
I was taking multiple courses this term	○	○
I was a part-time student this term	○	○
I was a full-time student this term	○	○

20. Were you working while taking this course?

- ○ Yes, part-time
- ○ Yes, full-time
- ○ No

21. Were you an intern (paid or unpaid) or an employee working for pay in Land Surveying or a related field while taking this course?

- ○ Yes
- ○ No

22. Would you be interested in taking additional continuing education (non-degree) courses in fields related to Land Surveying at (check all that apply):

	Yes, In-person (when allowed after the pandemic)	Yes, online	Not sure	No
East Los Angeles College	☐	☐	☐	☐
California State University, Fresno	☐	☐	☐	☐
California State Polytechnic University, Pomona	☐	☐	☐	☐
Oregon Institute of Technology	☐	☐	☐	☐
another university	☐	☐	☐	☐

23. At this time, to what extent would you agree or disagree with the following statements?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
One of my long-term goals is to obtain a Land Surveyor license	○	○	○	○	○
I intend to become a professional Land Surveyor	○	○	○	○	○
I intend to become a licensed Civil Engineer	○	○	○	○	○
I intend to design construction projects	○	○	○	○	○
I have other career plans in which Land Surveying can be a useful skill	○	○	○	○	○

24. At this time are you interested in seeking

	Yes	Not Sure	No
A college certificate in Land Surveying			
An internship (paid or unpaid) in Land Surveying?			
An Associate degree in land surveying			
A Bachelor's degree in a field related to Land Surveying			
A Master's degree in a field related to Land Surveying			
A PhD in a field related to Land Surveying			

25. At this time do you understand the steps needed to:

	Yes	Not Sure	No
Obtain a Land Surveyor license			
Obtain a Civil Engineering license			

26. Can one be both

	Yes	Not Sure	No
a licensed Land Surveyor AND a licensed Civil Engineer			

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Working or Unemployed Adults

The questions on this page are intended for people who primarily consider themselves to be working adults (even if currently only working part-time or unemployed), rather than as students. If that is not the BEST description of your current status, scroll down to the bottom of this page without answering any questions and click on "Prev" to return to the routing page and choose the category that BEST describes your current status.

27. Did you work for pay in any job while taking this course?

- ◯ Yes, part-time
- ◯ Yes, full-time
- ◯ No

28. What is your current job title, if employed (or last job title if not currently employed)?

29. Do you have any current or prior part-time or full-time experience as an employee working for pay or as an intern (paid or unpaid) in Land Surveying or a related field?

- ◯ Yes
- ◯ No

30. At this time, to what extent would you agree or disagree with the following statements?

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Already Achieved
One of my long-term goals is to obtain a Land Surveyor license	◯	◯	◯	◯	◯	◯
I intend to become a professional Land Surveyor	◯	◯	◯	◯	◯	◯
I intend to become a licensed Civil Engineer	◯	◯	◯	◯	◯	◯

31. Would you be interested in taking additional continuing education courses related to land surveying at any of the following (check all that apply)?

- ☐ East Los Angeles College (online or in person)
- ☐ California State Polytechnic University, Pomona (online or in person)
- ☐ California State University, Fresno (online or in person)
- ☐ Oregon Institute of Technology (online)
- ☐ Other university or college (online)

32. At this time are you interested in seeking:

	Yes	Not Sure	No
A college certificate in Land Surveying			
An Associate degree in land surveying			
A Bachelor's degree in a field related to Land Surveying			
A Master's degree in a field related to Land Surveying			
A Ph.D. in a field related to Land Surveying			

33. Last Questions

	Yes	No	Don't Know	Not Applicable
Does your company use Bentley software?				
Do you see yourself using Bentley software in the future?				
Would you be interested in more training in Bentley software?				

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End of Survey

Thank you for your responses!! Click "Done" to exit this page.